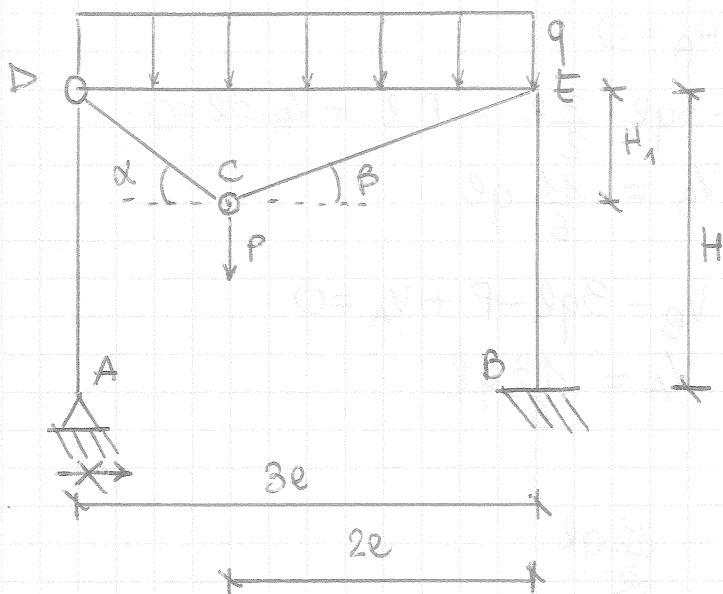




$$l = 2m$$

$$H = 4m = 2l$$

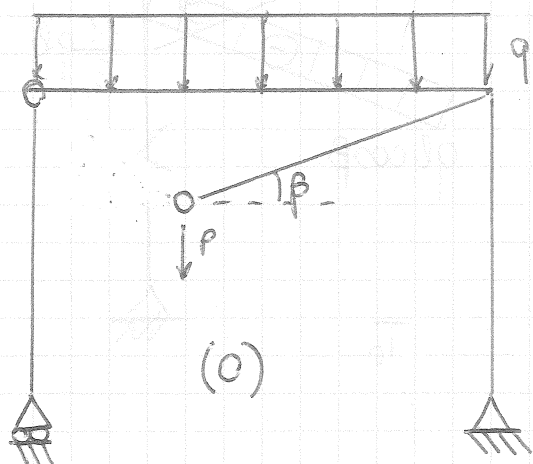
$$H_1 = 1m = l/2$$

$$q = 1000 \text{ N/m}$$

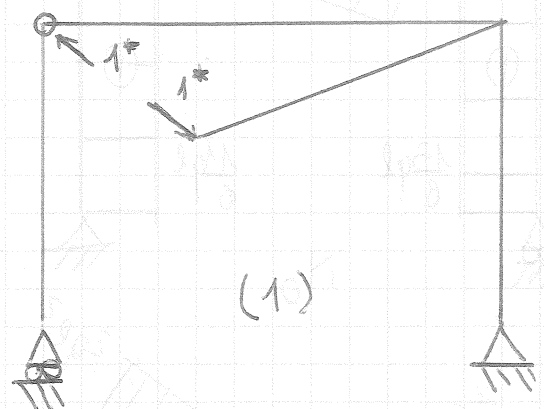
$$P = ql$$

$$\alpha = \arctan(0,5) =$$

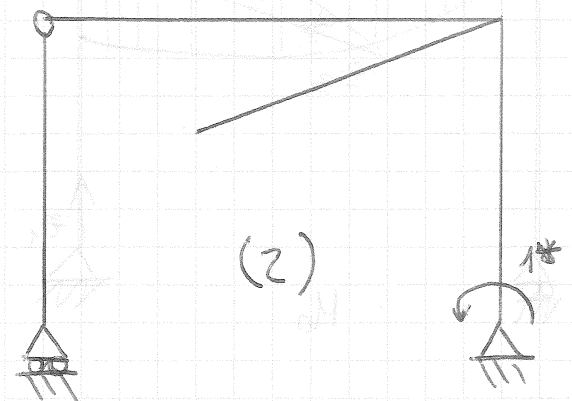
$$\beta = \arctan(0,25) =$$



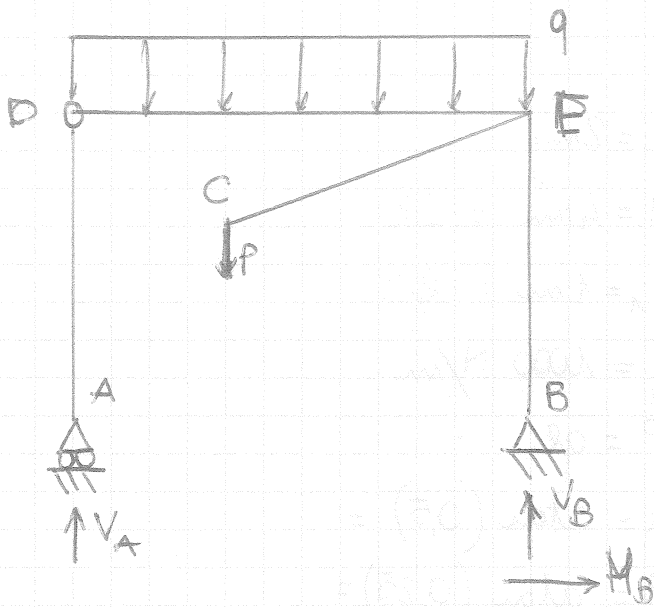
+ x_1



+ x_2



SIST. (0)



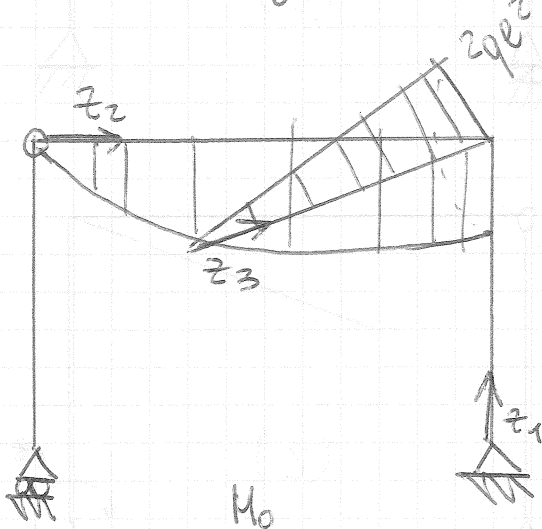
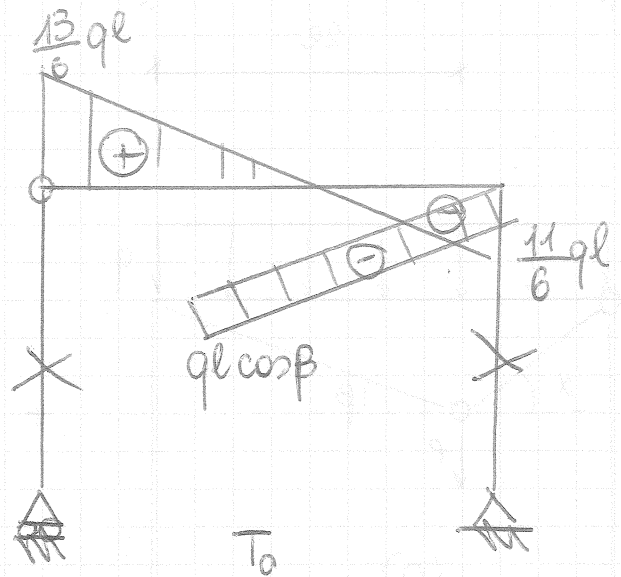
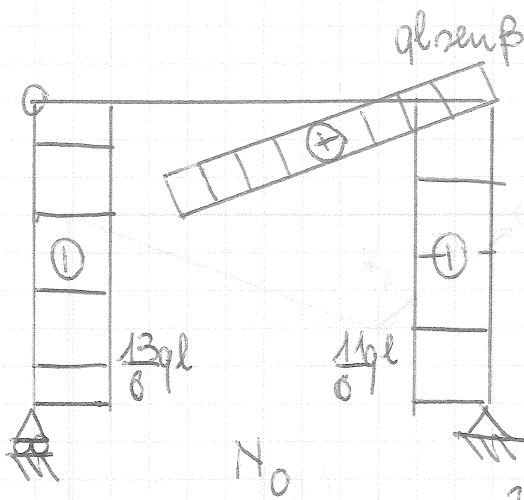
$$\rightarrow) H_B = 0$$

$$\uparrow) -3ql \cdot \frac{3}{2}l - P \cdot l + V_B \cdot 3l = 0$$

$$V_B = \frac{11}{6} ql$$

$$\uparrow) V_B - 3ql - P + V_A = 0$$

$$V_A = \frac{13}{6} ql$$



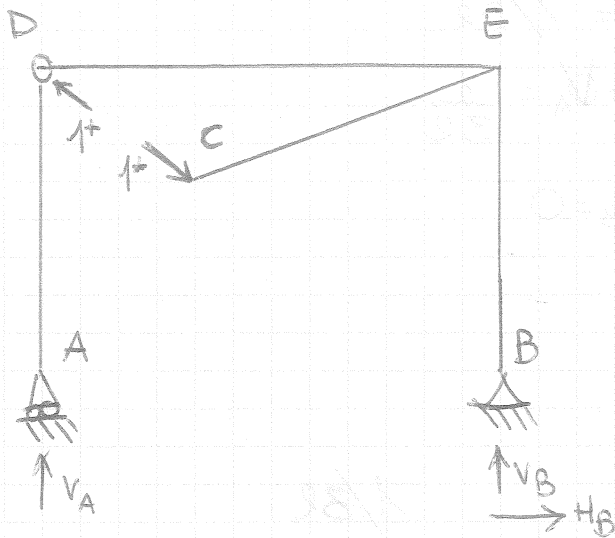
$$M_0(z_1) = 0$$

$$M_0(z_2) = \frac{13}{6} ql z - \frac{qz^2}{2}$$

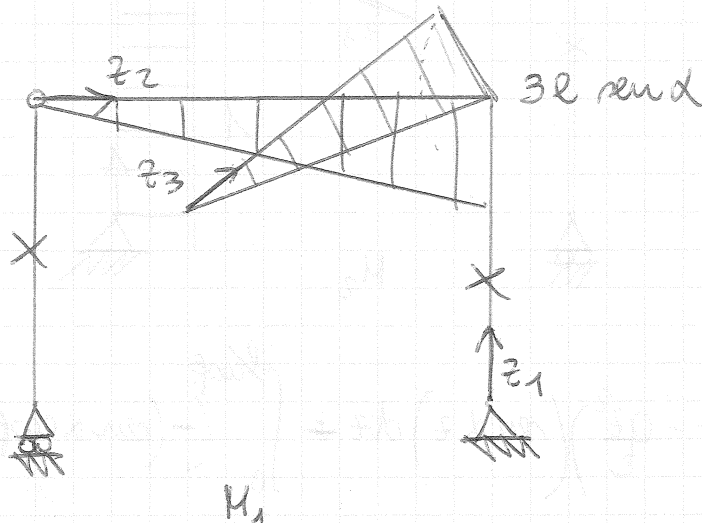
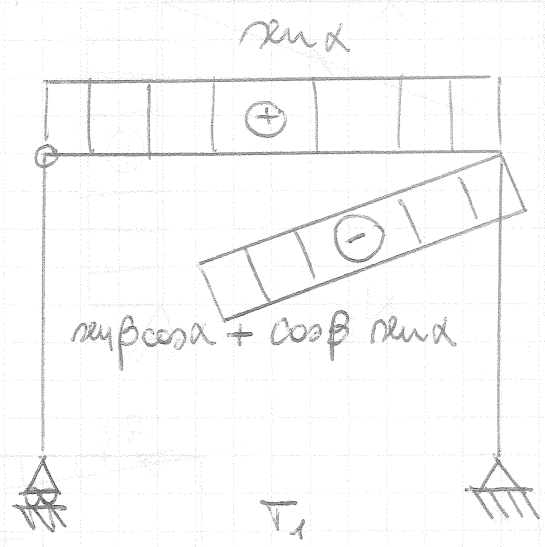
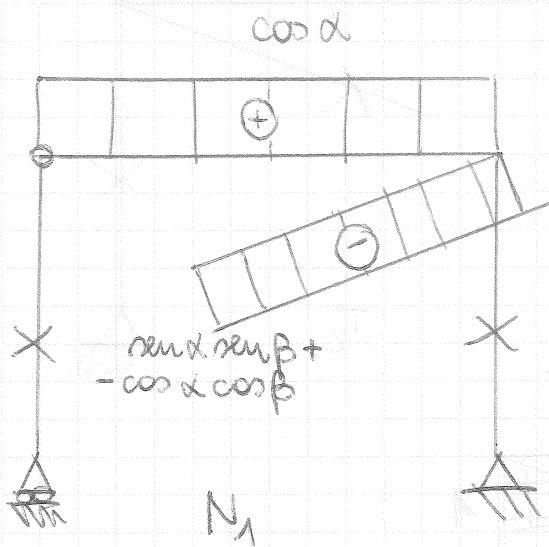
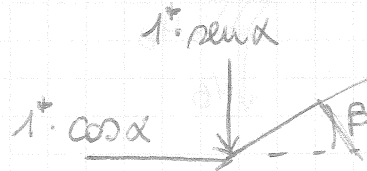
$$M_0(z_3) = -ql \cos \beta z$$

SIST (1)

(5) 30/06



$$\begin{aligned} \rightarrow & H_B = 0 \\ \uparrow & V_B = 0 \\ \uparrow & V_A = 0 \end{aligned}$$

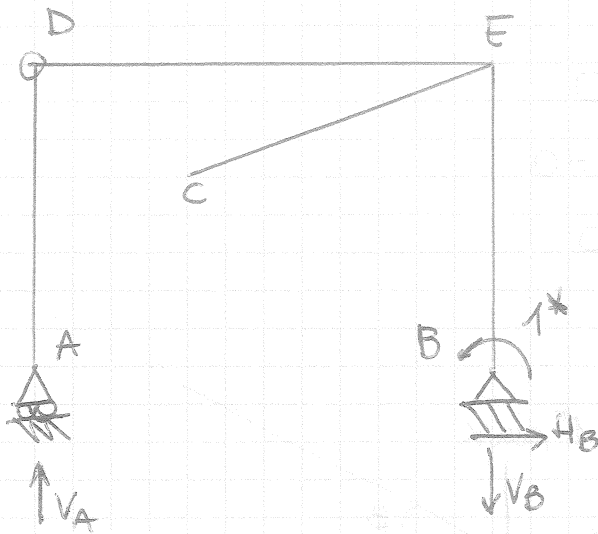


$$M_1(z_1) = 0$$

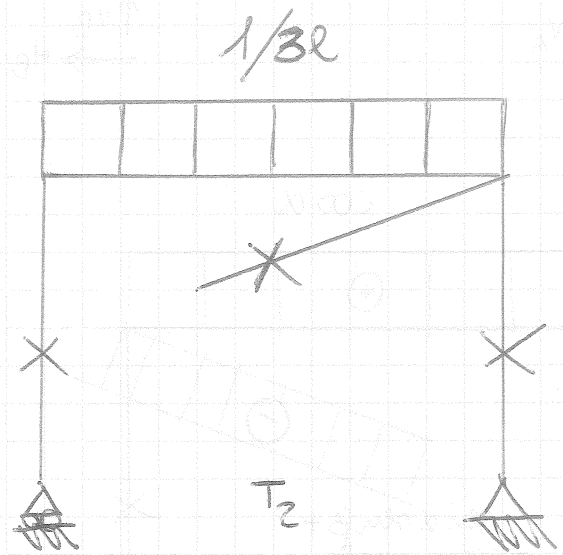
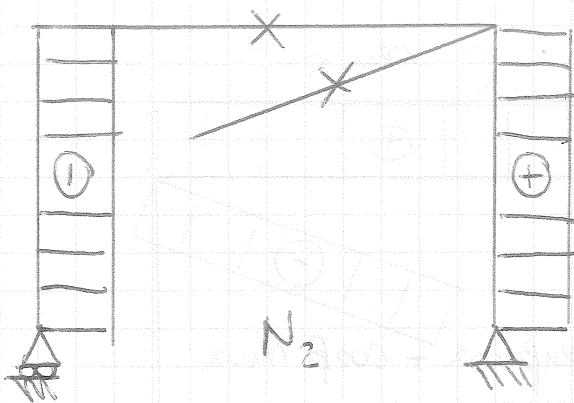
$$M_1(z_2) = \sin \alpha \cdot z$$

$$M_1(z_3) = -(\sin \beta \cos \alpha + \cos \beta \sin \alpha) z$$

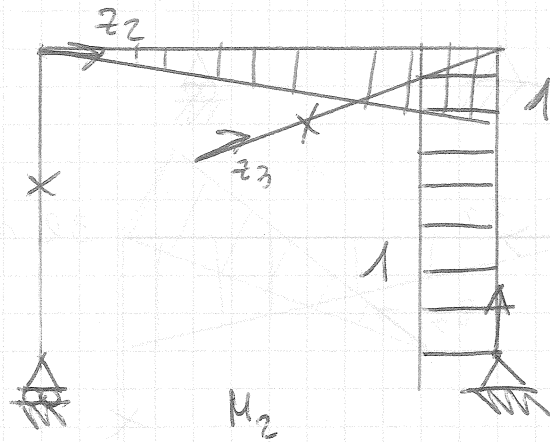
SIST. (2)



$$\begin{aligned} B) \quad & V_A = 1/3l \\ \uparrow) \quad & V_B = \cancel{V_A} = \frac{1}{3l} \\ D) \quad & H_B = 0 \end{aligned}$$



$$\begin{aligned} M_2(z_1) &= 1 \\ M_2(z_2) &= \frac{z}{3l} \\ M_2(z_3) &= 0 \end{aligned}$$



$$\begin{aligned} M_{10} &= \frac{1}{EJ} \left[\int_0^{3l} \left(\frac{13}{6} qlz - \frac{qz^2}{2} \right) (\sin \alpha z) dz + \int_0^{3l \cos \beta} \left(-(\sin \alpha \cos \beta + \cos \alpha \sin \beta) z \right) (-ql \cos \beta z) dz \right] \\ &= 96584,6 / EJ \end{aligned}$$

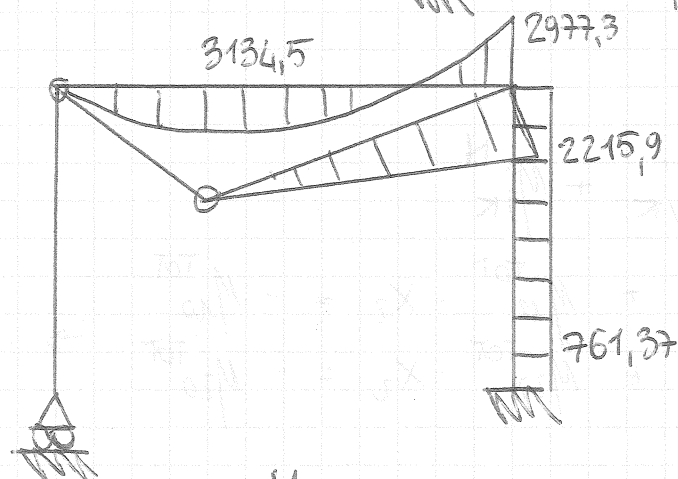
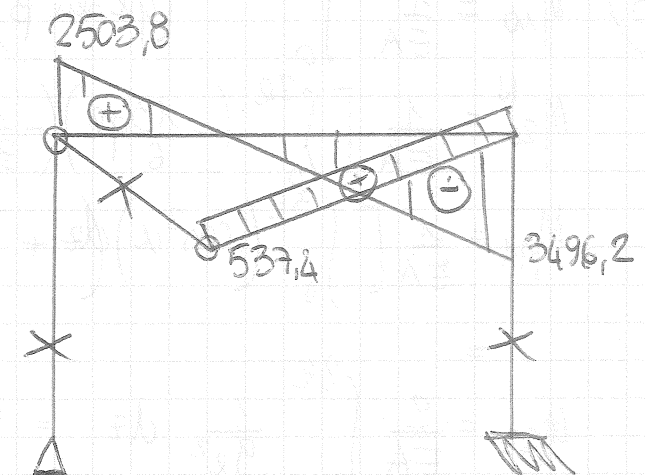
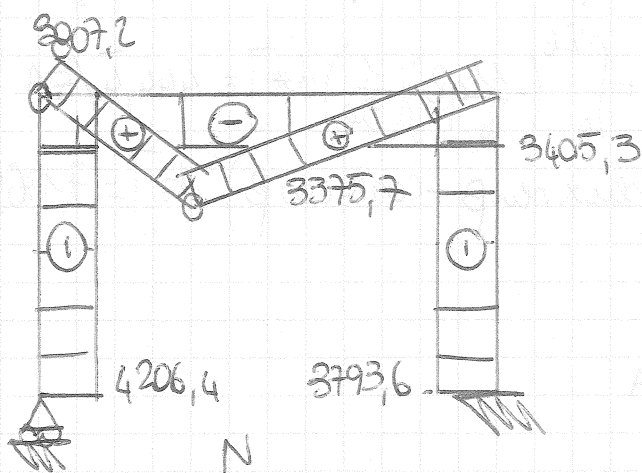
$$M_{20} = \frac{1}{EJ} \int_0^{3l} \left(\frac{z}{3l} \right) \left(\frac{13}{6} qlz - \frac{ql^2}{2} \right) dz = 25000/EJ$$

$$M_{11} = \frac{1}{EJ} \left[\int_0^{3l} (\sin^2 \alpha z^2) dz + \int_0^{2l/\cos \beta} (\sin \alpha \cos \beta + \cos \alpha \sin \beta)^2 z^2 dz \right] = 24,2955/EJ$$

$$M_{22} = \frac{1}{EJ} \left[\int_0^{2l} 1 dz + \int_0^{3l} \frac{z^2}{9l^2} dz \right] = 6/EJ$$

$$M_{12} = \frac{1}{EJ} \int_0^{3l} \left(\frac{z}{3l} \right) (\sin \alpha z) dz = 5,36656/EJ$$

$$\begin{aligned} 1) & \rightarrow \begin{cases} M_{11} \cdot X_1 + M_{12} \cdot X_2 = -M_{10} \\ M_{12} \cdot X_1 + M_{22} \cdot X_2 = -M_{20} \end{cases} \rightarrow \begin{aligned} X_1 &= -3807,24 \text{ N} \\ X_2 &= -761,37 \text{ Nm} \end{aligned} \\ 2) & \rightarrow \end{aligned}$$



2) PROGETTO

combinazione $M_{max} = 3134,5 \text{ Nm}$ $N = 3405,3 \text{ N}$

$$\sigma_{am} = 390 \text{ MPa}$$

$$W_{min} = \frac{M_{max}}{\sigma_{am}} = \frac{3134,5 \cdot 10^3}{390} = 8037 \text{ mm}^3 = 8,037 \text{ cm}^3$$

Adatto IPE 80

$$W_x = 20,03 \text{ cm}^3$$

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

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

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

VERIFICA

$$\sigma_{max} = - \frac{3405,3}{7,64 \cdot 10^2} - \frac{3134,5 \cdot 10^3}{20,03 \cdot 10^3} = 160,9 < 390 \text{ MPa} \quad \star!$$

$$3) \quad M_{10}^N = \frac{1}{EA} \int_0^{2l/\cos\beta} (q l \sin\beta) (\sin\alpha \sin\beta - \cos\alpha \cos\beta) dz = -1518,51/EA$$

$$M_{20}^N = \frac{1}{EA} \left[\int_0^{2l} \left(-\frac{13}{6} q l \right) \left(-\frac{1}{3l} \right) dz + \int_0^{2l} \left(-\frac{11}{6} q l \right) \left(\frac{1}{3l} \right) dz \right] = 444,4/EA$$

$$M_{11} = \frac{1}{EA} \left[\int_0^{3l} (\cos^2\alpha) dz + \int_0^{2l/\cos\beta} (\sin\alpha \sin\beta - \cos\alpha \cos\beta)^2 dz \right] = 7,1769/EA$$

$$M_{22} = \frac{2}{EA} \int_0^{2l} \frac{1}{9l^2} dz = 0,2/EA$$

$$M_{12} = 0$$

$$M_{ik}^{TOT} = M_{ik} + M_{ik}^N$$

$$\begin{cases} M_{11}^{TOT} \cdot X_1 + M_{12}^{TOT} \cdot X_2 = -M_{10}^{TOT} \\ M_{12}^{TOT} \cdot X_1 + M_{22}^{TOT} \cdot X_2 = -M_{20}^{TOT} \end{cases} \rightarrow \begin{aligned} X_1 &= -3805,69 \text{ Nm} \\ X_2 &= -762,75 \text{ N} \end{aligned}$$

