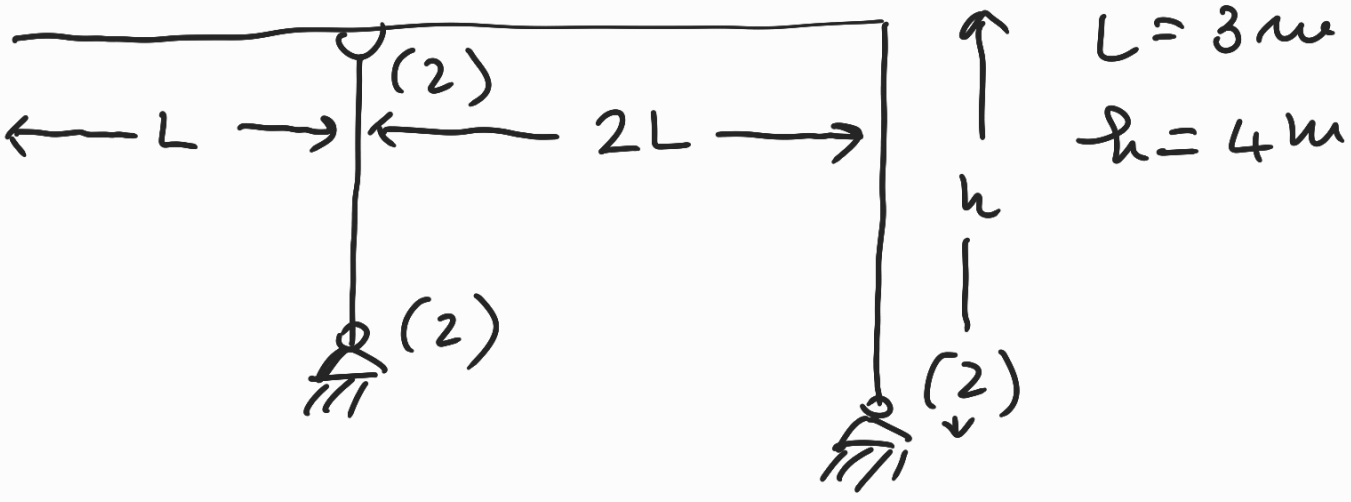
1)

- Verifica se la struttura è isostatica

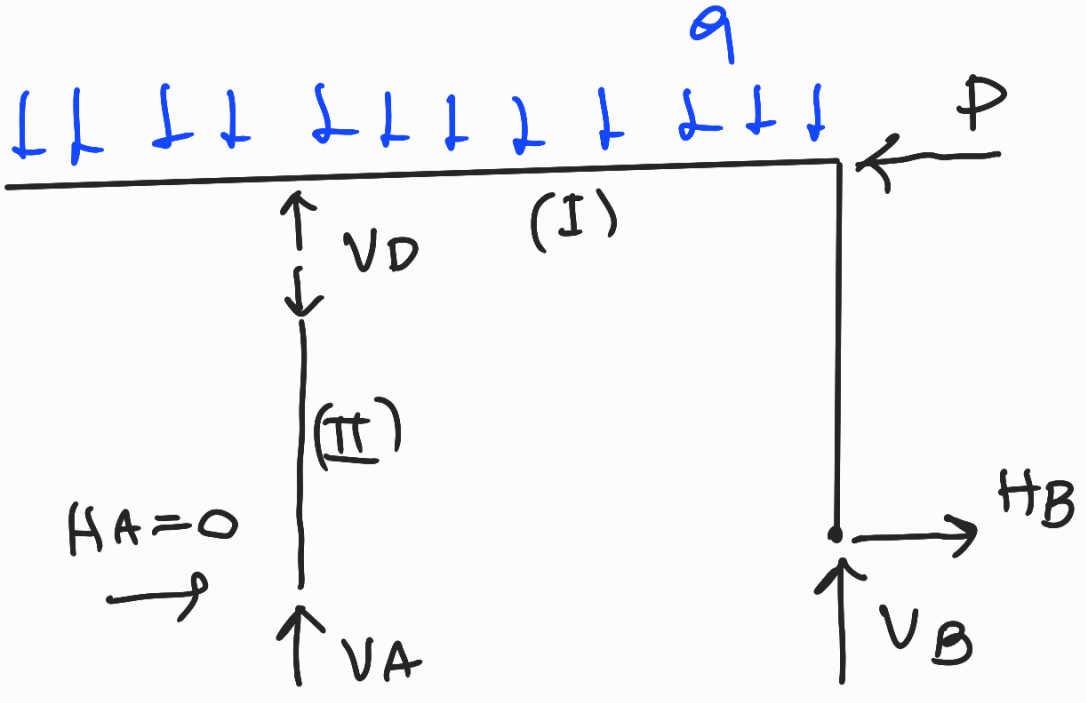
$n_{aste} = 2$

$g = 2 \cdot 3 = 6$ $\quad$ $v = 2+2+2 = 6$

→ isostatica



- Calcolo delle reazioni vincolari



Equilibri delle aste

$$\text{I}\begin{cases} \xrightarrow{+} \quad -P + H_B = 0 \\ \uparrow \quad -q \cdot 3L + V_D + V_B = 0 \\ \circlearrowright_B : \quad V_D \cdot 2L - q\frac{(3L)^2}{2} - Ph = 0 \end{cases}$$

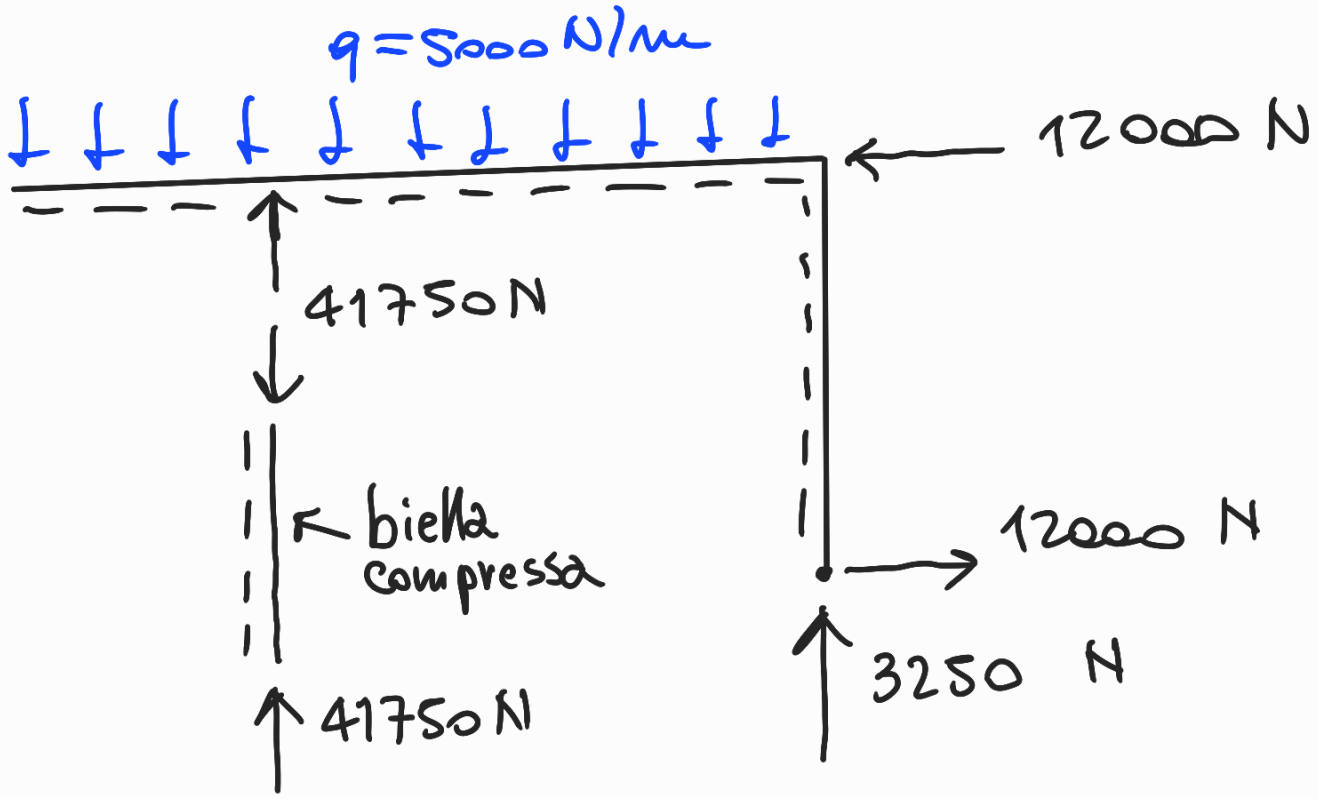
$H_B = P = 12000\ N$

$$V_D = \frac{9}{4}qL + \frac{Ph}{2L} = 41750\ N$$

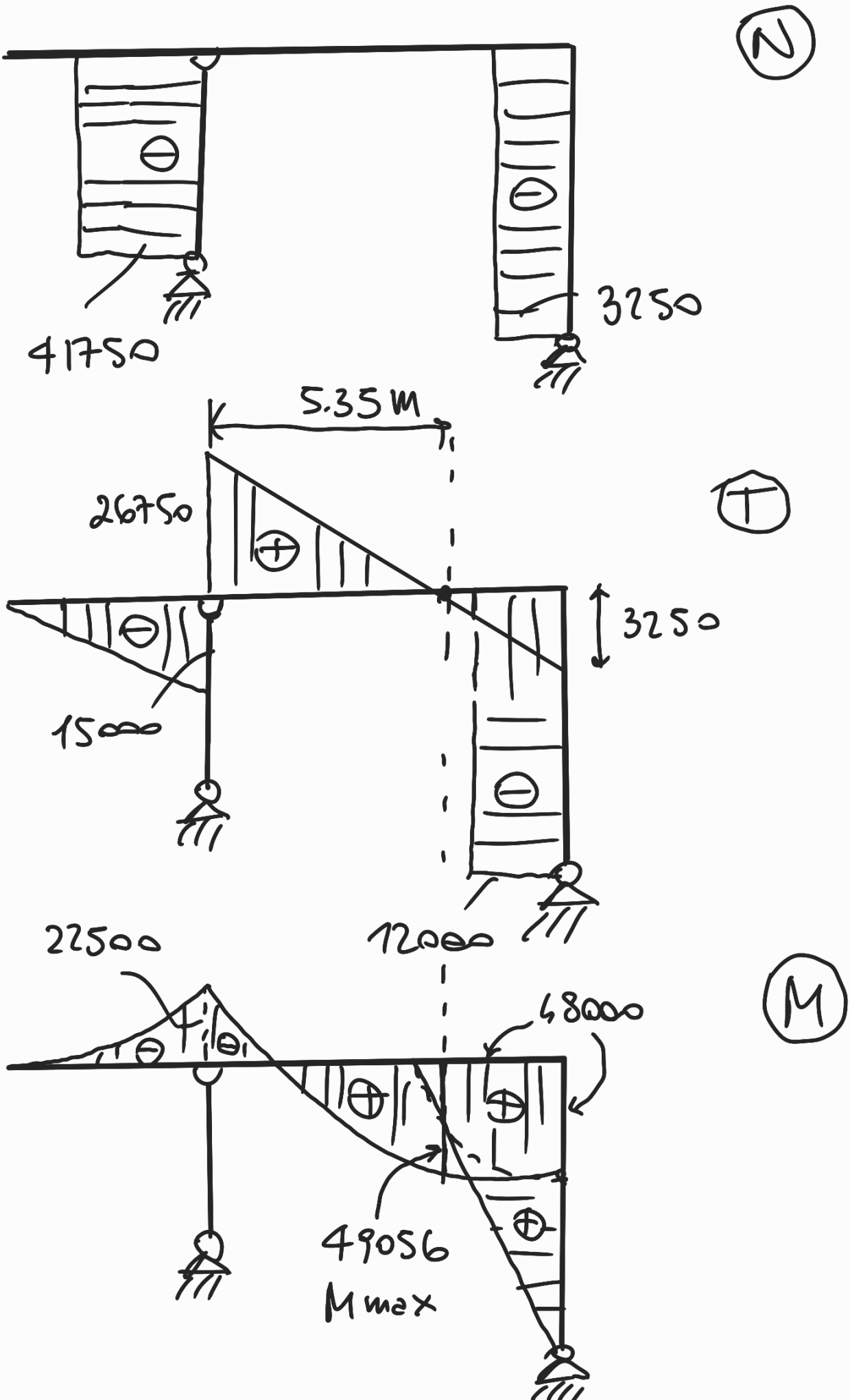
$$V_B = 3qL - V_D = 3250\ N$$

$$\text{II}\begin{cases} H_A = 0 \\ V_A - V_D = 0 \rightarrow V_A = 41750\ N \\ M = 0 \end{cases}$$

Schema finale delle forze:

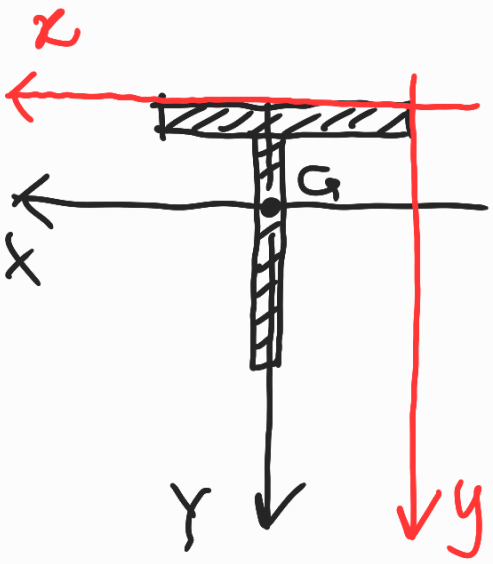


- Diagrammi delle azioni interne



2)

- Caratteristiche geometriche della sezione



$x_G = 0{,}10\ m$

$y_G = \frac{S_x}{A}$

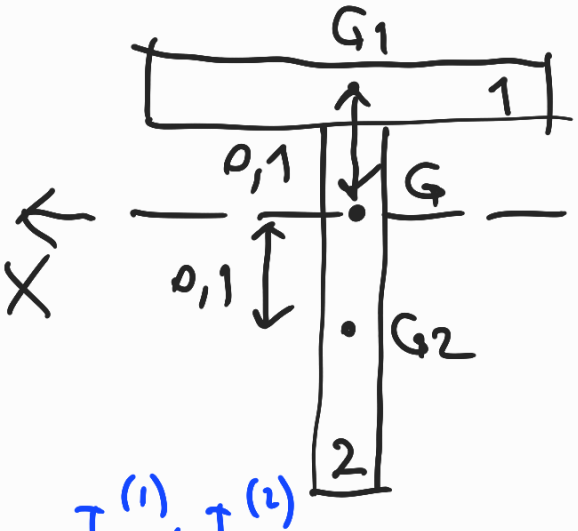
$A = 0{,}2 \cdot 0{,}02 + 0{,}4 \cdot 0{,}01 = 0{,}008\ m^2$

$S_x = 0{,}2 \cdot 0{,}02 \cdot 0{,}01 + 0{,}4 \cdot 0{,}01 \cdot 0.2 = 0{,}000084\ m^3$

$y_G = 0{,}105\ m$

per semplicità metto il baricentro a 0,1 m dalla linea media dell'ala superiore (considero la sezione sottile)

Momento d'inerzia Ix:



trascurabile

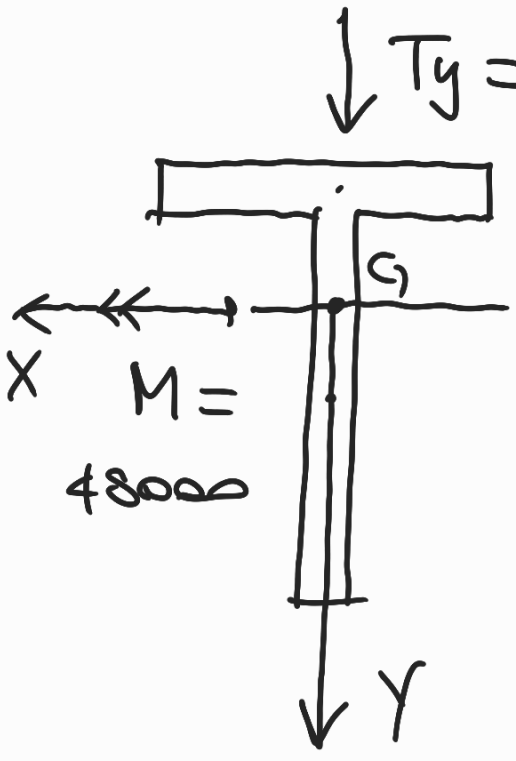
$I_x^{(1)} = \frac{0{,}2 \cdot 0{,}02^3}{12} + 0{,}2 \cdot 0{,}02 \cdot 0{,}1^2 \cong 0{,}000004\ m^4$

$I_x^{(2)} = \frac{0{,}01 \cdot 0{,}4^3}{12} + 0{,}4 \cdot 0{,}01 \cdot 0{,}1^2 = 9{,}33 \cdot 10^{-5}\ m^4$

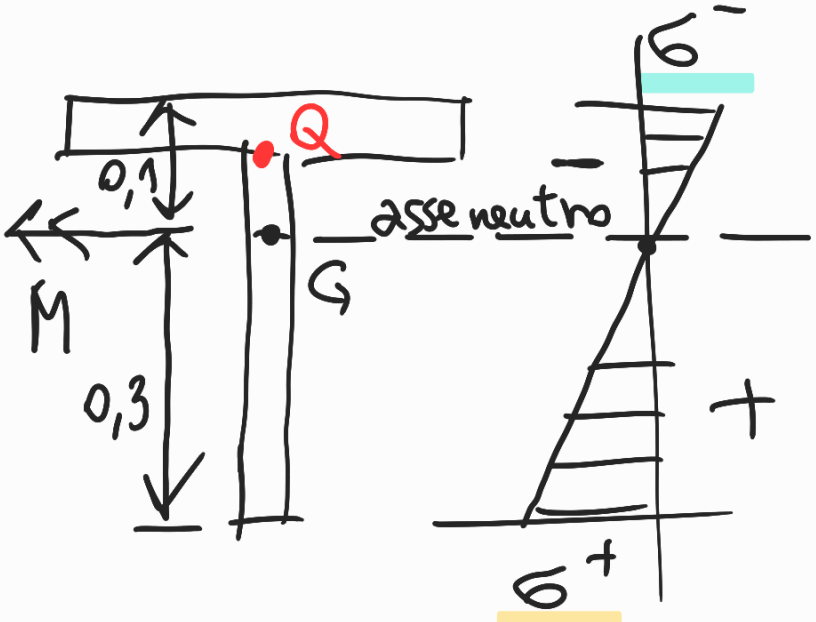
$= I_x^{(1)} + I_x^{(2)}$

$I_x = 1{,}33 \cdot 10^{-4}\ m^4$

- Calcolo delle tensioni nella sez. S



- Flessione retta:



$$\sigma_z^- = \frac{M}{Ix} \cdot (-0,1) =$$

$$= \frac{48000}{1,33 \cdot 10^{-4}} \cdot (-0,1) =$$

$$= -36,1 \text{ MPa}$$

$$\sigma_z^+ = \frac{M}{Ix} (0,3) = 108 \text{ MPa}$$

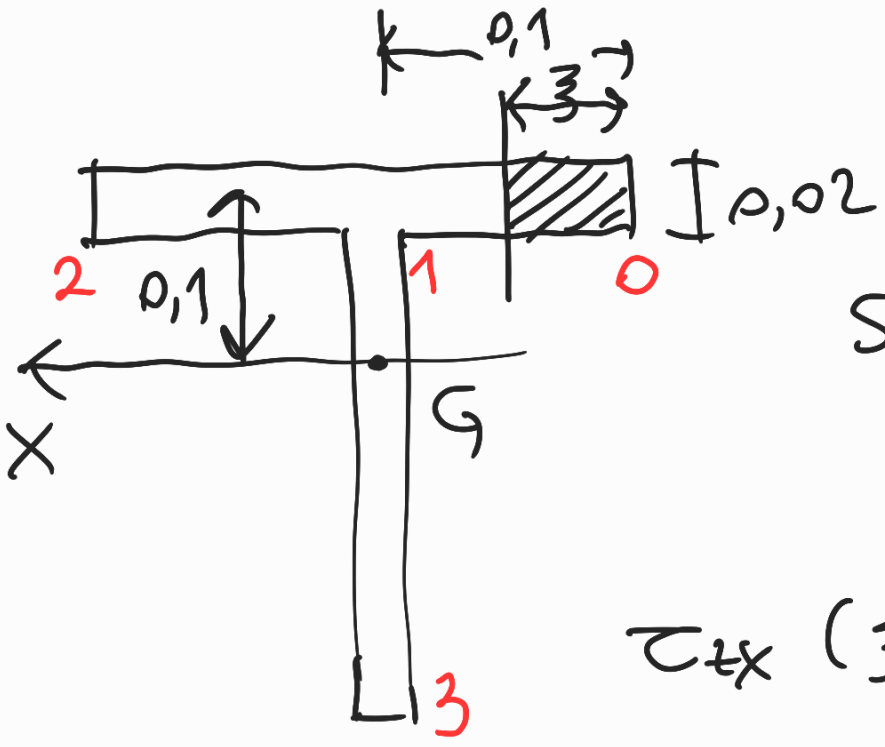
$$\sigma_z(Q) = -28,9 \text{ MPa}$$

- taglio (formula di Jourawski)

$$\tau_{zs}(s) = -\frac{T_y \cdot S_x^*}{I_x \cdot b}$$

Tratto 0-1 e 2-1

$$\tau_{zx}(\zeta) = -\frac{T_y \cdot S_x^*(\zeta)}{I_x \cdot 2t}$$

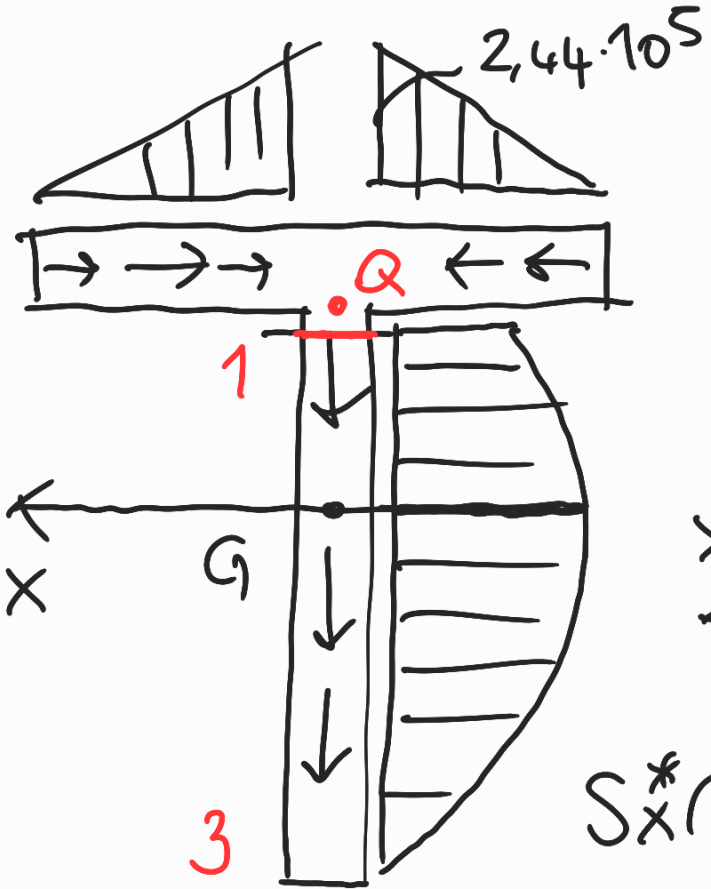


$$S_x^* = -\zeta \cdot 0{,}02 \cdot 0{,}1 =$$

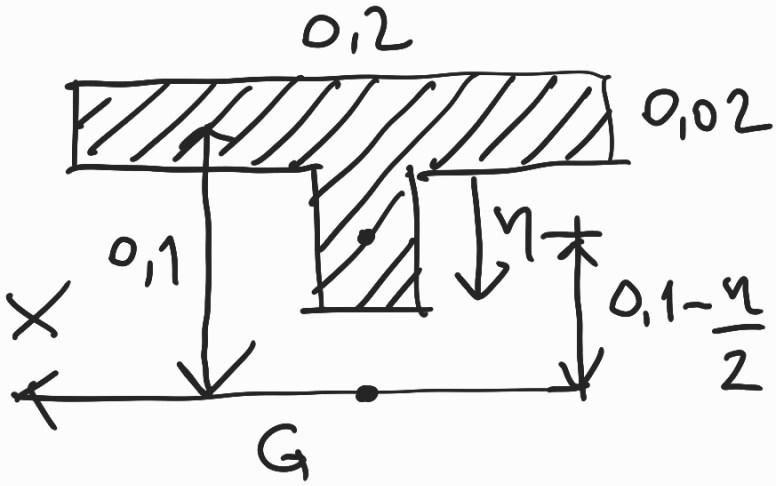
$$= -0{,}002\,\zeta \ m^3$$

$$\tau_{zx}(\zeta) = \frac{+3250 \cdot 0{,}002\,\zeta}{1{,}33 \cdot 10^{-4} \cdot 0{,}02}$$

$\tau_{zx}(\zeta = 0{,}1) = 2{,}44 \cdot 10^5$ Pa uscenti dall'area



Tratto 1-3



$$S_x^*(\eta) = -0{,}2 \cdot 0{,}02 \cdot 0{,}1 +$$

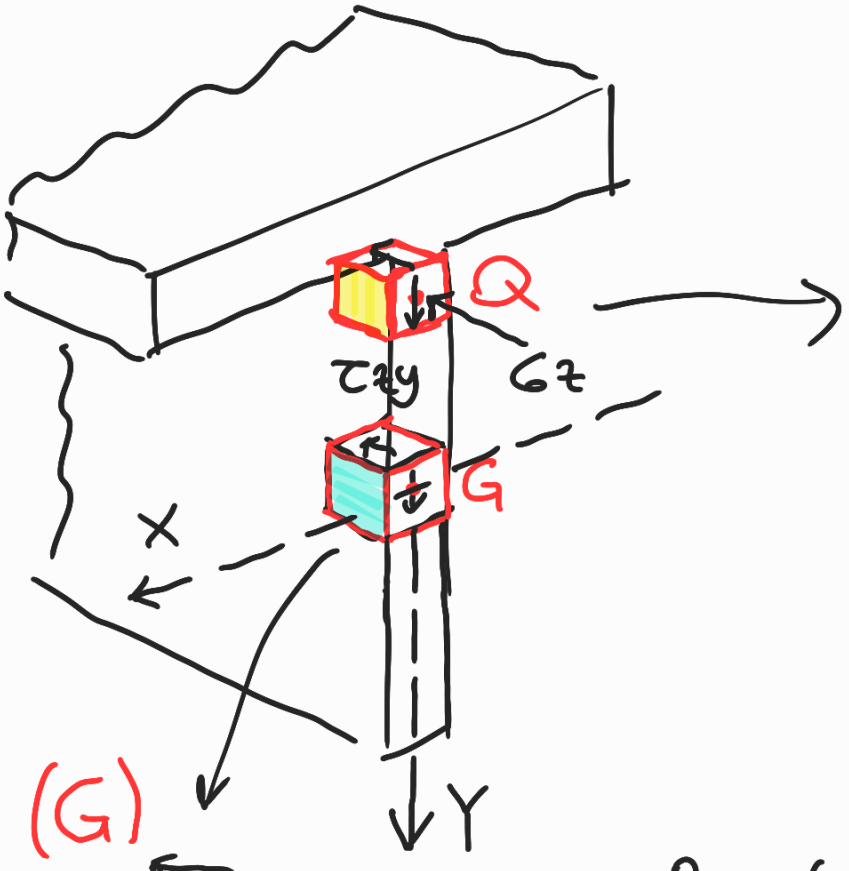
$$-0{,}01 \cdot \eta \cdot \left(0{,}1 - \frac{\eta}{2}\right) =$$

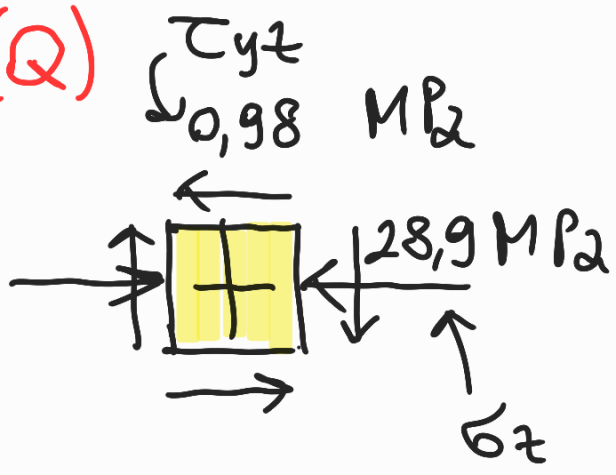
$$S_x^*(\eta) = -0{,}0004 - 0{,}001\eta + 0{,}005\eta^2$$

$$\tau_{zy}(\eta = 0{,}1) = \frac{3250 \cdot 0{,}00045}{1{,}33 \cdot 10^{-4} \cdot 0{,}01} = 1{,}10 \cdot 10^6 \text{ Pa}$$

$$\tau_{zy}(\eta = 0) = \frac{3250 \cdot 0{,}0004}{1{,}33 \cdot 10^{-4} \cdot 0{,}01} = 9{,}77 \cdot 10^5 \text{ Pa}$$

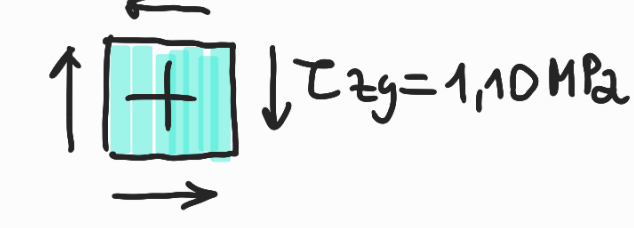
- Verifica di resistenza nei punti Q e G + Mohr





$P_x = (-28{,}9 ; 0{,}98)$

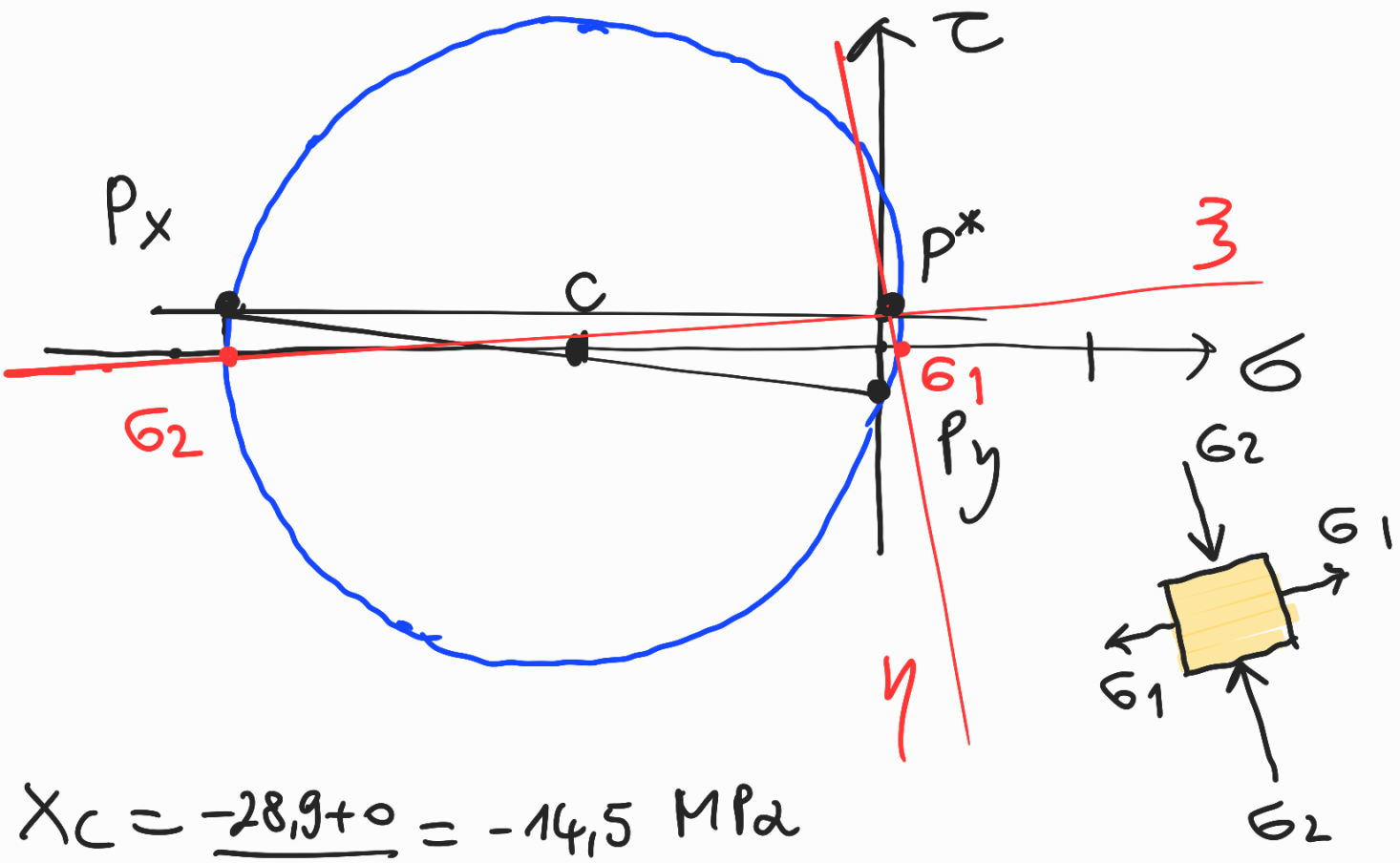
$P_y = (0 ; -0{,}98)$



$P_x = (0 ; 1{,}10)$

$P_y = (0 ; -1{,}10)$

Cerchio di Mohr nel punto Q



$$X_C = \frac{-28,9+0}{2} = -14,5 \text{ MPa}$$

$$R = \sqrt{14,5^2 + 0,98^2} = 14,53 \text{ MPa}$$

$$\sigma_1 = X_C + R = 0,03 \text{ MPa}$$

$$\sigma_2 = X_C - R = -29,03 \text{ MPa}$$

tens. amm.

$$\begin{cases} \sigma_t = 1 \text{ MPa} \\ \sigma_c = 10 \text{ MPa} \end{cases}$$

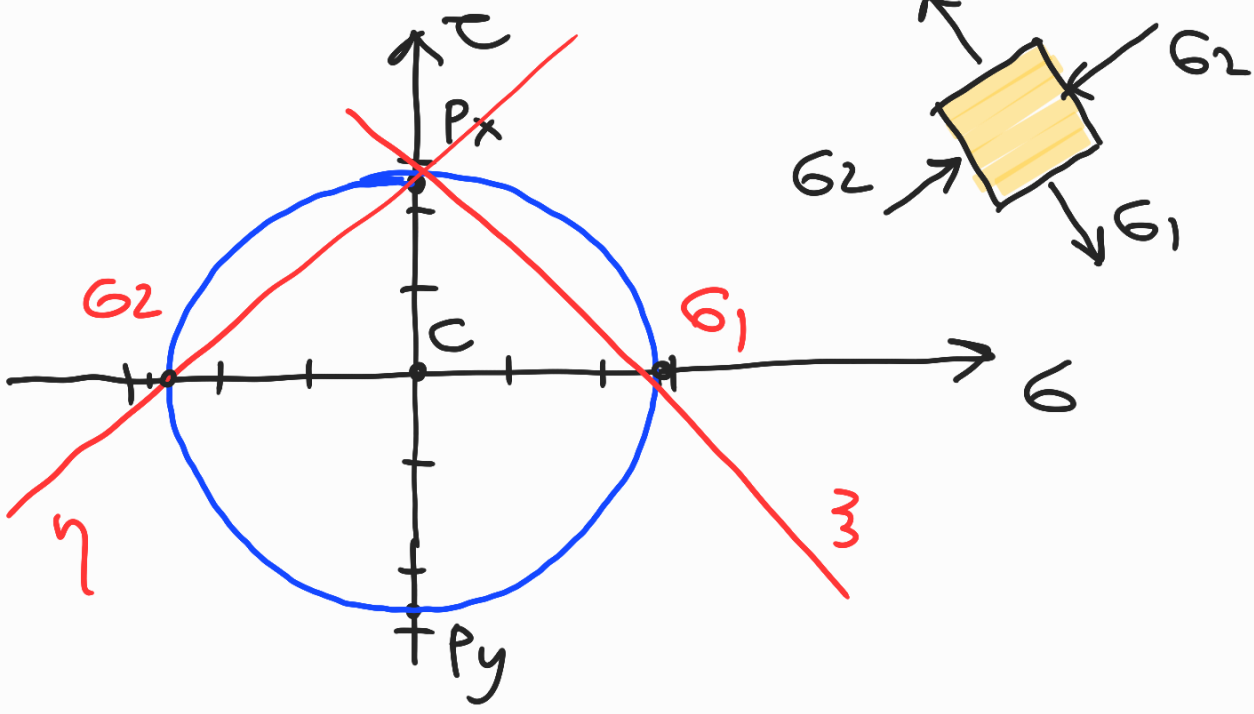
Criterio di Rankine:

$$|\sigma_1| \leq \sigma_t \qquad |\sigma_2| \leq \sigma_c$$

Trazione; $\sigma_1 = 0,03 < 1$ MPa verificato

Compressione; $|\sigma_2| = 29,03 > 10$ MPa non verificato

Cerchio di Mohr nel punto G



$\sigma_1 = 1{,}10$ MPa

$\sigma_2 = -1{,}10$ MPa

Verifica con criterio di Rankine

$|\sigma_1| \leq \sigma_t$ $\qquad$ $|\sigma_2| \leq \sigma_c$

frazione: $\sigma_1 = 1{,}10 > 1$ MPa non verificato

compress.: $|\sigma_2| = 1{,}10 < 10$ MPa verificato