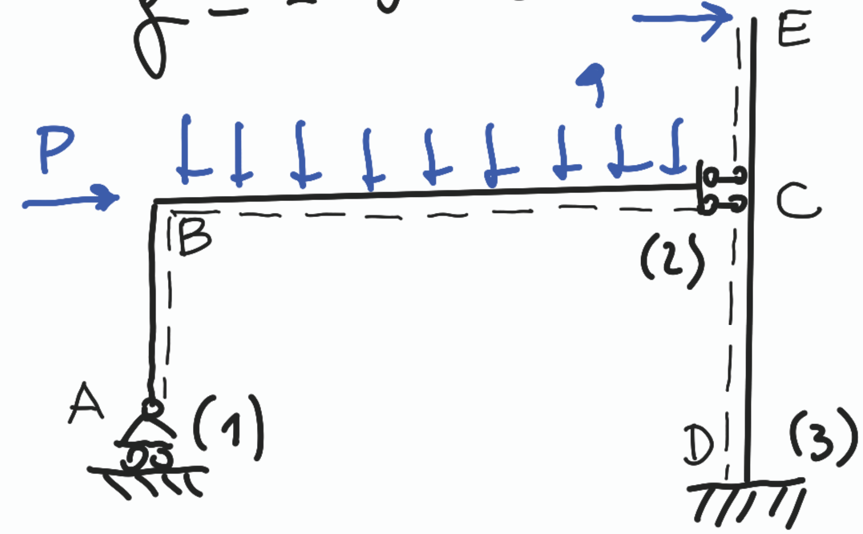
1) • Verifica che la struttura è isostatica

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

$g = 2 \cdot 3 = 6$ → isostatica

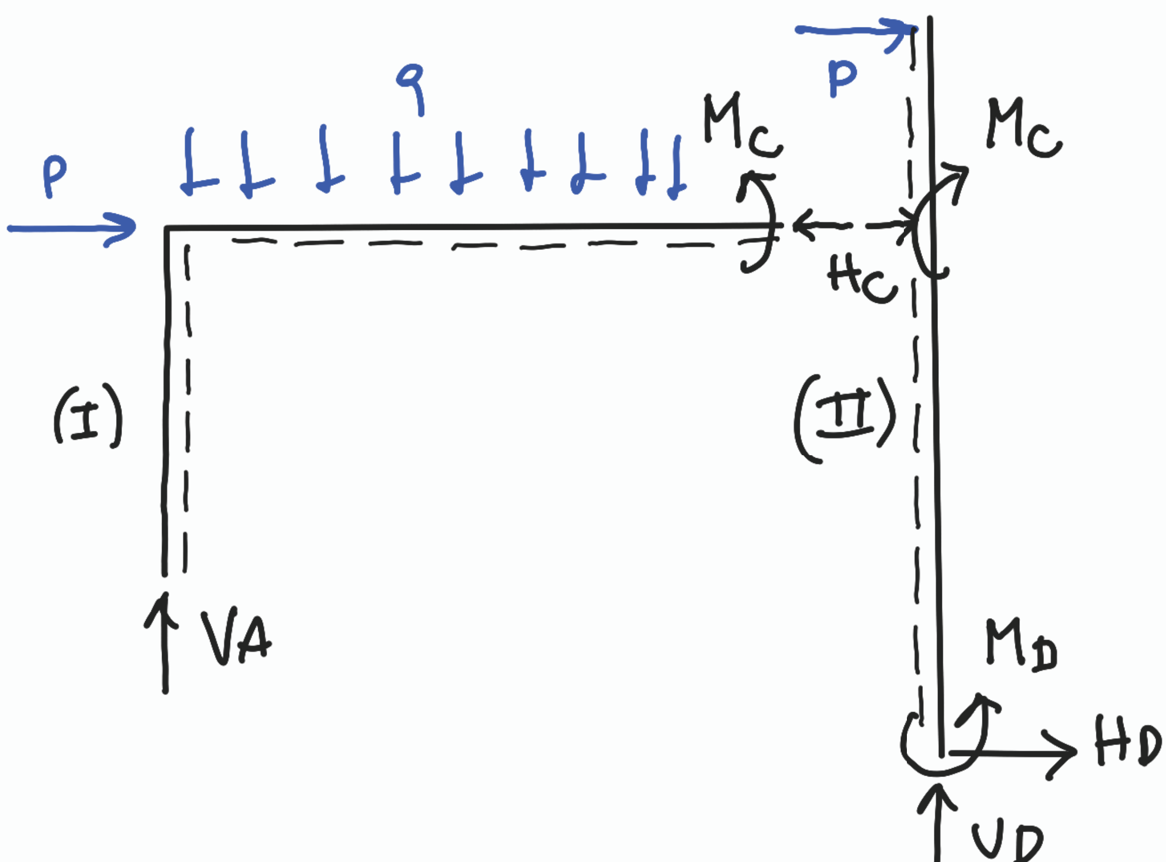


$L = 5\ m$

$q = 6000\ N/m$

$P = 5000\ N$

• Calcolo delle reazioni vincolari



Equilibri delle aste:

$$
\mathrm{I}\begin{cases}
\xrightarrow{+} & P - H_C = 0 \\
\uparrow & V_A - q\cdot 2L = 0 \\
\curvearrowright_A & PL + q2L\,L - M_C - H_C\cdot L = 0
\end{cases}
$$

$H_C = P = 5000\ \mathrm{N}$

$V_A = 2qL = 60'000\ \mathrm{N}$

$$
\mathrm{II}\begin{cases}
\xrightarrow{+} & P + H_C + H_D = 0 \\
\uparrow & V_D = 0 \\
\curvearrowright_D & -M_D + M_C + H_C\cdot \frac{3}{2}L + P\cdot\left(L + \frac{3}{2}L\right) = 0
\end{cases}
$$

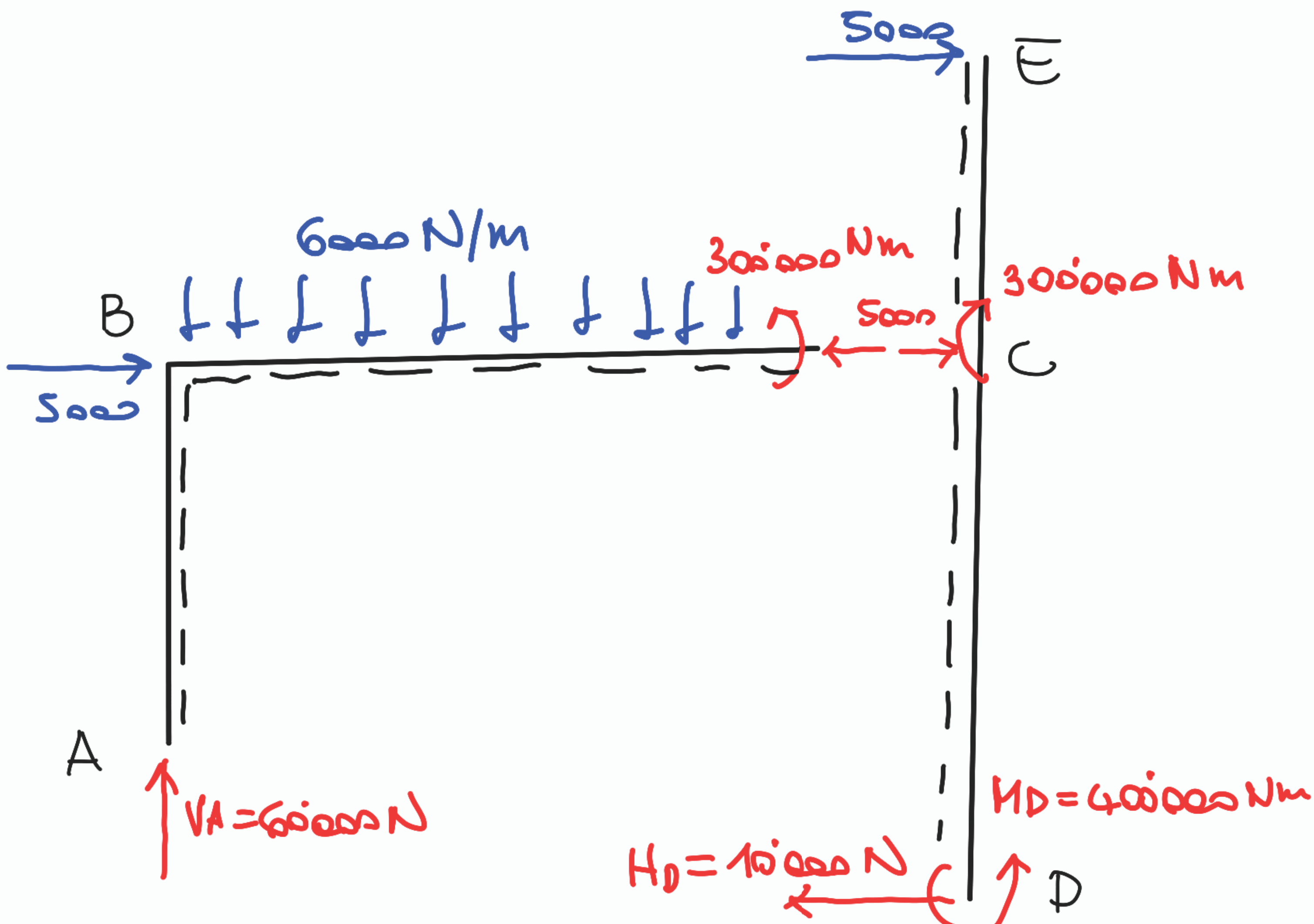
$H_D = -P - H_C = -10'000\ \mathrm{N}$

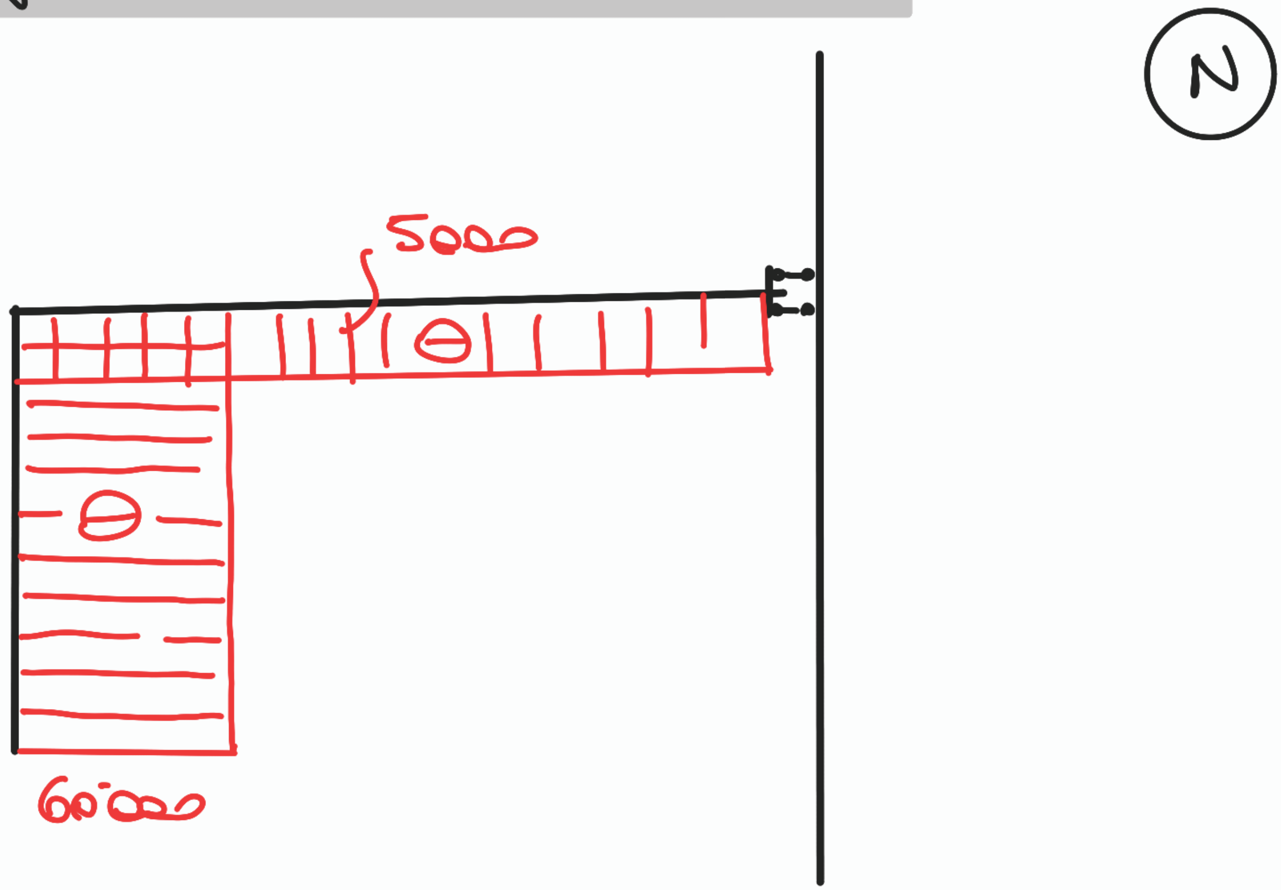
$V_D = 0$

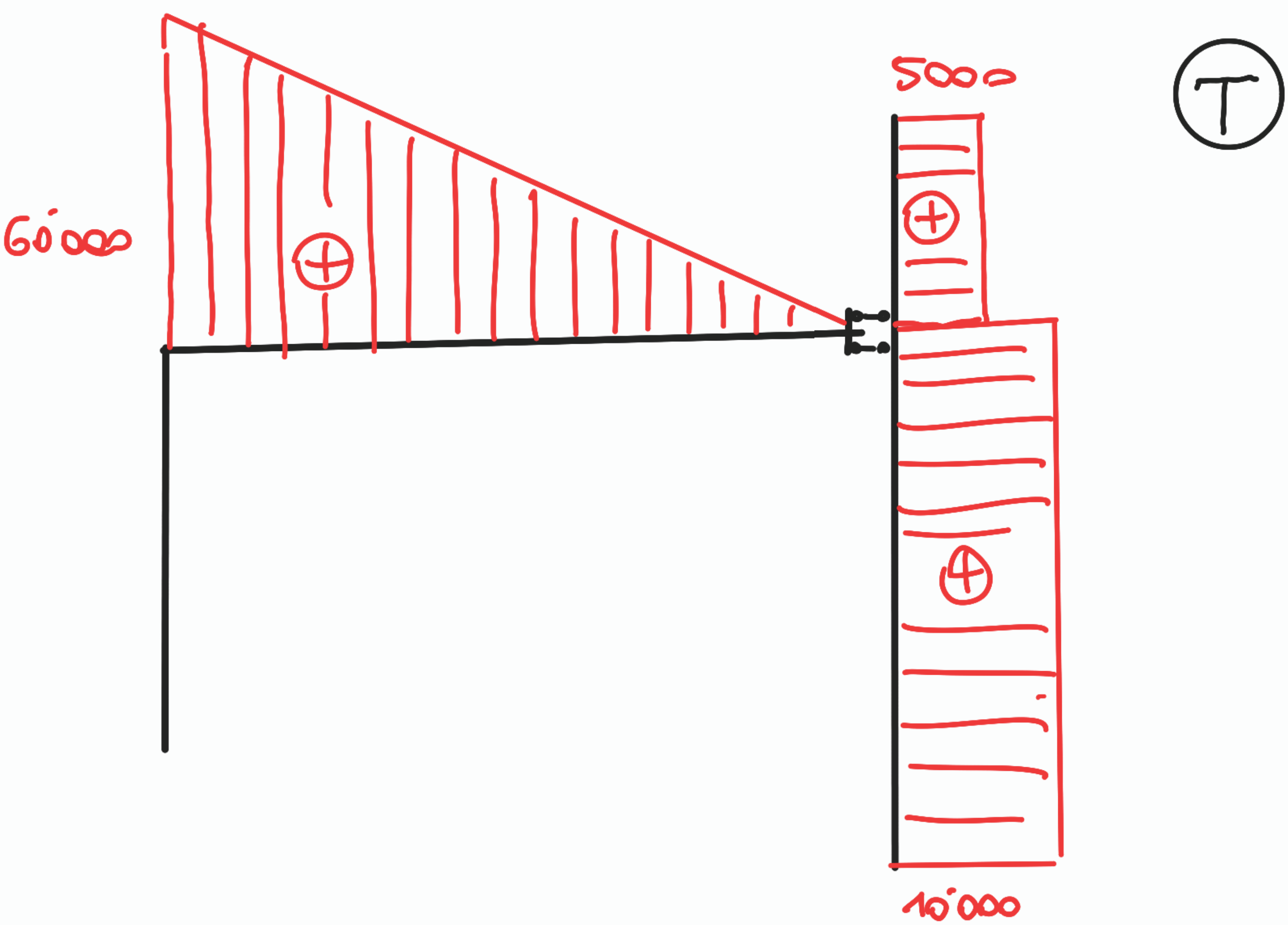
$M_C = 300'000\ \mathrm{Nm}$

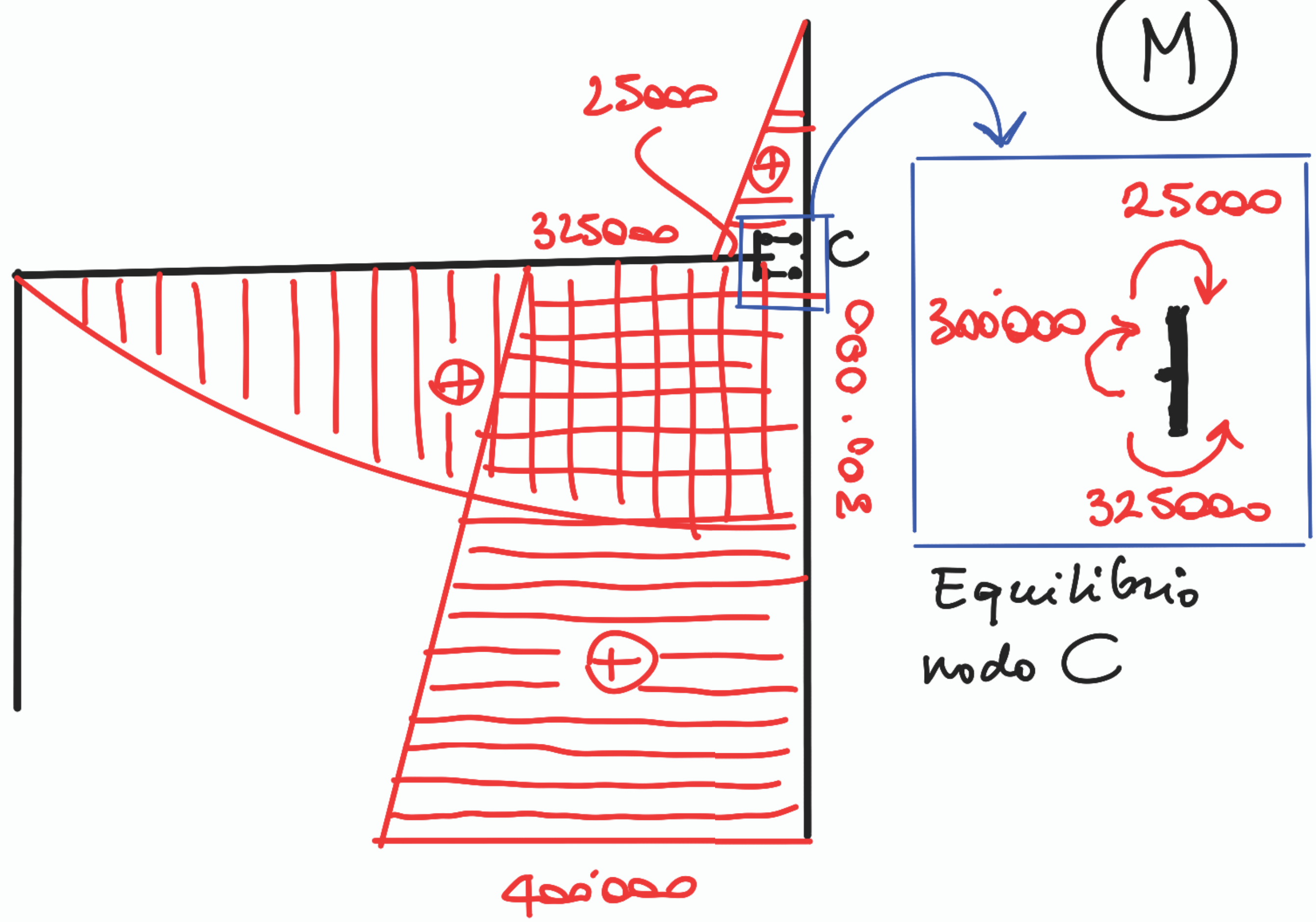
$M_D = 400'000\ \mathrm{Nm}$

Schema finale delle forze attive e reattive



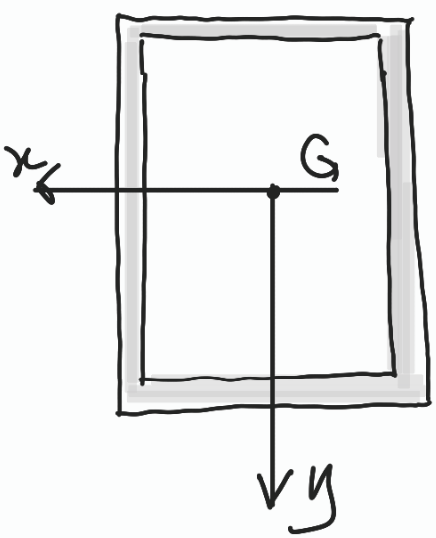

N
5000
60'000


T
5000
60'000
10'000



2)

- Caratteristiche geometriche della sezione



$$A = (0{,}2\cdot 2 + 0{,}2)\cdot 2\cdot 0{,}01 = 0{,}012\ m^2$$

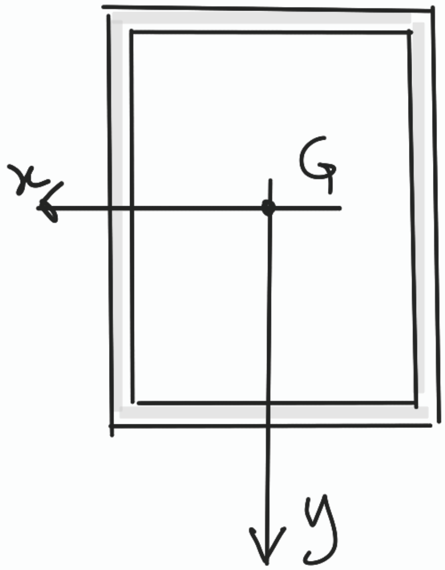
$$I_x = 2\cdot\frac{0{,}2\cdot 0{,}01^3}{12} + \left(0{,}2\cdot 0{,}01\cdot 0{,}2^2\right)\cdot 2$$

$$+ 2\cdot\frac{0{,}01\cdot 0{,}4^3}{12} = 3{,}33\cdot 10^{-8} + 1{,}6\cdot 10^{-4}$$

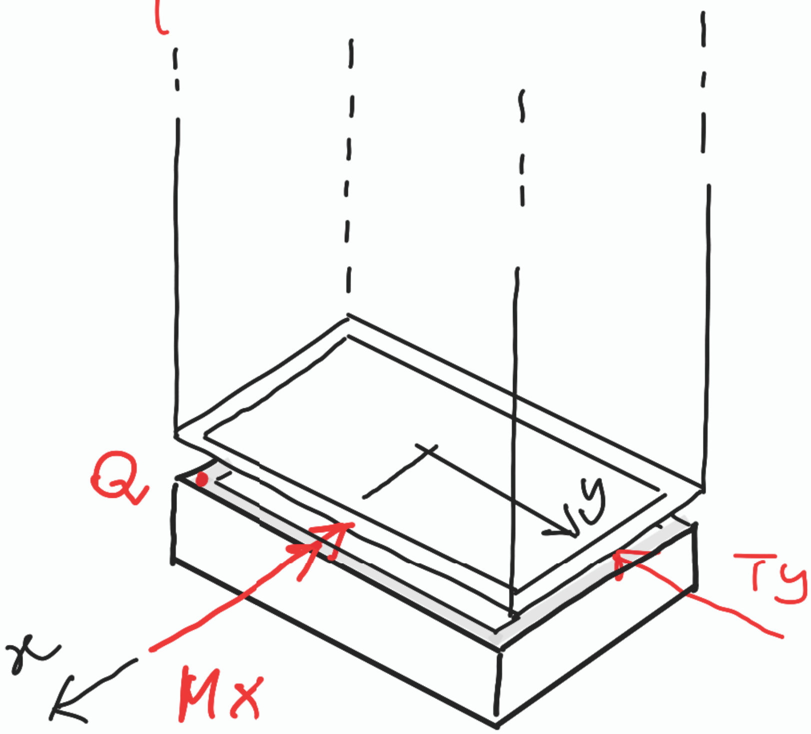
$$+ 1{,}06\cdot 10^{-4} = 2{,}667\cdot 10^{-4}\ m^4$$

Il momento di inerzia I_y non è

- Calcolo delle Tensioni nella sez. S-S



$$\begin{cases} N = 0 \ \mathrm{N} \\ T = 10'000 \ \mathrm{N} \\ M_x = 400'000 \ \mathrm{Nm} \end{cases}$$

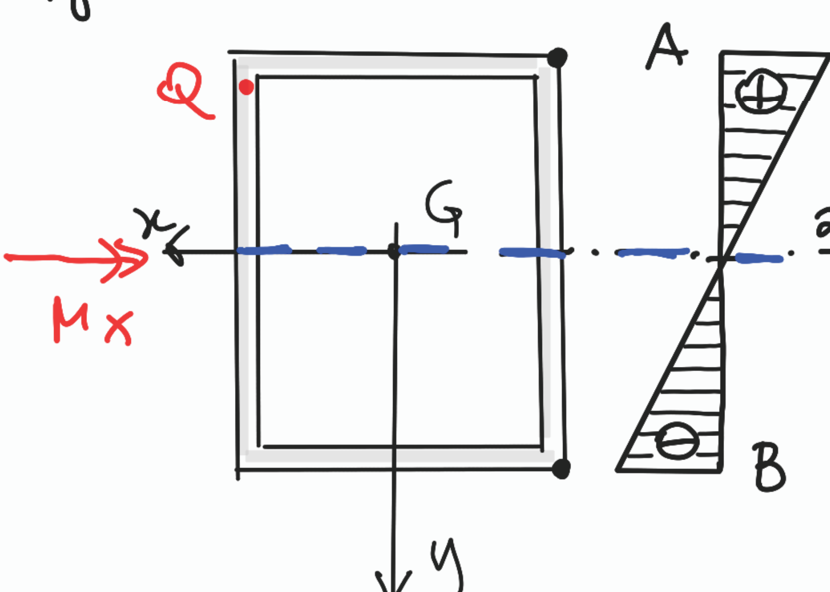


Sez. S-S

(Base del pilastro CD)

- **Flessione retta** (f. di Navier)

(guardo la sez d'incastro S dall'alto)



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

asse neutro $y = 0$

$$\sigma_z(A) = -\frac{400'000}{2.667 \cdot 10^{-4}} \cdot (-0{,}2)$$

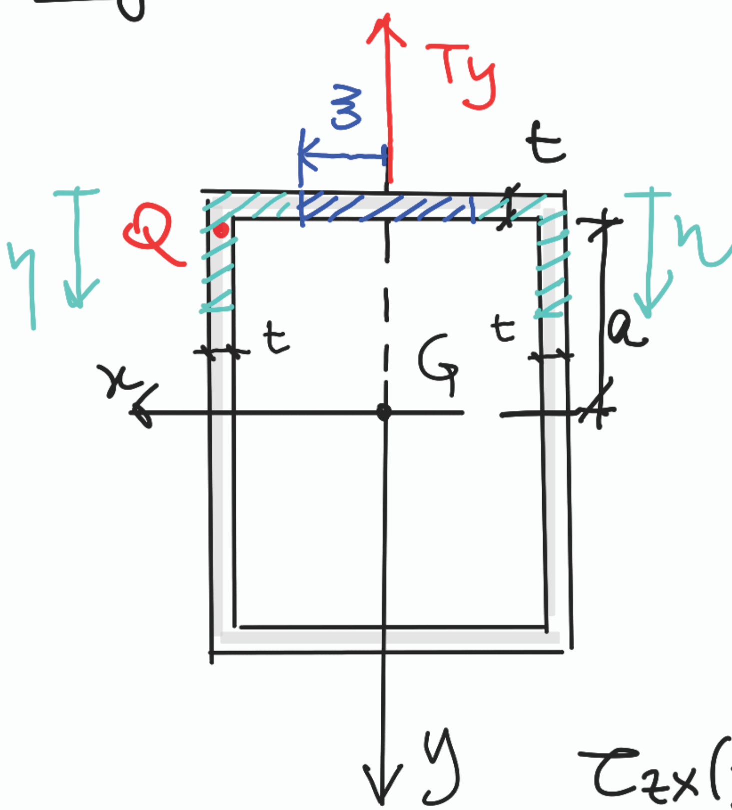
$$= 2{,}99 \cdot 10^{8} \ \mathrm{Pa}$$

$\sigma_z(B) = -2,99 \cdot 10^8$ Pa

$\sigma_z(Q) \cong +299$ MPa

(il punto Q ha circa la stessa coord. y del punto A)

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



$$\tau_{zx}(\xi) = -\frac{\overset{\text{negativo}}{\overset{\uparrow}{T_y}}(2\,\xi\, t \cdot a)}{I_x \cdot 2\, t}$$

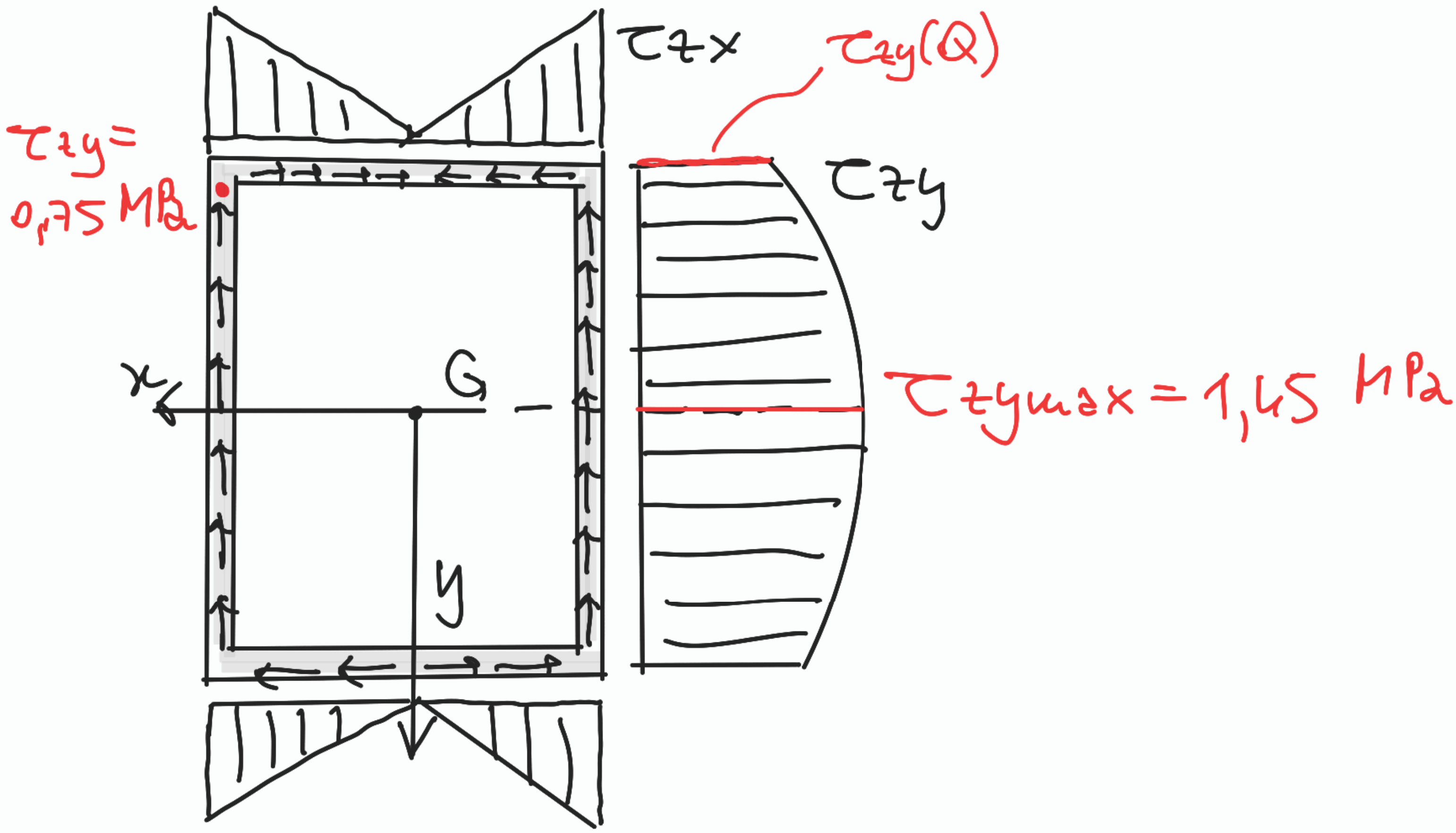
$$\tau_{zx}(\xi = 0,1) = \frac{-10000\,(2 \cdot 0,1 \cdot 0,01 \cdot 0,2)}{2.667 \cdot 10^{-4} \cdot 2 \cdot 0,01}$$

$$= -7,50 \cdot 10^5 \text{ Pa}$$

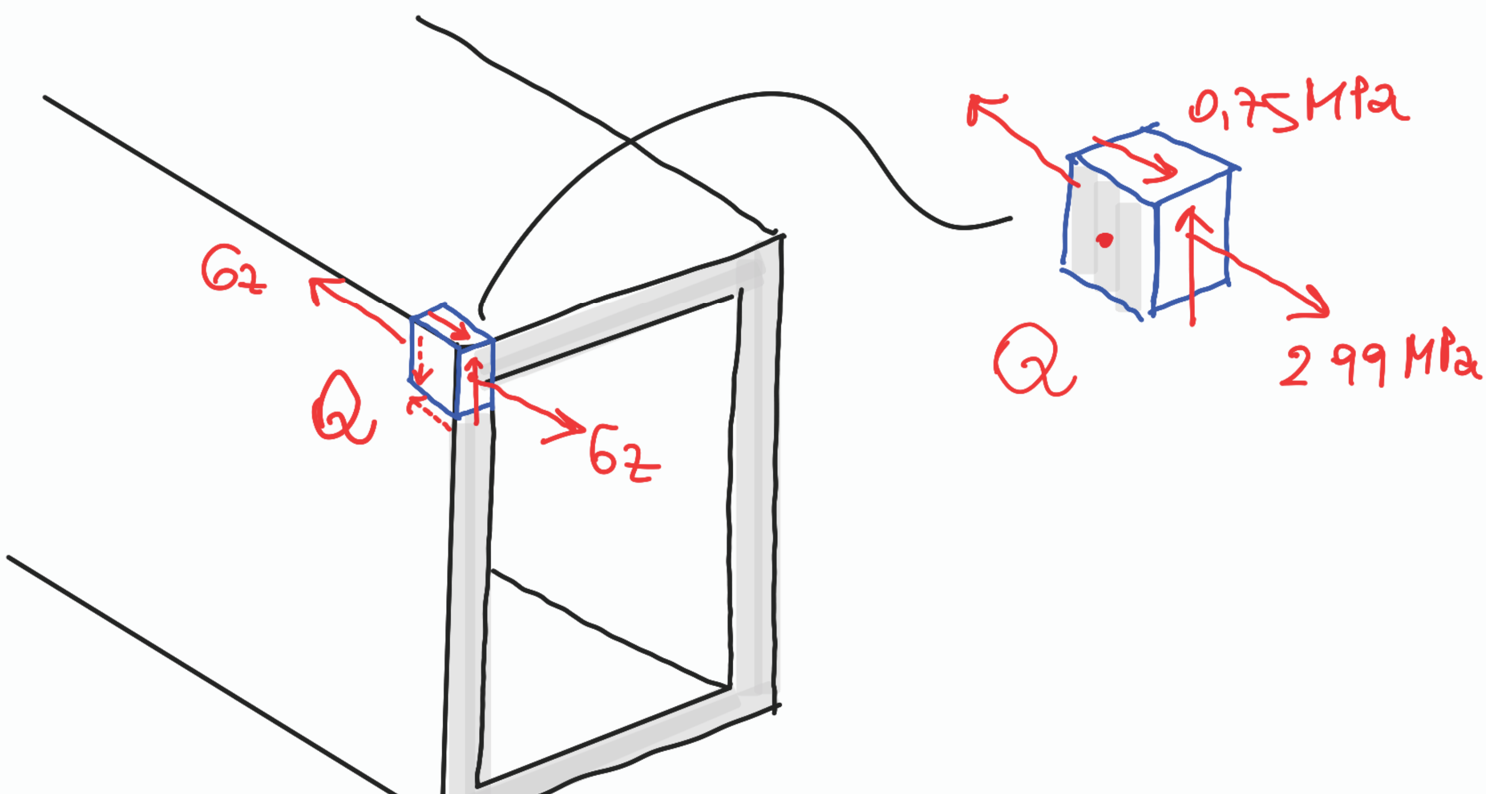
$\tau_{zx}(\xi = 0,1) = \tau_{zy}(Q) = 7,50 \cdot 10^5$ Pa entrante

$$\tau_{zy}(\eta) = +\frac{10000}{I_x \cdot 2t} \cdot \left[-0,2 \cdot 0,01 \cdot 0,2 - 2 \cdot 0,01 \cdot \eta \left(0,1 - \frac{\eta}{2}\right)\right]$$

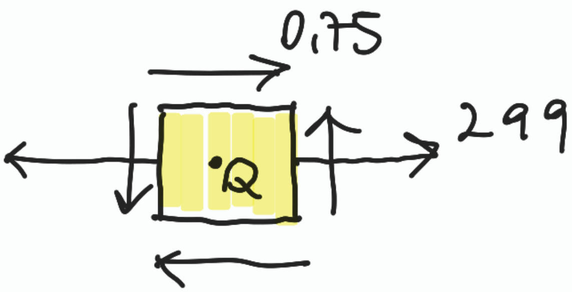
$$\tau_{zy}(y=0{,}2) = \tau_{zy\,max} = \frac{\text{[illegible]}}{2.667\cdot 10^{-4}\cdot 2\cdot 0{,}01} = 1{,}45\cdot 10^{6}\ \text{Pa}$$



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



Punto Q (MPa)

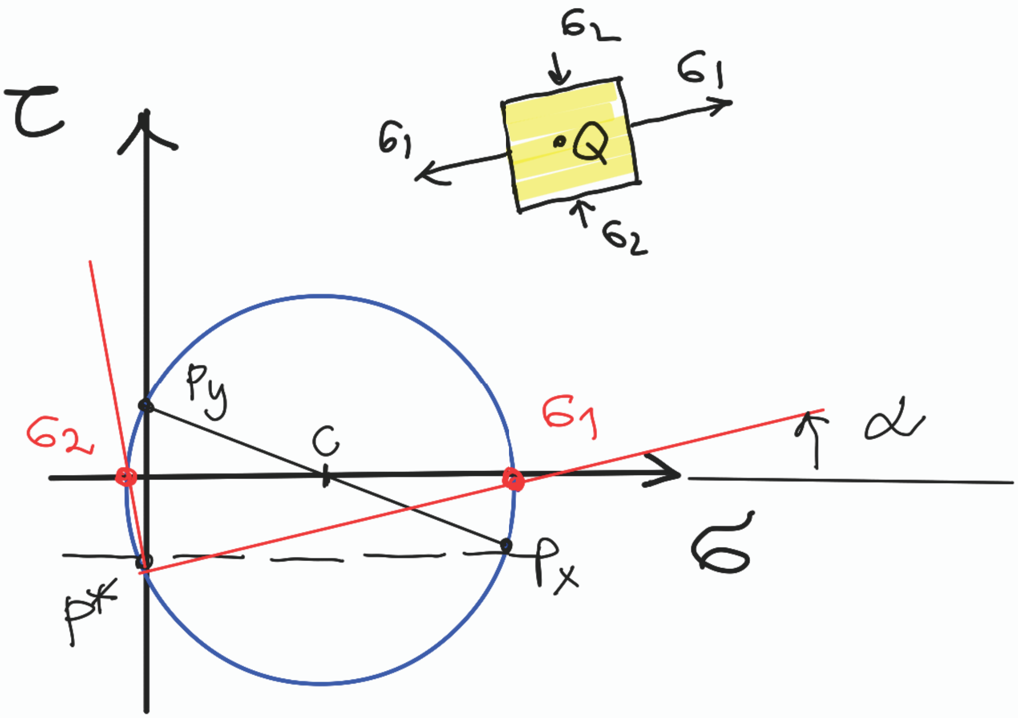


$P_x = (299 \; ; -0{,}75)$

$P_y = (0 \; ; \; 0{,}75)$

Piano di Mohr

(disegno non in scala)



$x_c = +149{,}5 \text{ MPa} \qquad r = 149{,}51 \text{ MPa}$

$$\begin{cases} \sigma_1 = x_c + r = 299{,}01 \text{ MPa} \\ \sigma_2 = x_c - r = -0{,}01 \text{ MPa} \end{cases}$$

$$\alpha = \frac{1}{2} \operatorname{arctg} \frac{\tau_{zy}}{\frac{\sigma_x - \sigma_y}{2}} = +0{,}144^\circ \text{ antiorario}$$

- Verifica di resistenza nel punto Q

Criterio di Von Mises

$$\sigma_{eq.VM} = \sqrt{\sigma^2 + 3\tau^2}$$

$$\sigma_{eq\,VM} = \sqrt{299^2 + 3 \cdot 0{,}75^2} = 299{,}01 \text{ MPa} < 300 \text{ MPa}$$

verificato