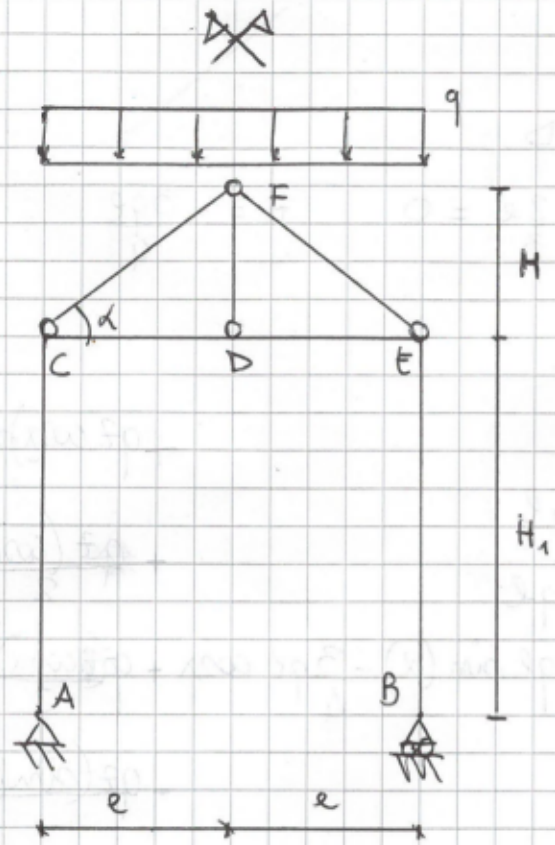
15/06/2018



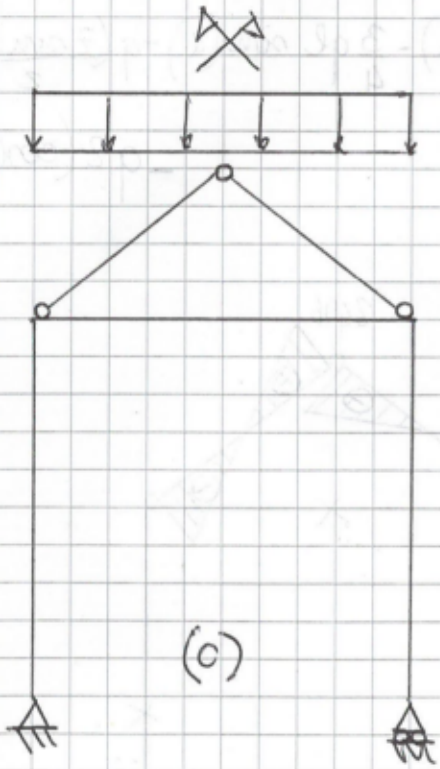
$q = 2000\ N/m$

$\ell = 3\ m$

$H = 2\ m = \frac{2}{3}\ell$

$H_1 = 5\ m = \frac{5}{3}\ell$

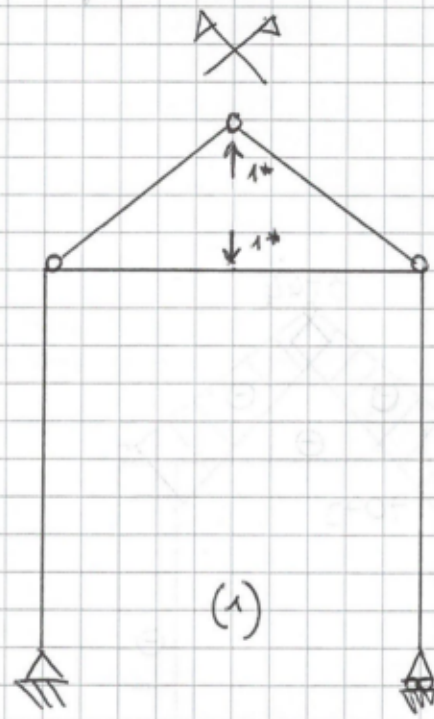
$\alpha = \operatorname{atan}\left(\frac{2}{3}\right) \simeq 33{,}7°$



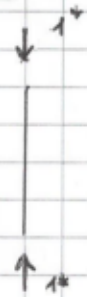
(0)

+

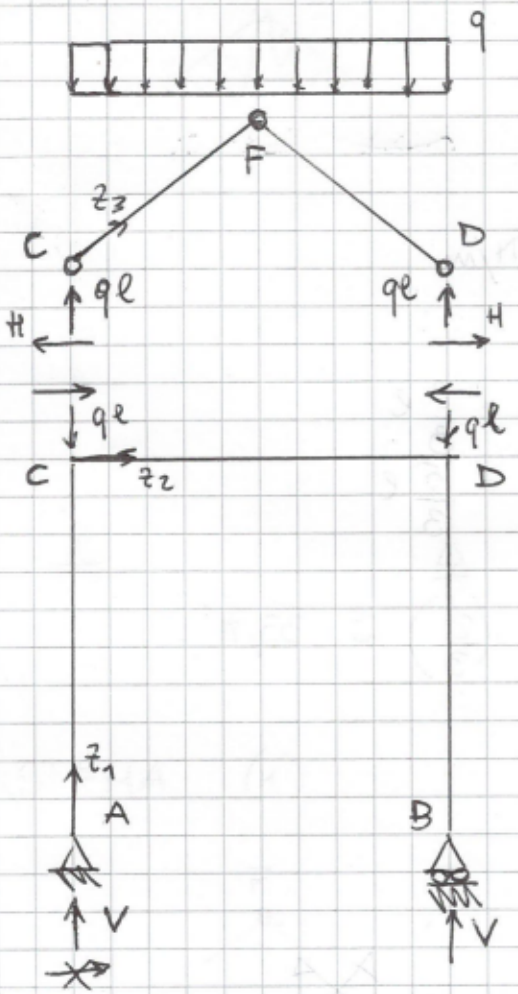
X



(1)



1) SISTEMA (0)



F↑ Tratto FD

$$ql^2 + H \cdot \frac{2}{3}l = 0 \qquad H = -\frac{3ql}{4}$$

↑) $V = ql$

$$N_0(z_1) = -ql$$

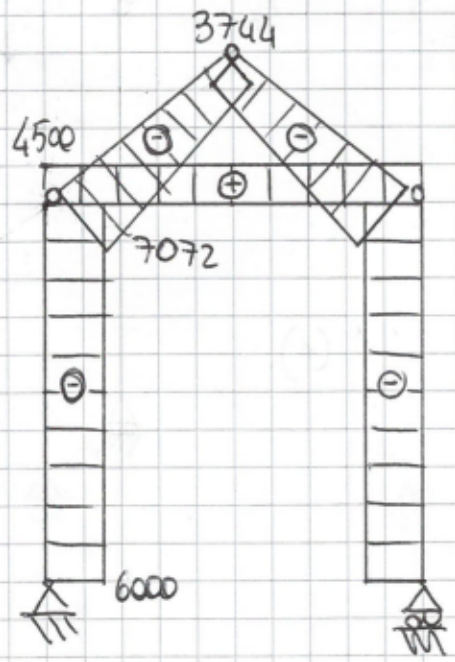
$$N_0(z_2) = \frac{3}{4}ql$$

$$N_0(z_3) = -ql\sin(\alpha) - \frac{3}{4}ql\cos\alpha + qz\cos(\alpha)\operatorname{sen}(\alpha)$$

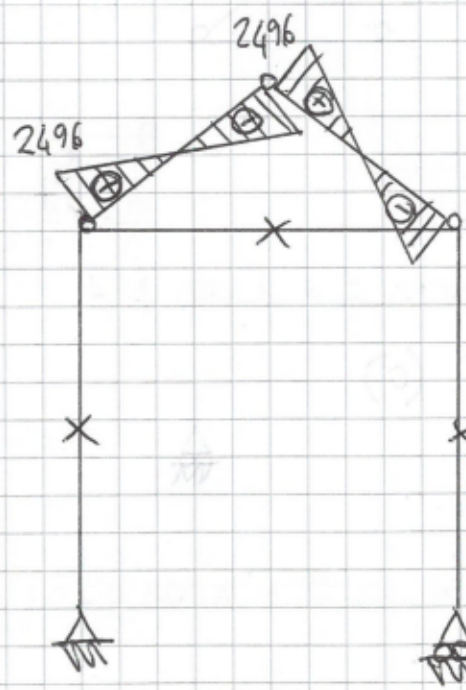
$$T_0(z_1) = 0$$

$$T_0(z_2) = 0$$

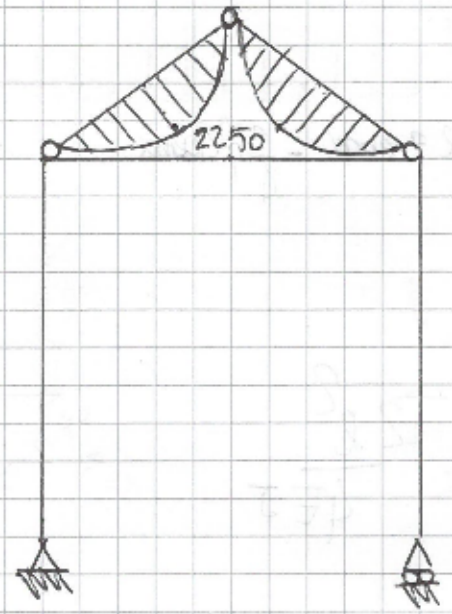
$$T_0(z_3) = ql\cos(\alpha) - \frac{3}{4}ql\sin(\alpha) - qz(\cos(\alpha))^2$$



N_0



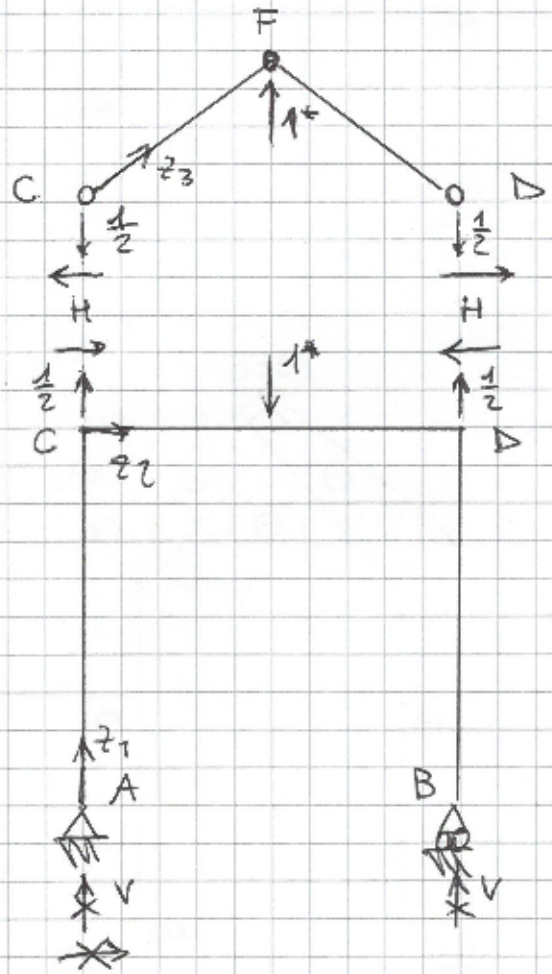
T_0



M_0

$$M_0(z_1) = 0$$
$$M_0(z_2) = 0$$
$$M_0(z_3) = qlz\cos\alpha - \frac{3}{4}qlz\,\mathrm{sen}\,\alpha - \frac{q(z\cos\alpha)^2}{2}$$

SISTEMA (1)



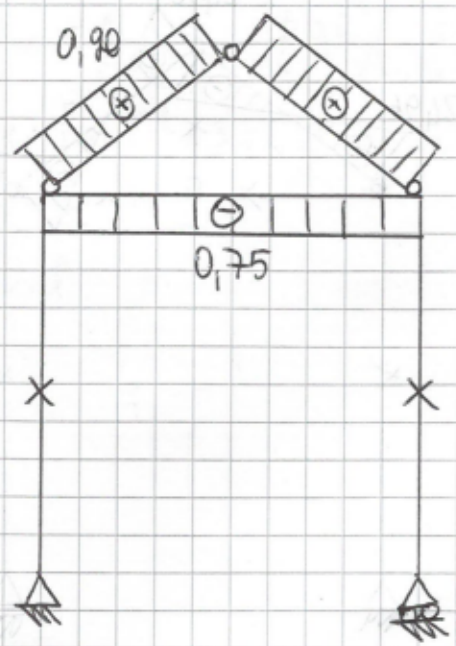
F↑ Tratto FD

$$\frac{1}{2}\ell + H\cdot\frac{2}{3}\ell = 0 \qquad H = \frac{3}{4}$$

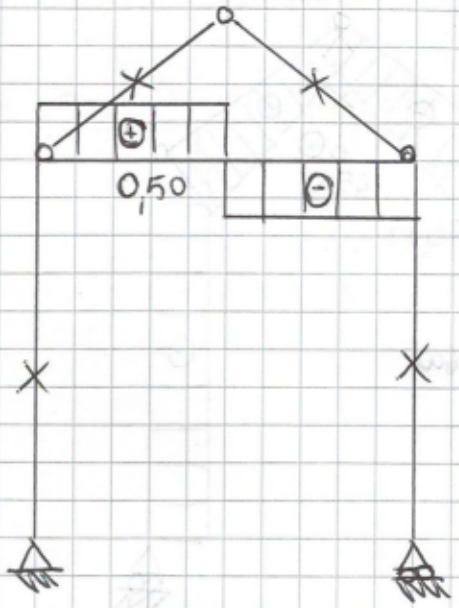
↑) $V = 0$

$$N_1(z_1) = 0$$
$$N_1(z_2) = -\frac{3}{4}$$
$$N_1(z_3) = \frac{1}{2}\,\mathrm{sen}\,\alpha + \frac{3}{4}\cos\alpha$$

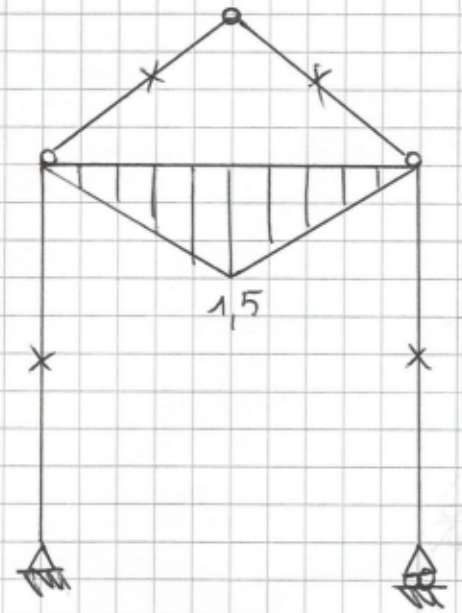
$$T_1(z_1) = 0$$
$$T_1(z_2) = \frac{1}{2}$$
$$T_1(z_3) = -\frac{1}{2}\cos\alpha + \frac{3}{4}\,\mathrm{sen}\,\alpha = 0$$



N_1



T_1



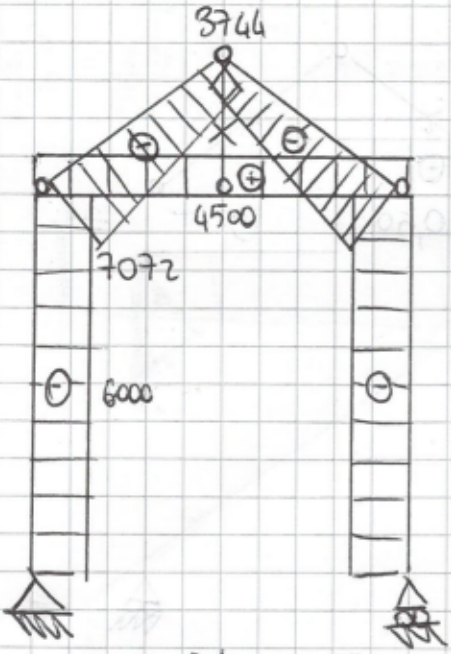
M_1

$$M_1(z_1) = 0$$
$$M_1(z_2) = \frac{1}{2} z$$
$$M_1(z_3) = 0$$

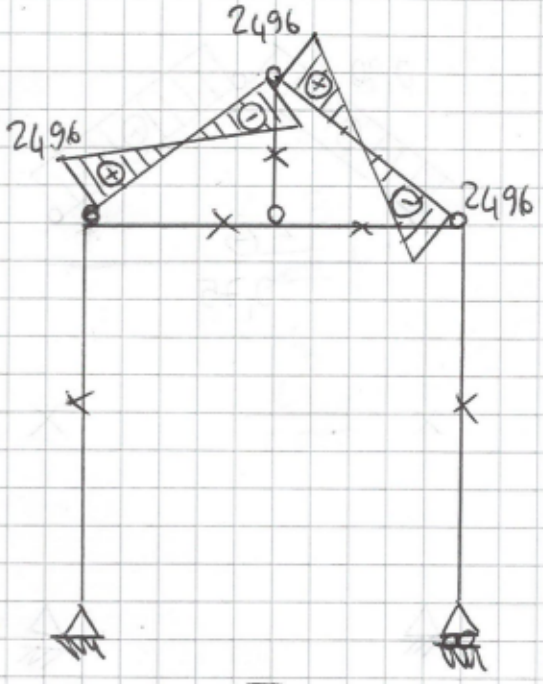
$$M_{10} = 0$$

$$M_{11} = \frac{2}{EJ} \int_0^e \left(\frac{z}{2}\right)^2 dz = \frac{e^3}{6EJ}$$

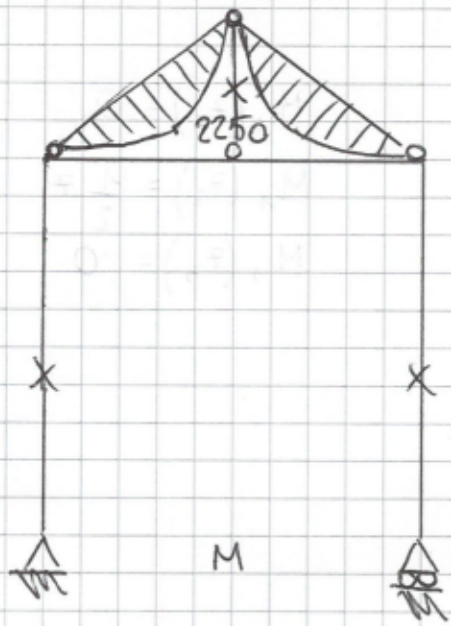
$$\Rightarrow \quad X = 0$$



N



T



M

2) $N = -5408\ N$ $\quad \sigma_{am} = 190\ MPa$

$M = 2250\ Nm$ $\quad E = 210000\ MPa$

$T = 0$

$$W_{min} = \frac{2250 \cdot 10^3}{190} = 11842\ mm^3$$

ADOTTO IPE 80 $\quad A = 7{,}64\ cm^2 \quad W_x = 20{,}03\ cm^3$

$J_x = 80{,}14\ cm^4$

$$\sigma_z = \frac{N}{A} \pm \frac{M}{W} = -\frac{5408}{7{,}64 \cdot 100} + \frac{2250 \cdot 1000}{20{,}03 \cdot 1000} = \begin{cases} 105\ MPa < 190\ MPa \\ 119\ MPa < 190\ MPa \end{cases}$$

3)

$$\eta_{10}^{N} = \frac{1}{EA}\left[2\int_0^{\ell/\cos(\alpha)}\left(-q\ell\sin(\alpha) - \frac{3}{4}q\ell\cos(\alpha) + q\ell\cos\alpha\sin\alpha\right)\left(\frac{\sin(\alpha)}{2} + \frac{3\cos(\alpha)}{4}\right)dz + \right.$$

$$\left. + 2\int_0^{\ell}\left(-\frac{3}{4}\right)\left(\frac{3}{4}q\ell\right)dz\right] = -3{,}078\,\frac{q\ell^2}{EJ}$$

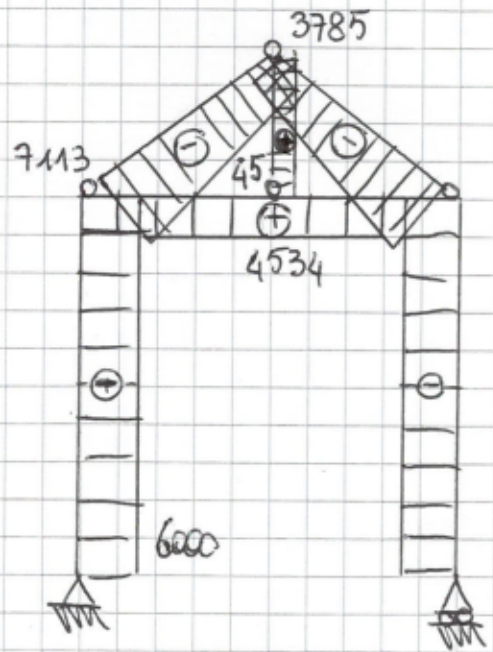
$$\eta_{11}^{N} = \frac{1}{EA}\left[2\int_0^{\ell/\cos(\alpha)}\left(\frac{1}{2}\sin(\alpha) + \frac{3}{4}\cos(\alpha)\right)^2 dz + 2\int_0^{\ell}\left(-\frac{3}{4}\right)^2 dz + \int_0^{\frac{2}{3}\ell} 1^2\,dz\right] =$$

$$= 3{,}745\,\frac{\ell}{EA}$$

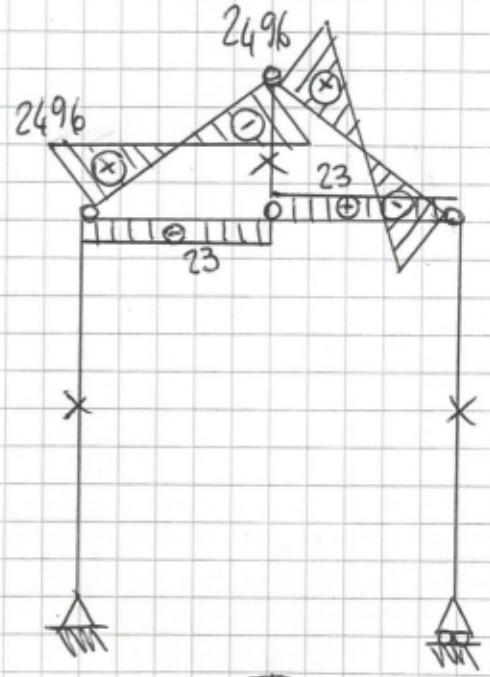
$$\eta_{ij}^{TOT} = \eta_{ij}^{J} + \eta_{ij}^{N}$$

$$L_{VE} = 0 = \eta_{10}^{TOT} + X\,\eta_{11}^{TOT} + 2\int_0^{\frac{\ell}{\cos\alpha}}\left(\frac{\cos(\alpha)}{2} - \frac{3\sin(\alpha)}{4}\right)\cdot\alpha\,\Delta t\,dz$$

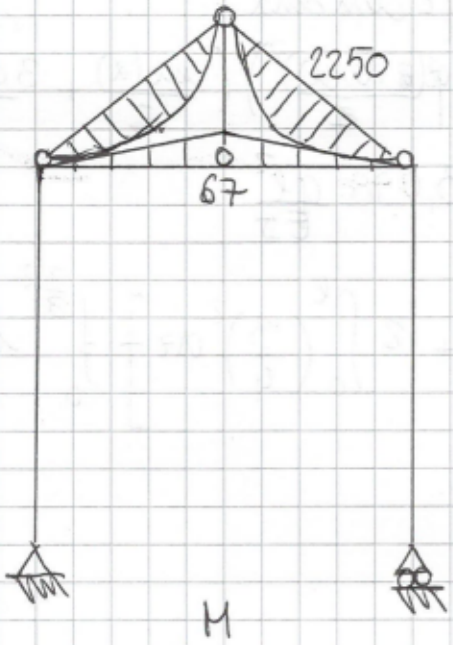
$$X = -45{,}3 \quad N$$



N



T



M