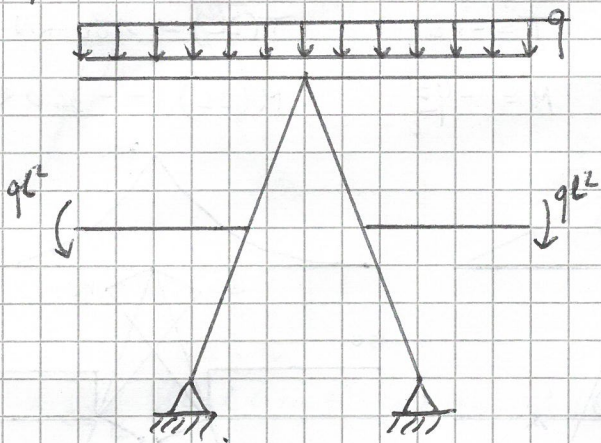
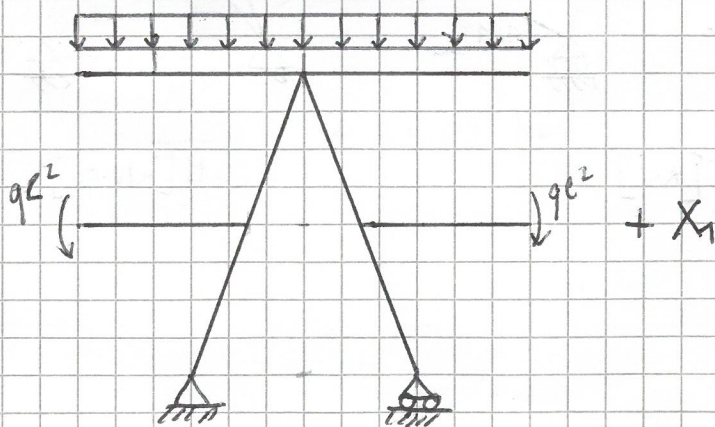


$q = 20 \text{ kN/m}$ $l = 3 \text{ m}$ $h = 4 \text{ m}$ $\tan \alpha = \frac{2h}{l} = \frac{8}{3} \rightarrow \alpha = 69^\circ.444$

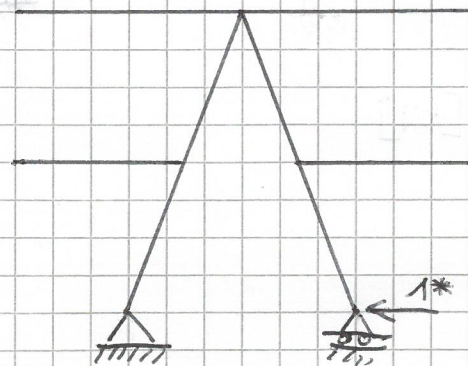
1) $k = \infty$



1 volta iperstatica

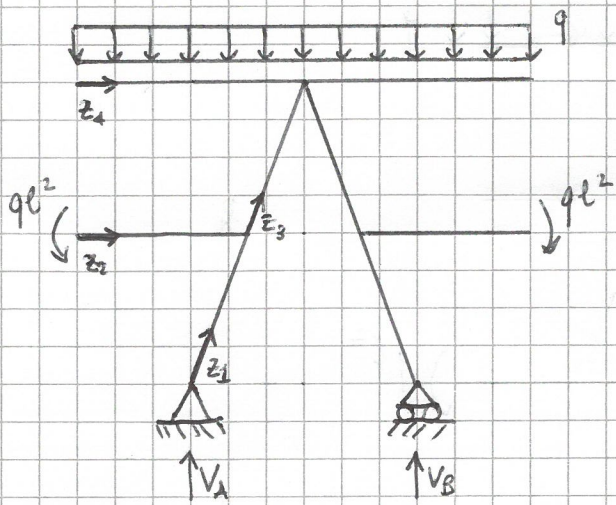


SISTEMA 0



SISTEMA 1

SISTEMA 0



$$\uparrow) V_A + V_B = 4ql$$

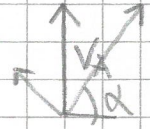
$$\rightarrow) H_A = 0$$

$$\star) V_B \cdot 2l - 4ql \cdot l = 0$$

$$V_A = 2ql = 120 \text{ KN}$$

$$V_B = 2ql = 120 \text{ KN}$$

$$H_A = 0 \text{ KN}$$



Tratto z1

$$N = -V_A \sin \alpha = -112.4 \text{ KN}$$

$$T = V_A \cos \alpha = 42.1 \text{ KN}$$

$$M = V_A \cos \alpha z \rightarrow M \left(\frac{L}{2 \cos \alpha} \right) = 180 \text{ KNm}$$

Tratto z2

$$N = 0$$

$$T = 0$$

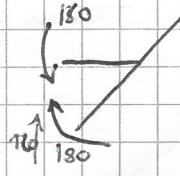
$$M = -ql^2 = -180 \text{ KNm}$$

Tratto z3

$$N = -V_A \sin \alpha = -112.4 \text{ KN}$$

$$T = V_A \cos \alpha = 42.1 \text{ KN}$$

$$M = V_A \cos \alpha z \rightarrow M \left(\frac{L}{2 \cos \alpha} \right) = 180 \text{ KNm}$$



Tratto z4

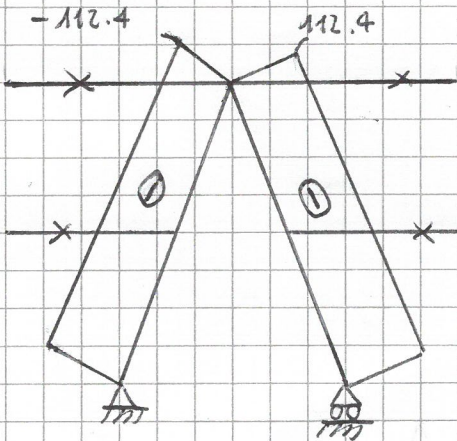
$$N = 0$$

$$T = -qlz$$

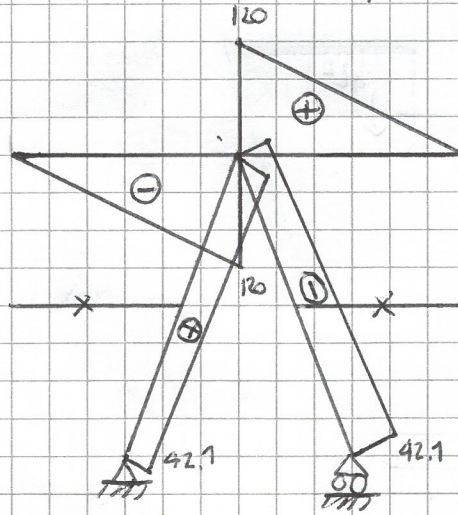
$$M = -\frac{ql^2 z}{2}$$

$$T(2L) = 180 \text{ KN}$$

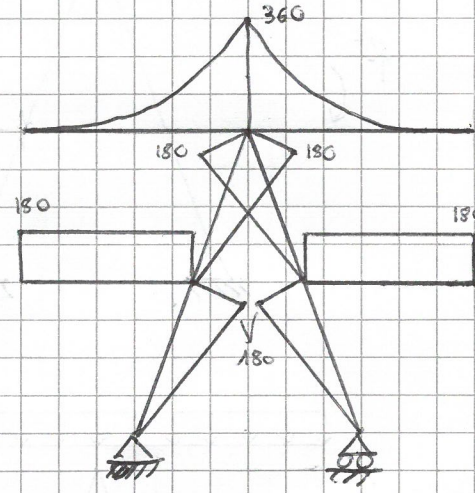
$$M(2L) = -360 \text{ KNm}$$



N [KN]

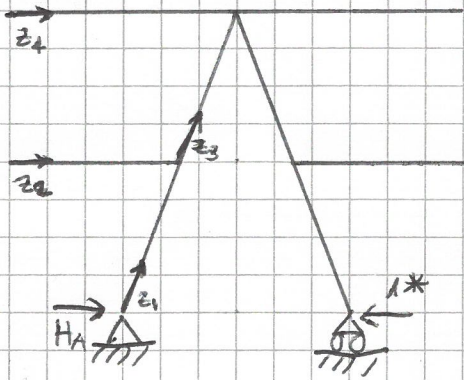


T [KN]



M [KN·m]

SISTEMA 1

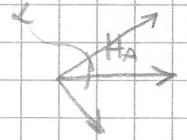


$$V_A = 0$$

$$V_B = 0$$

$$H_A = 1^*$$

Nei tratti z_2 e z_4 $N, T, M = 0$



Tratto z_1

$$N = -1 \cos \alpha = -0.3511 \text{ kN}$$

$$T = -1 \sin \alpha = -0.9363 \text{ kN}$$

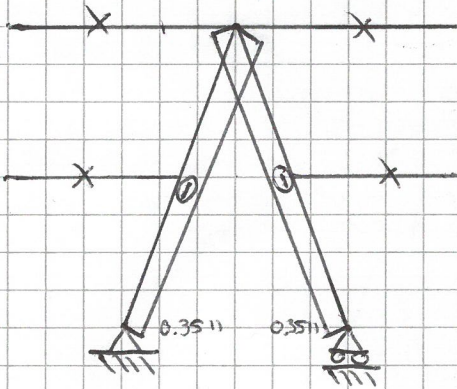
$$M = -1 \sin \alpha z \quad M\left(\frac{L}{2 \cos \alpha}\right) = -4 \text{ kN}\cdot\text{m}$$

Tratto z_3

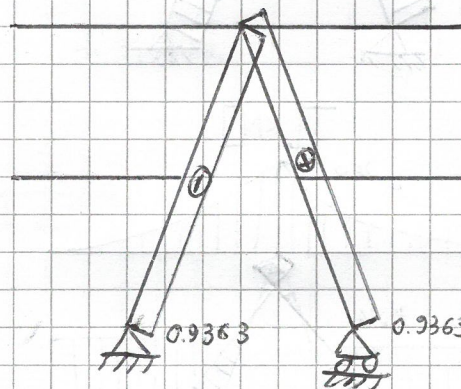
$$N = -1 \cos \alpha$$

$$T = -1 \sin \alpha$$

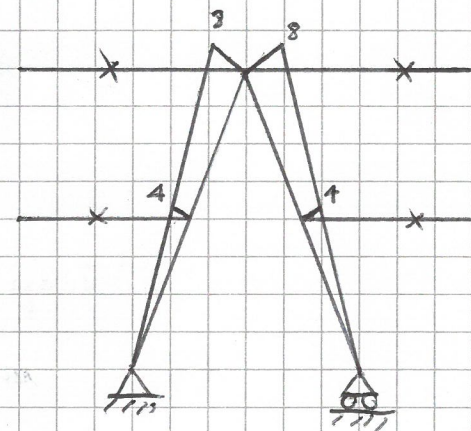
$$M = -4 - 1 \sin \alpha z \quad M\left(\frac{L}{2 \cos \alpha}\right) = -8 \text{ kN}\cdot\text{m}$$



N [kN]



T [kN]

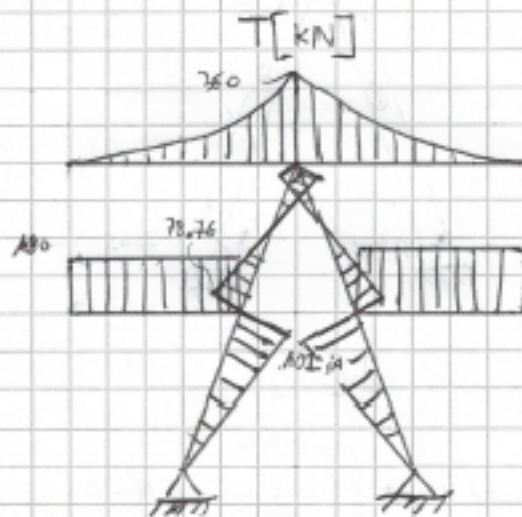
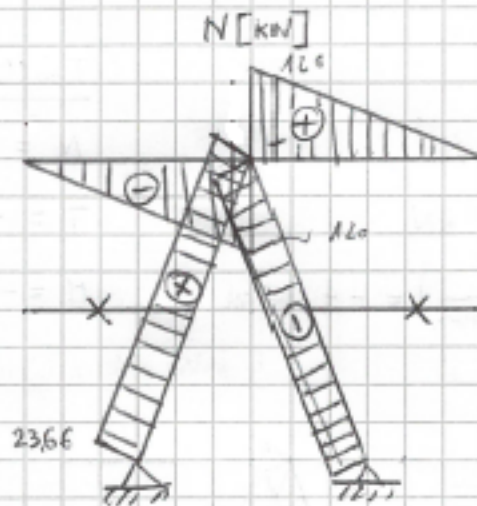
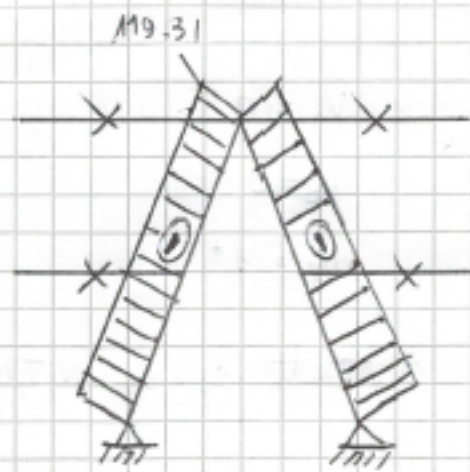


M [kN·m]

$$\eta_{10} = \frac{2}{EJ} \left[\int_0^{L/2 \cos \alpha} (2qL \cos \alpha z) \cdot (-4 \sin \alpha z) dz + \int_0^{L/2 \cos \alpha} (2qL \cos \alpha z) \cdot (-4 - 1 \sin \alpha z) dz \right] = - \frac{7176.99}{EJ}$$

$$\eta_{11} = \frac{2}{EJ} \int_0^{L/2 \cos \alpha} (-1 \sin \alpha z)^2 dz = \frac{364.55}{EJ}$$

$$X_1 = \frac{-\eta_{10}}{\eta_{11}} = +19.69 \text{ kN}$$



M [kN·m]

2) $M = 360 \text{ kN}\cdot\text{m}$
 $T = 120 \text{ kN}$
 $N = 0 \text{ kN}$

$\sigma_{\text{adm}} = 190 \text{ N/mm}^2$
 $E = 210000 \text{ MPa}$

$$W_{\text{min}} = \frac{M}{\sigma_{\text{adm}}} = \frac{120 \cdot 1000}{190} = 631.58 \text{ cm}^3$$

Adopto 1PE330 $A = 62.6 \text{ cm}^2$ $J_x = 11770 \text{ cm}^4$ $W_x = 713 \text{ cm}^3$

$$\sigma_z = \frac{N}{A} = \frac{M}{W} = \pm \frac{M}{W} = \pm \frac{360 \cdot 10^5}{713 \cdot 10^3} = \begin{cases} +504 > \sigma_{adm} & \times \\ -504 < \sigma_{adm} & \checkmark \end{cases}$$

momento perfilo IPE 500 $W = 1930 \text{ cm}^3$ $J_x = 48200 \text{ cm}^4$

$$\sigma_z = \pm \frac{M}{W} = \begin{cases} +186.5 < \sigma_{adm} & \checkmark \\ -186.5 < \sigma_{adm} & \checkmark \end{cases}$$

3) $k = 700 \text{ N/m}$

(1) $\rightarrow L_{ve} = 0 = L_{v1} = \eta_{11} X_1 + \eta_{10} + \frac{1}{k^*} (1^* X_1)$

$X_1 = 0.02 \text{ kN}$

