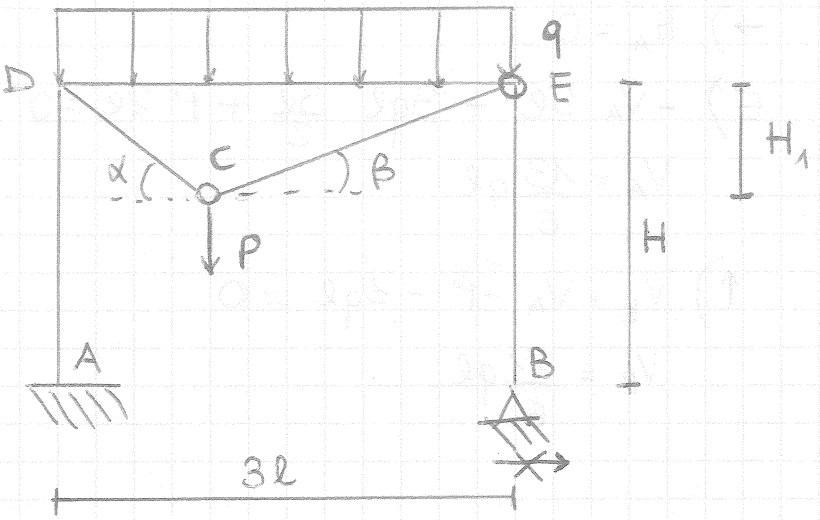
FILA A

15/07/2016



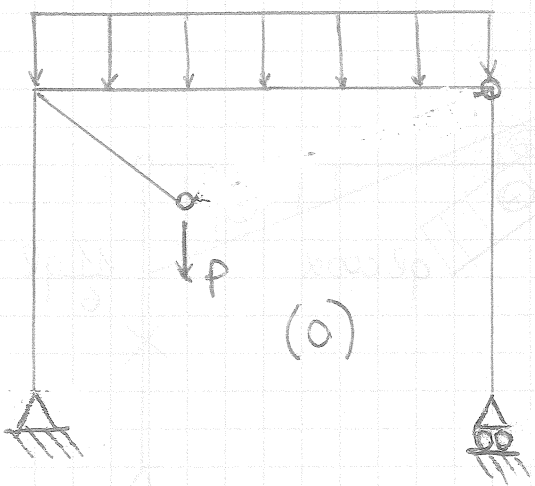
$q = 1000\ N/m$

$P = ql$

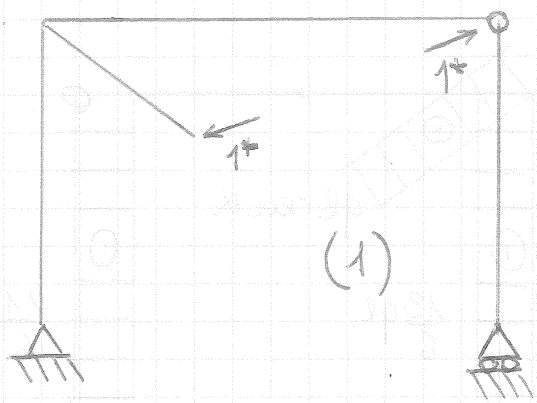
$l = 2\ m$

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

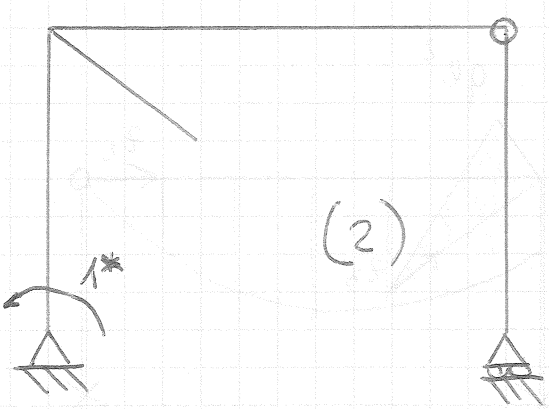
$H_1 = 1\ m = \frac{l}{2}$



$+ \quad X_1$



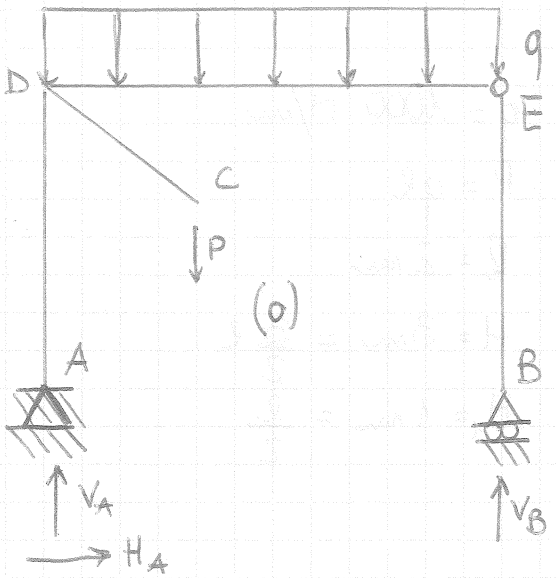
$+ \quad X_2$



$\alpha = \operatorname{atan}(0{,}5) = 26{,}6°$

$\beta = \operatorname{atan}(0{,}25) = 14{,}0°$

SIST. (0)



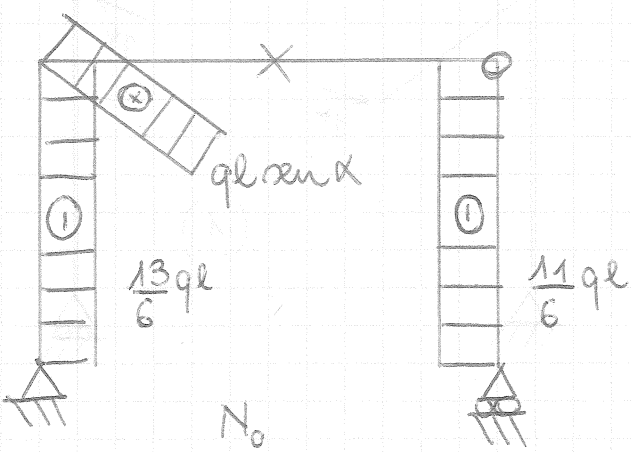
$\rightarrow) \quad H_A = 0$

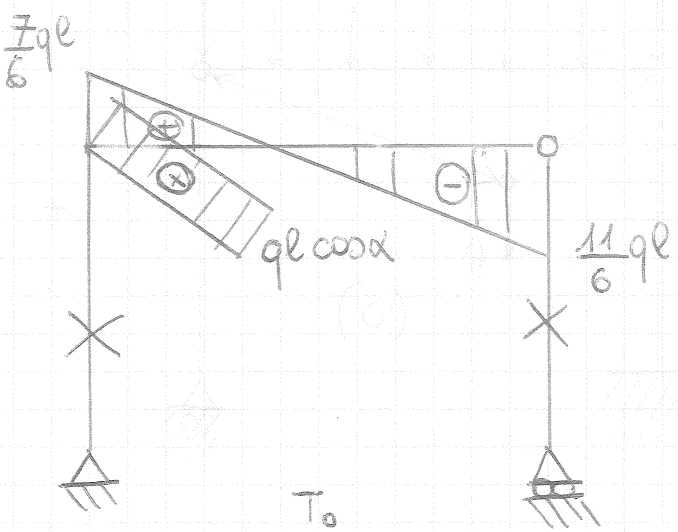
$E\uparrow) \quad -V_A \cdot 3\ell + 3q\ell \cdot \frac{3\ell}{2} + P \cdot 2\ell = 0$

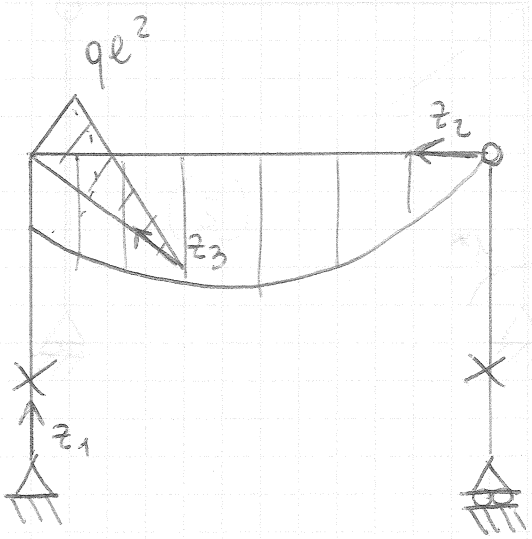
$V_A = \frac{13}{6} q\ell$

$\uparrow) \quad V_B + V_A - P - 3q\ell = 0$

$V_B = \frac{11}{6} q\ell$





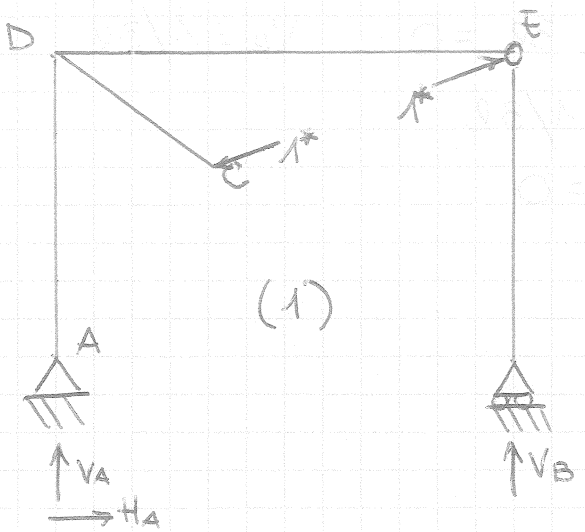


$M_0(z_1) = 0$

$M_0(z_2) = \frac{11}{6} q\ell z - \frac{q z^2}{2}$

$M_0(z_3) = -q\ell \cos\alpha \, z$

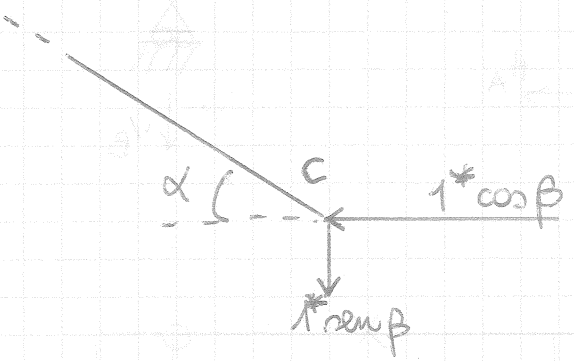
SIST. (1)

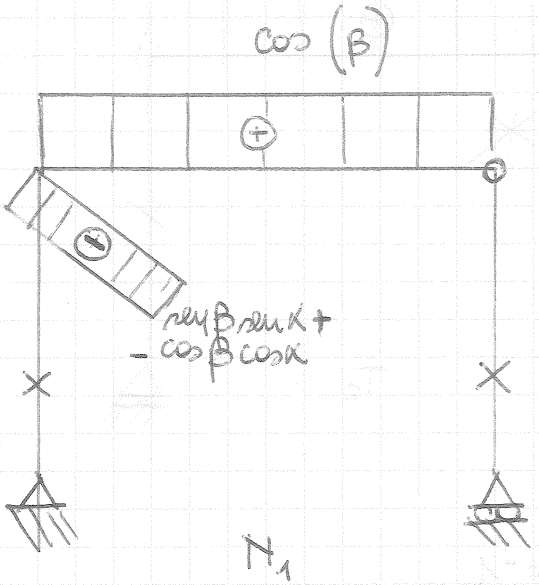


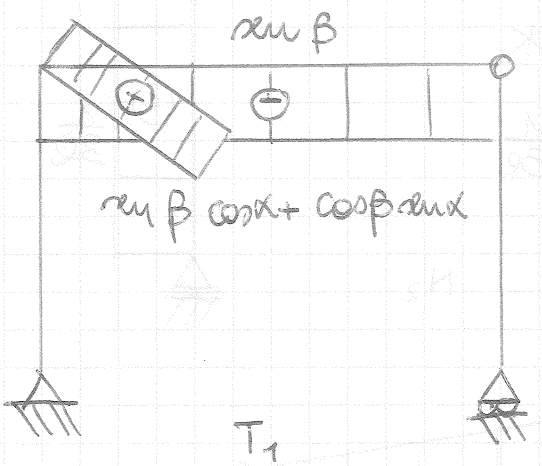
$\rightarrow) H_A = 0$

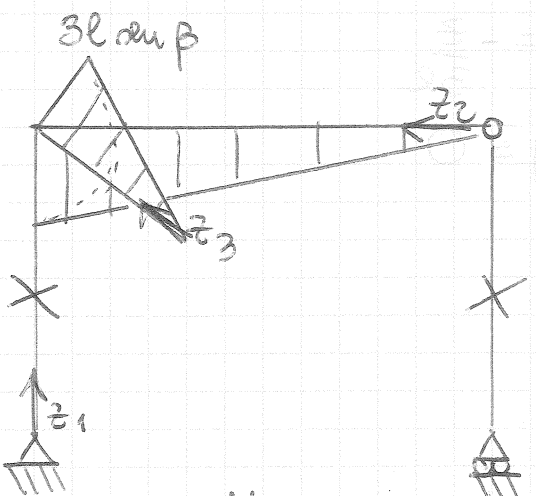
$\circlearrowleft \uparrow V_A = 0$

$\uparrow) V_B = 0$







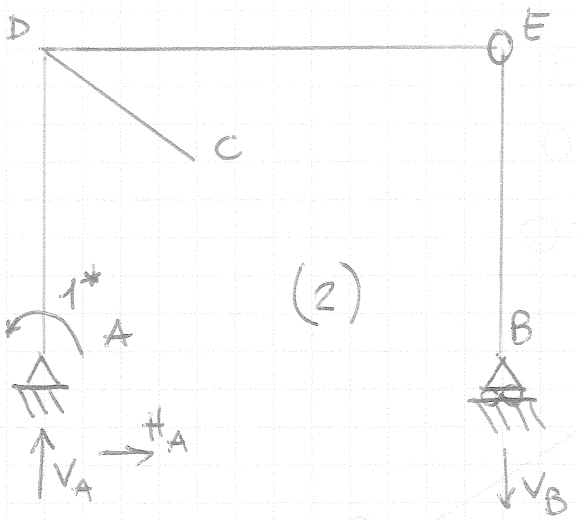


$M(z_1) = 0$

$M(z_2) = \operatorname{sen}\beta \cdot z$

$M(z_3) = -(\operatorname{sen}\beta\cos\alpha + \cos\beta\operatorname{sen}\alpha) \cdot z$

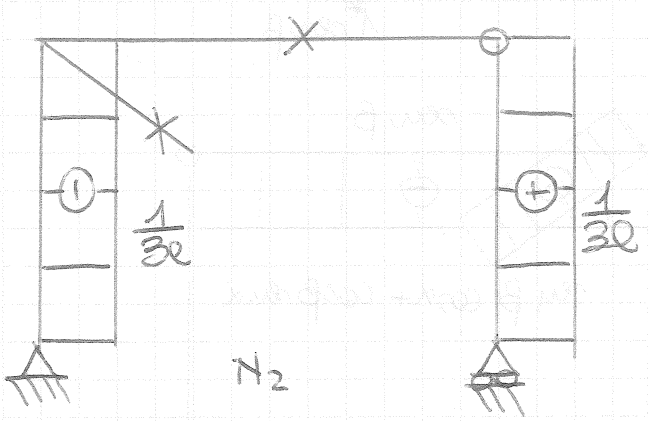
SIST. (2)

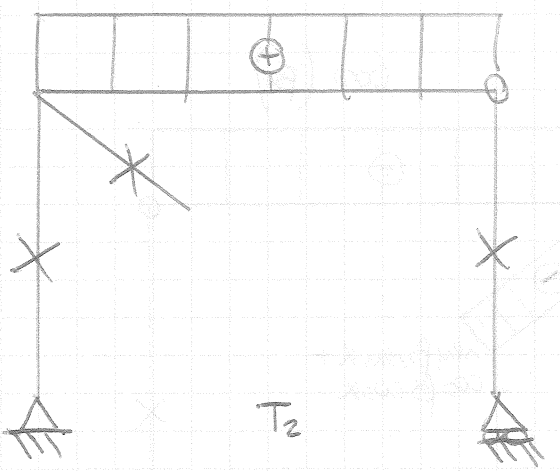


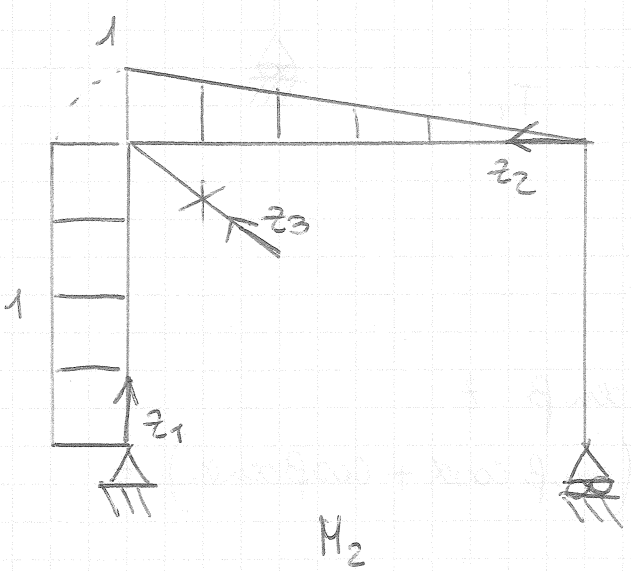
A) $1 - V_B \cdot 3\ell = 0$ $\quad V_B = 1/3\ell$

↑) $V_A = 1/3\ell$

E) $H_A = 0$







$M_2(z_1) = -1$

$M_2(z_2) = -\frac{z}{3\ell}$

$M_2(z_3) = 0$

$$M_{10} = \frac{1}{EJ}\cdot\left[\int_0^{3\ell}(\operatorname{sen}\beta z)\left(\frac{11}{6}q\ell z - \frac{qz^2}{2}\right)dz + \int_0^{\ell/\cos x}\left(-z\cdot(\operatorname{sen}\cos x + \cos\beta\operatorname{sen}x)\right)\cdot(q\ell\cos x\, z)\,dz\right] =$$

$$= \frac{29077.2}{EJ}$$

$$M_{20} = \frac{1}{EJ}\int_0^{3\ell}\left(-\frac{z}{3\ell}\right)\left(\frac{11}{6}q\ell z - \frac{qz^2}{12}\right)dz = -\frac{17000}{EJ}$$

$$M_{11} = \frac{1}{EJ}\left[\int_0^{3\ell}\operatorname{sen}^2\beta\, z^2\,dz + \int_0^{\ell/\cos x}(\operatorname{sen}\beta\cos x + \cos\beta\operatorname{sen}x)^2 z^2\,dz\right] =$$

$$= \frac{5,8137}{EJ}$$

$$M_{22} = \frac{1}{EJ}\cdot\left[\int_0^{\frac{3}{2}\ell} 1\,dz + \int_0^{3\ell}\frac{z^2}{9\ell^2}\,dz\right] = \frac{5}{EJ}$$

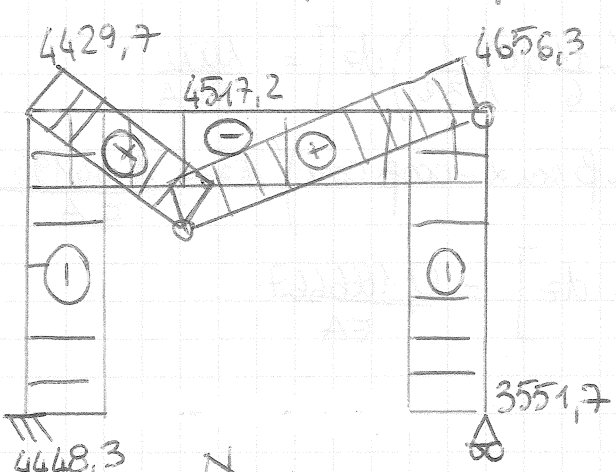
$$M_{12} = \frac{1}{EJ}\int_0^{3\ell}(\operatorname{sen}\beta z)\left(-\frac{z}{3\ell}\right)dz = -\frac{2,91063}{EJ}$$

1) → $M_{11}\cdot X_1 + M_{12}\cdot X_2 = -M_{10}$

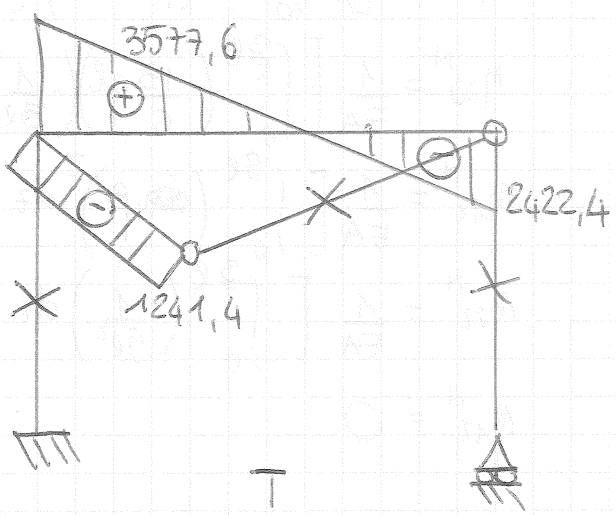
2) → $M_{12}\cdot X_1 + M_{22}\cdot X_2 = -M_{20}$

→ $X_1 = -4656,25$ N

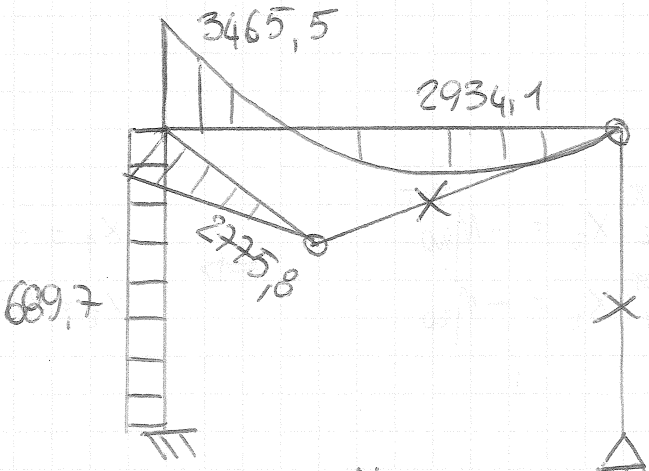
$X_2 = 689,66$ Nm



N



T



M

2) PROGETTO

Combinazione $M_{max} = 3465,5$ Nm $\quad N = -4517,2$

$\sigma_{am} = 390$ MPa

$$W_{min} = \frac{M_{max}}{\sigma_{am}} = \frac{3465,5 \cdot 10^3}{390} \simeq 8886 \text{ mm}^3 = 8,886 \text{ cm}^3$$

$\Rightarrow$ Adotto IPE 80 $\quad W_x = 20,03 \text{ cm}^3 \quad E = 210000$ MPa

$A = 7,64 \text{ cm}^2$

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

VERIFICA

$$\sigma_{max} = -\frac{4517,2}{7,64 \cdot 10^2} - \frac{3465,5 \cdot 10^3}{20,03 \cdot 10^3} = -178,92 < 390 \quad \text{ok!}$$

3) $$\eta_{10}^N = \frac{1}{EA}\int_0^{\ell/\cos\alpha} (q\ell \operatorname{sen}\alpha)(\operatorname{sen}\beta \operatorname{sen}\alpha - \cos\beta\cos\alpha)\,dz = -\frac{1518,51}{EA}$$

$$\eta_{20}^N = \frac{1}{EA}\left[\int_0^{\frac{3}{2}\ell}\left(-\frac{13}{6}q\ell\right)\left(-\frac{1}{3\ell}\right)dz + \int_0^{\frac{3}{2}\ell}\left(-\frac{11}{6}q\ell\right)\left(\frac{1}{3\ell}\right)dz\right] = \frac{1000}{3EA}$$

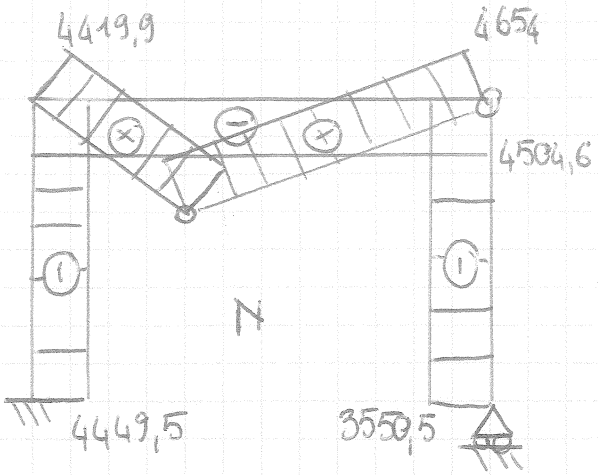
$$\eta_{11}^N = \frac{1}{EA}\left[\int_0^{3\ell}(\cos\beta)^2\,dz + \int_0^{\ell/\cos\alpha}(\operatorname{sen}\beta\operatorname{sen}\alpha - \cos\beta\cos\alpha)^2\,dz\right] = \frac{1,64196}{EA}$$

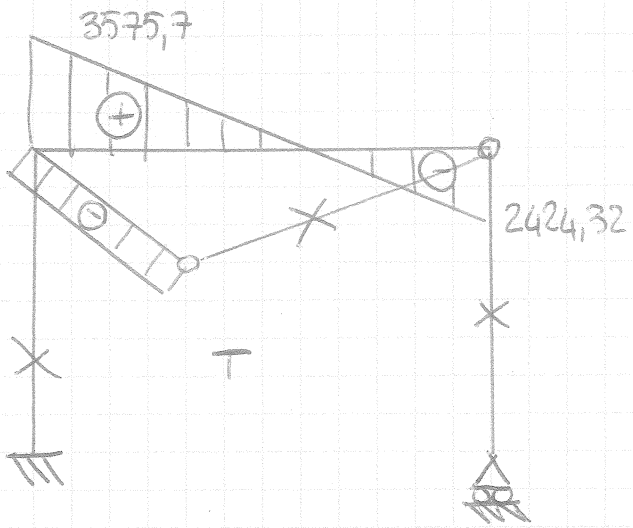
$$\eta_{22}^N = \frac{1}{EA}\left[\int_0^{\frac{3}{2}\ell}\left(\frac{1}{9\ell^2}\right)dz + \int_0^{\frac{3}{2}\ell}\left(\frac{1}{9\ell^2}\right)dz\right] = \frac{0,166667}{EA}$$

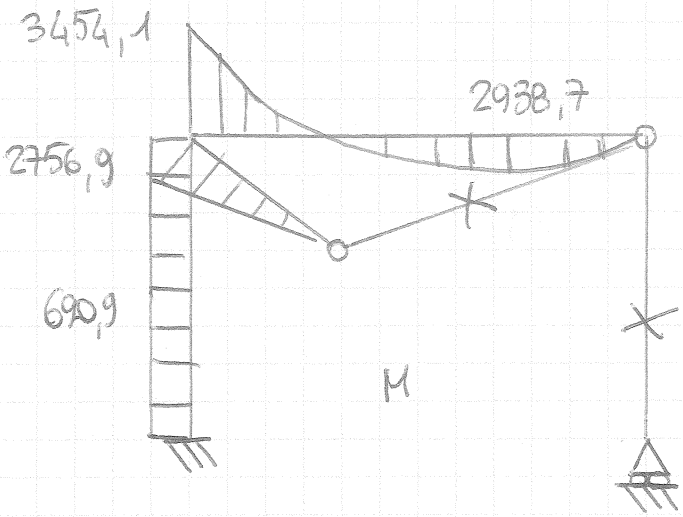
$$\eta_{12}^N = 0$$

$$\eta_{jk}^{TOT} = \eta_{jk} + \eta_{jk}^N$$

$$\begin{cases} 1) \rightarrow \eta_{11}^{TOT} X_1 + \eta_{12}^{TOT} X_2 = -\eta_{10}^{TOT} \\ 2) \rightarrow \eta_{12}^{TOT} X_1 + \eta_{22}^{TOT} X_2 = -\eta_{20} \end{cases} \Rightarrow \begin{array}{l} X_1 = -4654 \text{ N} \\ X_2 = 690,89 \text{ Nm} \end{array}$$


4419,9
4654
4504,6
N
4449,5
3550,5


3575,7
2424,32
T


3454,1
2938,7
2756,9
690,9
M