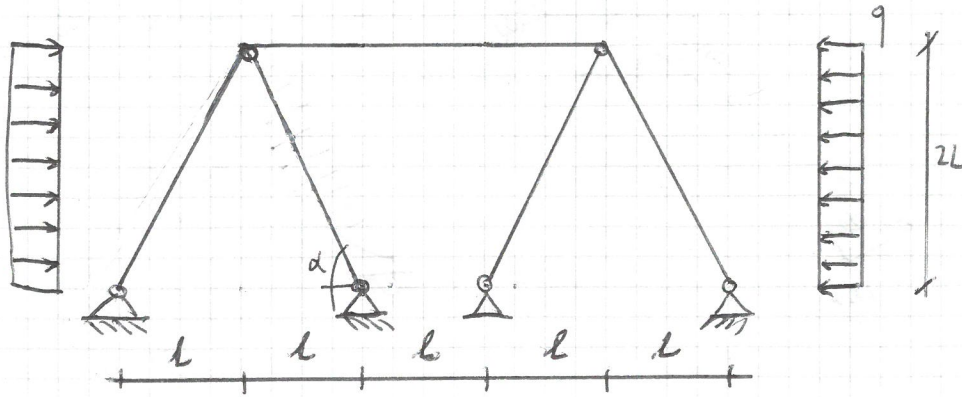


TOTALE

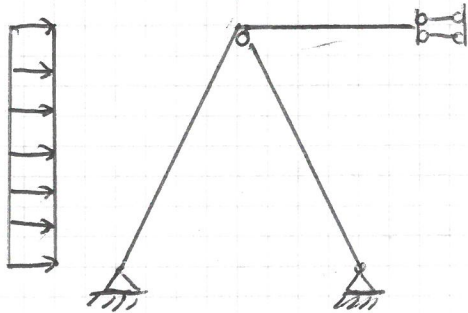


$$q = 3000 \text{ N/m}$$

$$L = 3 \text{ m}$$

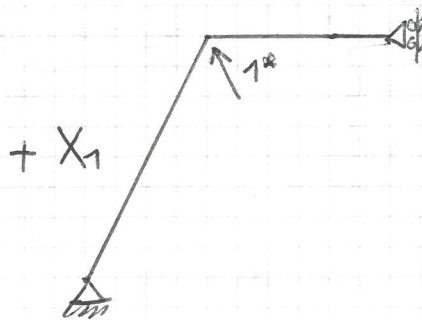
$$\alpha = 63.43^\circ$$

2 volte iperstatica

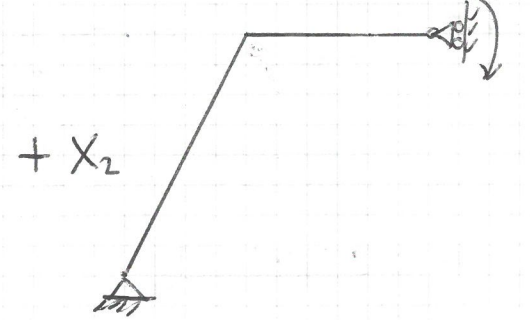


SISTEMA 0

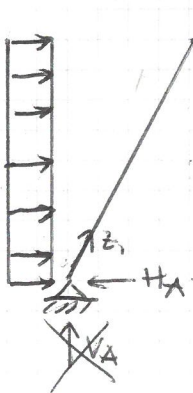
SISTEMA 1



SISTEMA 2



SISTEMA 0



$$A \rightarrow 2qL \cdot L + H_G \cdot 2L = 0 \rightarrow H_G = qL = 9000 \text{ N}$$

$$H_A = H_G$$

$$V_A = 0$$

$$z_1 \rightarrow N(z_1) = H_A \cos \alpha - q \sin \alpha \cos \alpha z$$

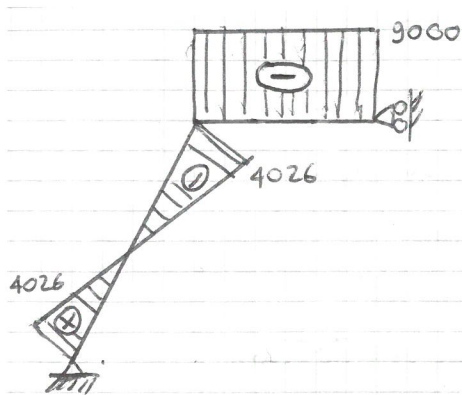
$$T(z_1) = H_A \sin \alpha - q \sin^2 \alpha z$$

$$M(z_1) = H_A \sin \alpha z - q \sin^2 \alpha \frac{z^2}{2}$$

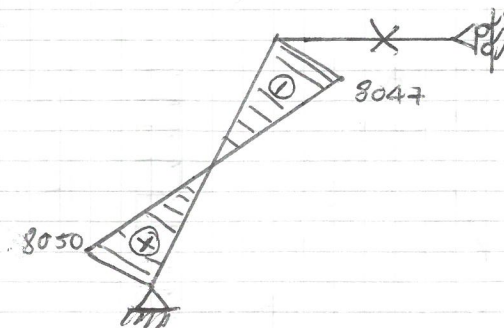
$$z_2 \rightarrow N(z_2) = -qL = -9000 \text{ N}$$

$$T(z_2) = 0$$

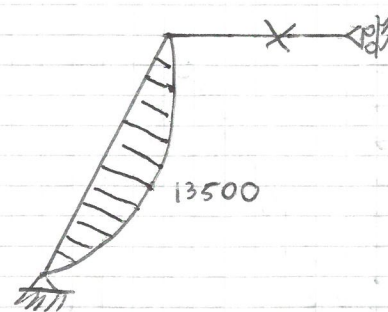
$$M(z_2) = 0$$



N[N]

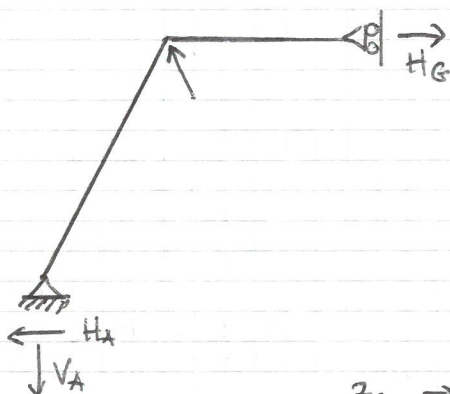


T[N]



M[Nm]

SISTEMA 1



$$l_x = 1 \cdot \cos \alpha = 0.45$$

$$l_y = 1 \cdot \sin \alpha = 0.89$$

$$\sum \rightarrow 1 \cdot \cos \alpha \cdot 2l + 1 \cdot \sin \alpha \cdot l + H_G \cdot 2l = 0$$

$$H_G = \frac{1}{2} (2 \cos \alpha + \sin \alpha) = 0.89$$

$$V_A = 0.89$$

$$H_A = H_G - l_y = 0.45$$

$$z_1 \rightarrow N(z_1) = 1^*$$

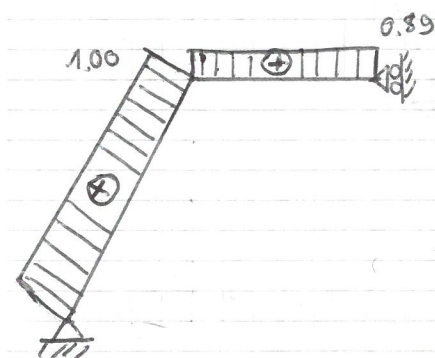
$$T(z_1) = 0$$

$$M(z_1) = 0$$

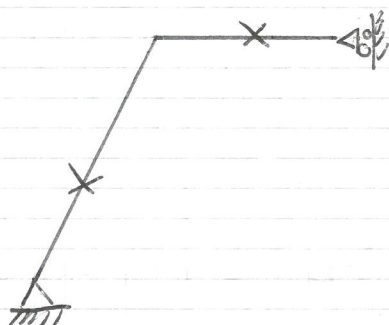
$$z_2 \rightarrow N(z_2) = 0.89$$

$$T(z_2) = 0$$

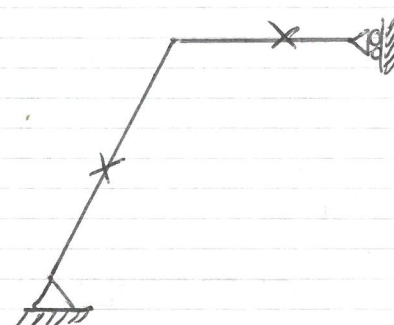
$$M(z_2) = 0$$



N[N]

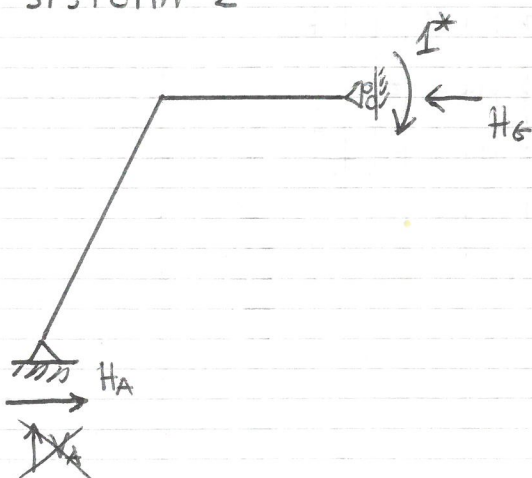


T[N]



M[N·m]

SISTEMA 2



$$\sum \rightarrow -1^* + H_G \cdot 2l = 0$$

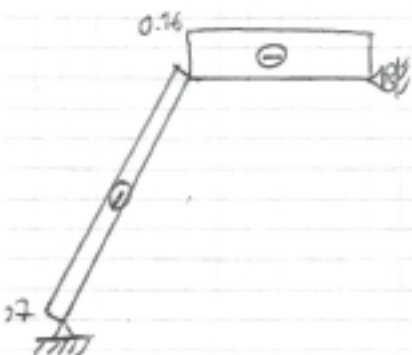
$$H_G = \frac{1}{2l} = \frac{1}{6}$$

$$H_G = H_A$$

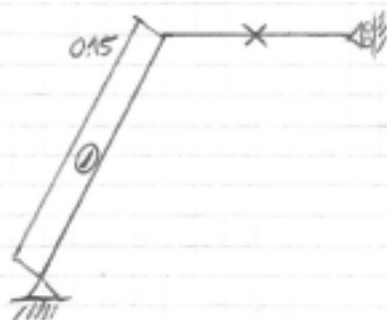
$$z_1 \rightarrow N(z_1) = -\frac{1}{6} \cos \alpha = -0.07 \text{ N}$$

$$T(z_1) = -\frac{1}{6} \sin \alpha = -0.15 \text{ N}$$

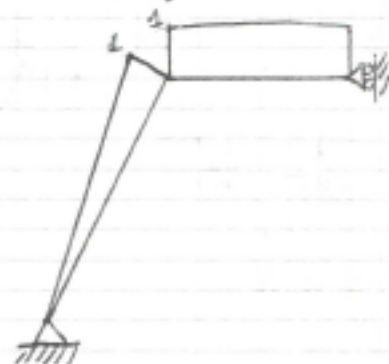
$$M(z_1) = -\frac{1}{6} \sin \alpha z$$



$N [N]$



$T [N]$



$M [N \cdot m]$

$$\eta_{10} = 0$$

$$\eta_{20} = \frac{1}{EJ} \int_0^{(3/\cos \alpha)} \left(-\frac{1}{6} \cos \alpha z \right) \left(H_A \cos \alpha z - q \sin^2 \alpha \frac{z^2}{2} \right) dz = -\frac{30185}{EJ}$$

$$\eta_{11} = 0$$

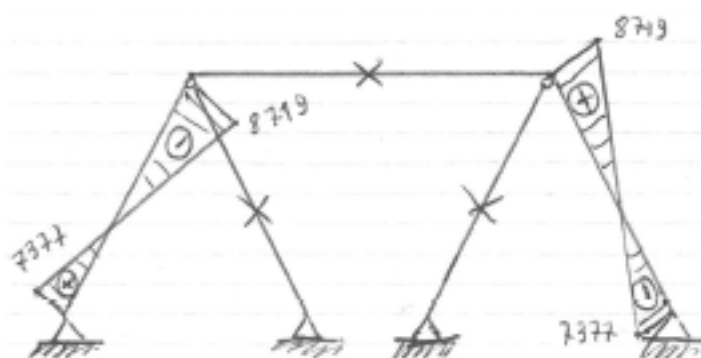
$$\eta_{21} = \frac{1}{EJ} \int_0^{(3/\cos \alpha)} \left(-\frac{1}{6} \cos \alpha z \right)^2 dz + \int_0^{(3+1.5)} (-1)^2 dz = \frac{6.73}{EJ}$$

$$\eta_{21} = 0$$

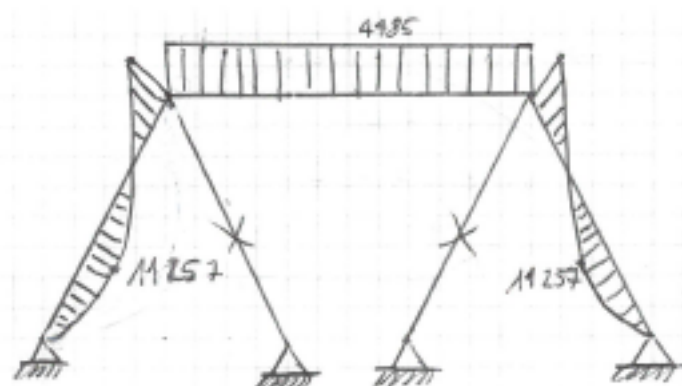
$$\begin{vmatrix} \eta_{11} & \eta_{12} \\ \eta_{21} & \eta_{22} \end{vmatrix} \begin{vmatrix} X_1 \\ X_2 \end{vmatrix} = \begin{vmatrix} -\eta_{10} \\ -\eta_{20} \end{vmatrix}$$

X_1 e indeterminato

$$X_2 = 4485 \text{ N} \cdot m$$



$T [N]$



$M [N \cdot m]$

$$2) \quad M = 11375 \text{ N} \\ T = 0 \text{ N} \\ N = 0 \text{ N}$$

$$\sigma_{amm} = 190 \text{ N/mm}^2$$

$$E = 210000 \text{ MPa}$$

$$W_{min} = \frac{M}{\sigma_{amm}} = \frac{11375}{190} = 59.86 \text{ cm}^3$$

Adotta IPE 140

$$A = 16.43 \text{ cm}^2 \quad J_x = 541.2 \text{ cm}^4$$

$$W = 77.32 \text{ cm}^3$$

$$\sigma_z = \pm \frac{M}{W} =$$

$$= \begin{cases} +147 \text{ N/mm}^2 < \sigma_{amm} \\ -147 \text{ N/mm}^2 < \sigma_{amm} \end{cases}$$

✓

✓

3) DEFORMABILITÀ ASSIALE BIELLA

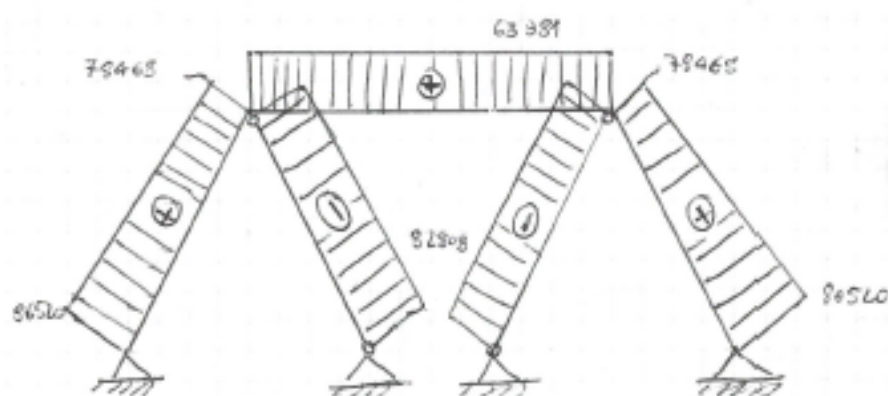
$$\eta_{11}^{NEW} = \eta_{11}^{OLD} + \eta_{11}^{biella} = 0 + \int_0^{3/\cos(\alpha)} \frac{(-1)^2}{EA} dz = \frac{6.707}{EA}$$

DEFORMABILITÀ ASSIALE BIELLA + CARICO TERMICO

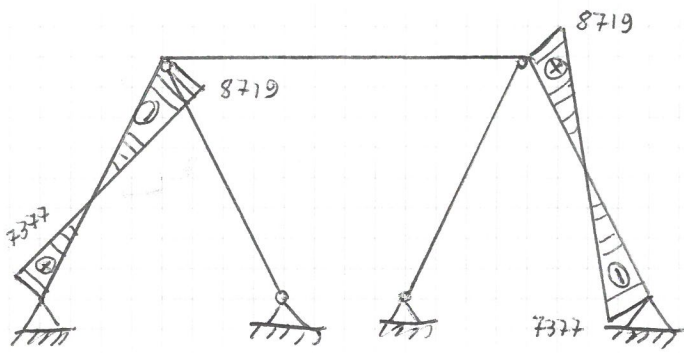
$$\begin{cases} \eta_{11}^{NEW} X_1 + \eta_{12} X_2 + \eta_{10} + \int_0^{3/\cos(\alpha)} \alpha \Delta T (-1) dz = 0 \\ \eta_{12} X_1 + \eta_{22} X_2 + \eta_{20} = 0 \end{cases}$$

$$X_1 = 82808 \text{ N}$$

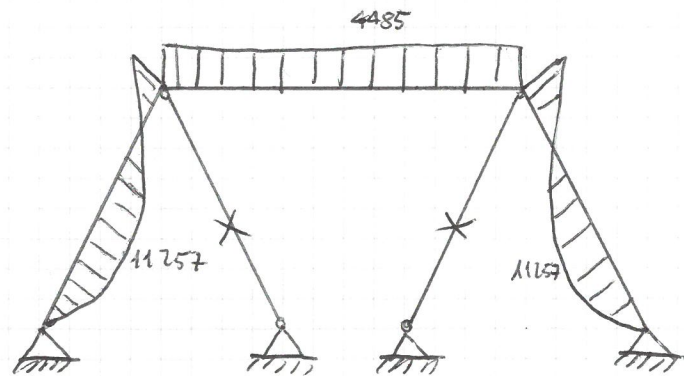
$$X_2 = 4485 \text{ N} \cdot \text{m}$$



N [N]



$T[N]$



$M[N \cdot m]$