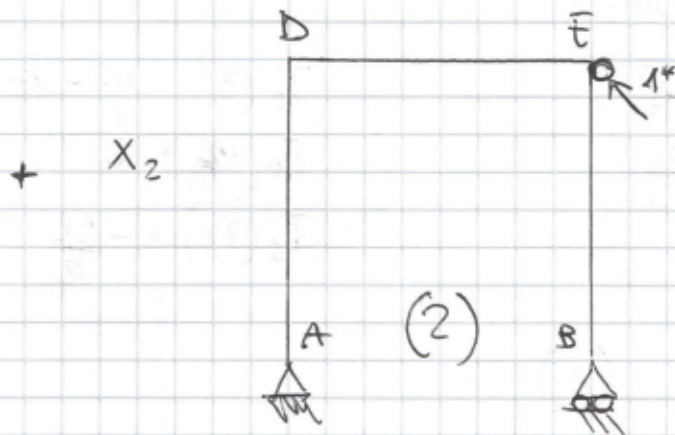
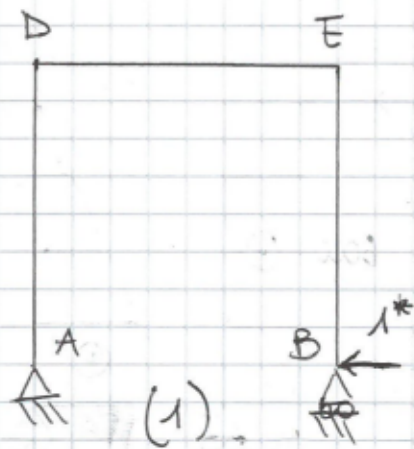
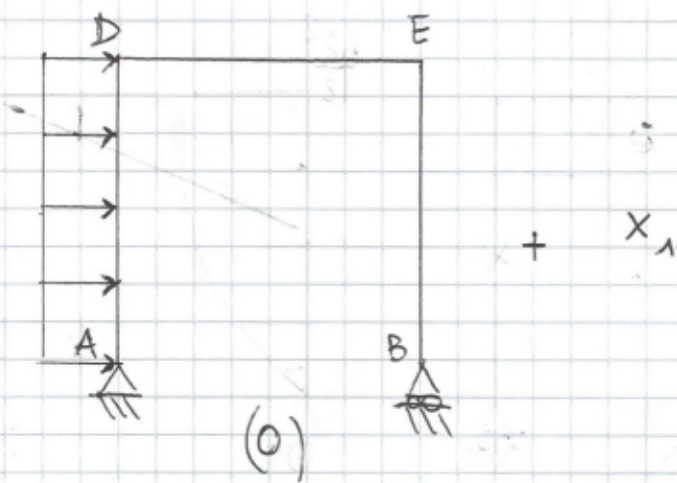
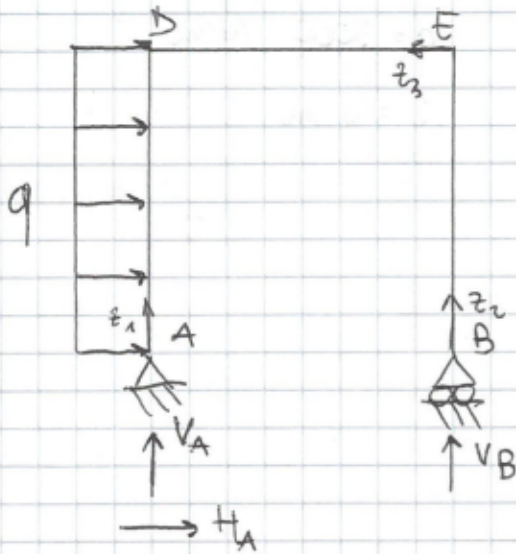


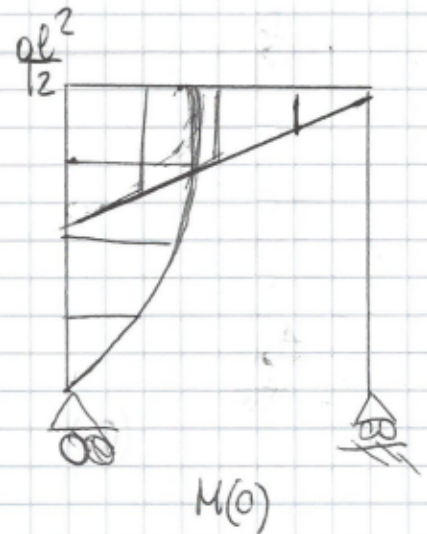
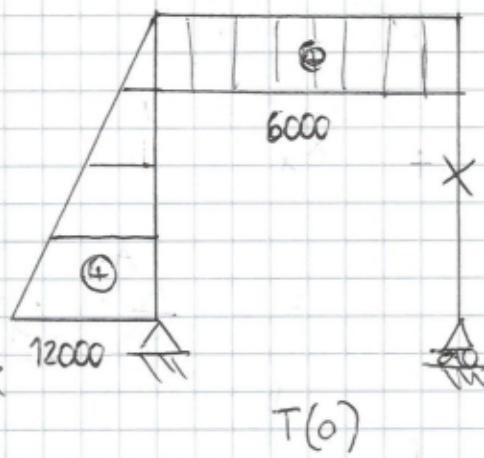
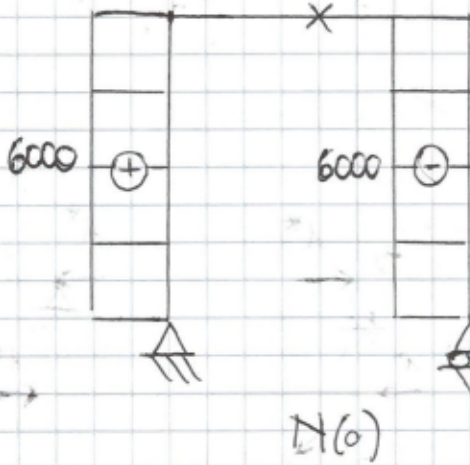
$q = 3000 \text{ N/m}$   
 $e = 4 \text{ m}$



# SISTEMA (0)



$$\begin{aligned} \rightarrow) \quad H_A + ql &= 0 & H_A &= -ql \\ A) \quad V_B - l - \frac{ql^2}{2} &= 0 & V_B &= \frac{ql}{2} \\ \uparrow) \quad V_A - V_B &= -\frac{ql}{2} \end{aligned}$$

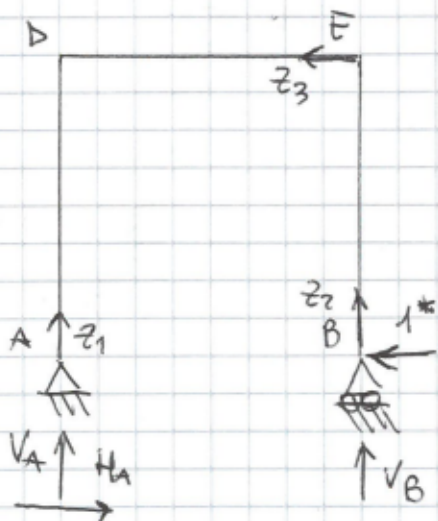


$$\begin{aligned} N_0(z_1) &= +\frac{ql}{2} \\ N_0(z_2) &= -\frac{ql}{2} \\ N_0(z_3) &= 0 \end{aligned}$$

$$\begin{aligned} T_0(z_1) &= ql - qz \\ T_0(z_2) &= 0 \\ T_0(z_3) &= -\frac{ql}{2} \end{aligned}$$

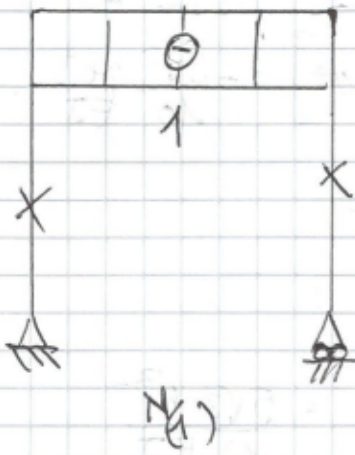
$$\begin{aligned} M_0(z_1) &= qlz - \frac{qz^2}{2} \\ M_0(z_2) &= 0 \\ M_0(z_3) &= \frac{ql}{2} \cdot z \end{aligned}$$

# SISTEMA (1)



$$\begin{aligned} \rightarrow) \quad H_A &= 1 \\ A) \quad V_B &= 0 \\ \uparrow) \quad V_A &= 0 \end{aligned}$$

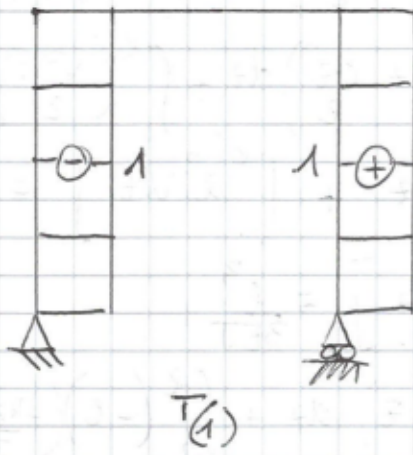




$$N_1(z_1) = 0$$

$$N_1(z_2) = 0$$

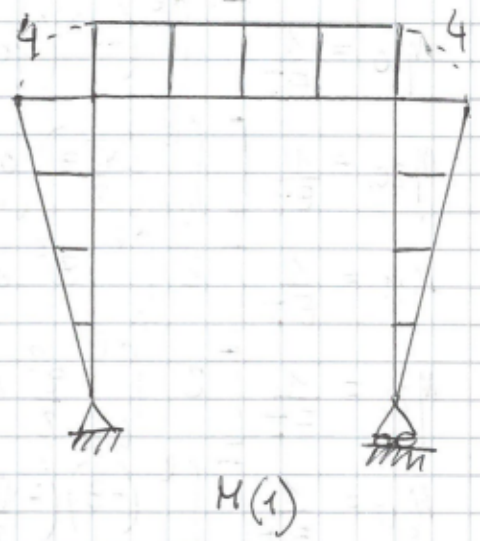
$$N_1(z_3) = -1$$



$$T_1(z_1) = -1$$

$$T_1(z_2) = 1$$

$$T_1(z_3) = 0$$

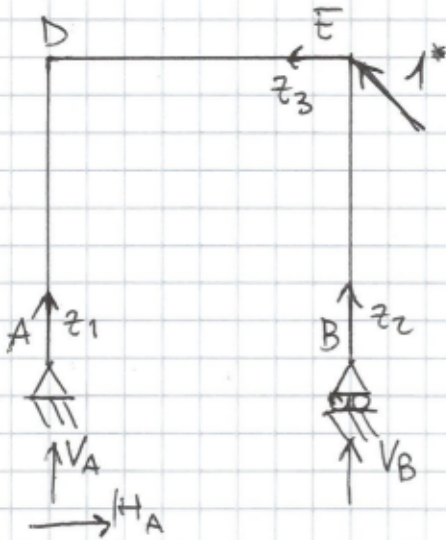


$$M_1(z_1) = -z$$

$$M_1(z_2) = -z$$

$$M_1(z_3) = -l$$

## SISTEMA (2)



$$\rightarrow H_A - \frac{\sqrt{2}}{2} = 0 \quad H_A = \frac{\sqrt{2}}{2}$$

$$\uparrow V_B \cdot l + 1 \cdot \sqrt{2}l = 0 \quad V_B = -\sqrt{2}$$

$$\uparrow V_A + V_B + \frac{\sqrt{2}}{2} = 0 \quad V_A = \sqrt{2} - \frac{\sqrt{2}}{2} = \frac{\sqrt{2}}{2}$$

$$N_2(z_1) = -\frac{\sqrt{2}}{2}$$

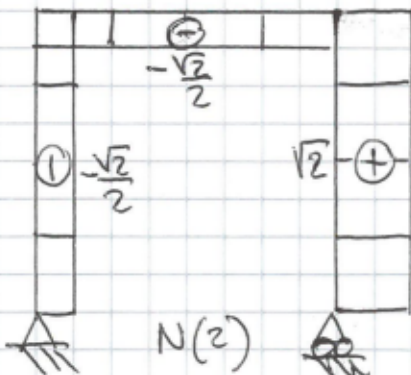
$$N_2(z_3) = -\frac{\sqrt{2}}{2}$$

$$T_2(z_2) = 0$$

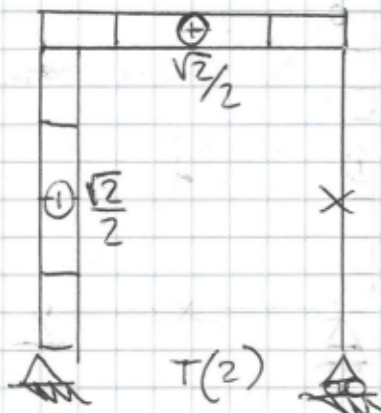
$$N_2(z_2) = \sqrt{2}$$

$$T_2(z_1) = -\frac{\sqrt{2}}{2}$$

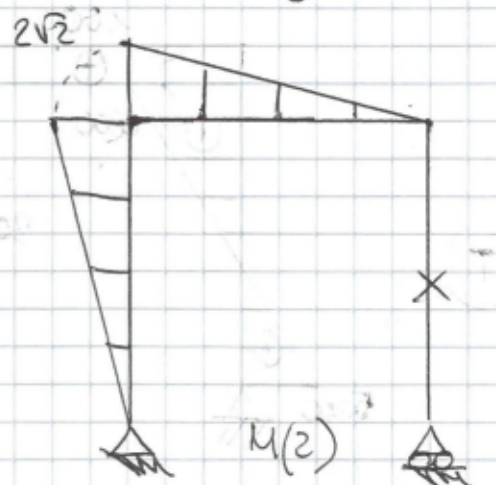
$$T_2(z_3) = \frac{\sqrt{2}}{2} + \sqrt{2}$$



$$M_2(z_1) = -\frac{\sqrt{2}}{2} z$$



$$M_2(z_2) = 0$$



$$M_2(z_3) = -\frac{\sqrt{2}}{2} z$$

$$M_{10} = \frac{1}{EJ} \left[ \int_0^l (-z) \left( qlz - \frac{qz^2}{2} \right) dz + \int_0^l (-l) \left( \frac{qlz}{2} \right) dz \right] = -\frac{11}{24} \frac{ql^4}{EJ}$$

$$M_{20} = \frac{1}{EJ} \left[ \int_0^l \left( -\frac{\sqrt{2}z}{2} \right) \left( qlz - \frac{qz^2}{2} \right) dz + \int_0^l \left( -\frac{\sqrt{2}z}{2} \right) \left( \frac{qlz}{2} \right) dz \right] = -\frac{3\sqrt{2}}{16} \frac{ql^4}{EJ}$$

$$M_{11} = \frac{1}{EJ} \left[ 2 \int_0^l z^2 dz + \int_0^l l^2 dz \right] = \frac{5}{3} \frac{l^3}{EJ}$$

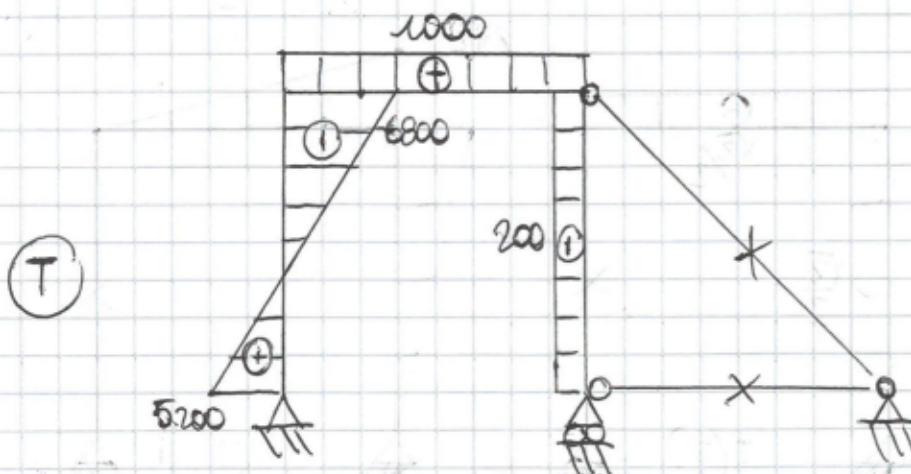
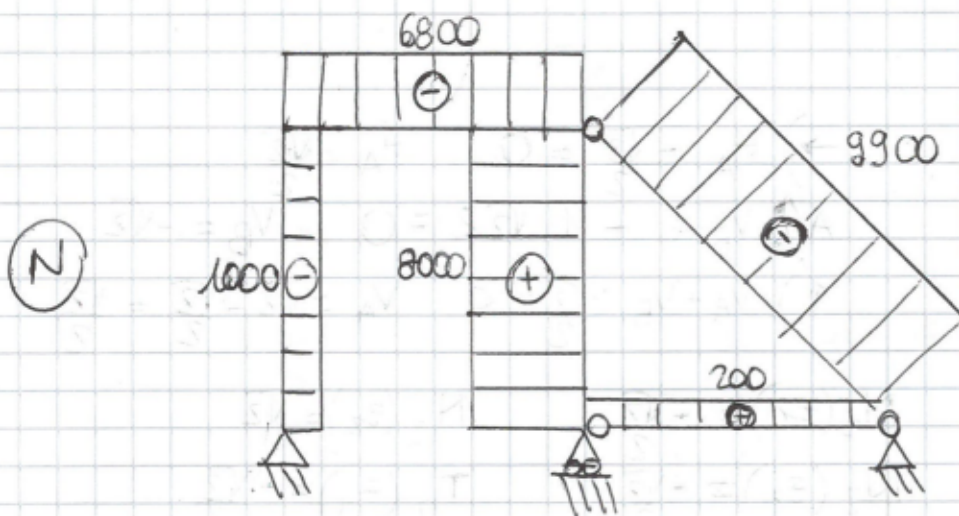
$$M_{22} = \frac{1}{EJ} \left[ 2 \int_0^l \frac{z^2}{2} dz \right] = \frac{l^3}{3EJ}$$

$$M_{12} = \frac{1}{EJ} \left[ \int_0^l (-z) \left( -\frac{\sqrt{2}z}{2} \right) dz + \int_0^l (-l) \left( -\frac{\sqrt{2}z}{2} \right) dz \right] = \frac{5\sqrt{2}l^3}{12EJ}$$

$$\begin{aligned} (1) &\rightarrow \begin{cases} M_{10} = M_{11} \cdot X_1 + M_{12} \cdot X_2 \\ (2) &\rightarrow \begin{cases} M_{20} = M_{12} \cdot X_1 + M_{22} \cdot X_2 \end{cases} \end{cases} \end{aligned}$$

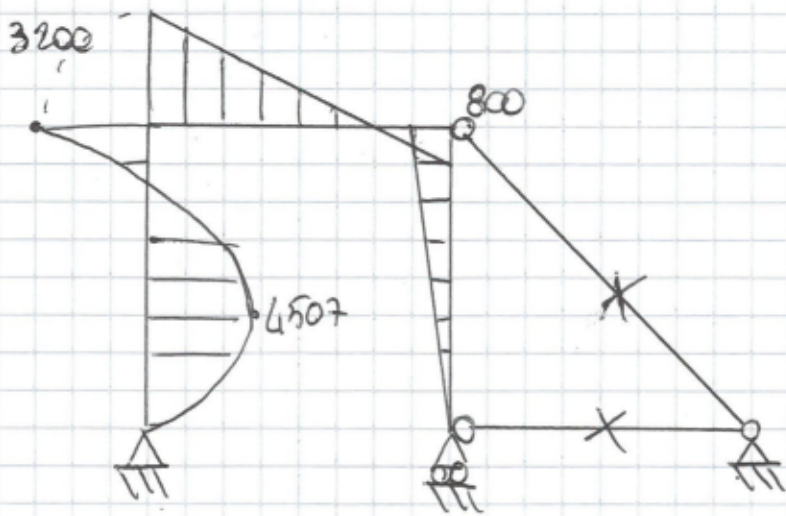
$$X_1 = -200 \text{ N}$$

$$X_2 = 9900 \text{ N}$$





(M)



2)  $M = 4507 \text{ Nm}$   
 $N = -1000 \text{ N}$

Progetto  $W_{\min} = \frac{M_{\max}}{\sigma_{\max}} = \frac{4507 \cdot 1000}{190} = 23721 \text{ mm}^3$

Adotto IPE 100  
 $W_x = 34,20 \text{ cm}^3$   
 $I_x = 171 \text{ cm}^4$   
 $A_{\text{IPE}} = 10,32 \text{ cm}^2$

$$\sigma_{1,2} = \frac{N}{A} \pm \frac{M}{W_x} = \frac{-1000}{10,32 \cdot 100} \pm \frac{4507 \cdot 1000}{34,20 \cdot 1000} \begin{cases} 130,8 \text{ MPa} < 190 \\ -132,8 \text{ MPa} < 190 \end{cases}$$

3)  $A_{\text{TOND}} = \pi \cdot 5^2 = 78,54 \text{ cm}^2$

$$M_{ij}^{\text{Tot}} = M_{ij}^T + M_{ij}^N$$

$$M_{10}^N = 0$$

$$M_{20}^N = \frac{1}{EA_{\text{IPE}}} \left[ \int_0^l \left( \frac{ql}{2} \right) \left( -\frac{\sqrt{z}}{2} \right) dz \right] + \int_0^l \left( -\frac{ql}{2} \right) \left( \sqrt{z} \right) dz = -\frac{3\sqrt{2}ql^2}{4EA}$$

$$M_{11}^N = \frac{1}{EA_{\text{IPE}}} \int_0^l 1 dz + \frac{1}{EA_{\text{TOND}}} \int_0^l 1 dz = \frac{l}{EA_{\text{IPE}}} + \frac{l}{EA_{\text{TOND}}}$$

$$M_{22}^N = \frac{1}{EA_{\text{IPE}}} \left[ 2 \int_0^l \frac{1}{2} dz + \int_0^l 2 dz \right] + \frac{1}{EA_{\text{TOND}}} \int_0^{\sqrt{2}l} 1 dz = \frac{3l}{EA_{\text{IPE}}} + \frac{\sqrt{2}l}{EA_{\text{TOND}}}$$

$$M_{12}^N = \frac{1}{EA_{\text{IPE}}} \int_0^l (-1) \left( -\frac{\sqrt{z}}{2} \right) dz = \frac{\sqrt{2}l}{2EA_{\text{IPE}}}$$

$$\begin{aligned}
 (1) & \rightarrow \begin{cases} M_{11}^{TOT} \cdot X_1 + M_{12}^{TOT} \cdot X_2 = -M_{10}^{TOT} \\ M_{12}^{TOT} \cdot X_1 + M_{22}^{TOT} \cdot X_2 = -M_{20}^{TOT} - \int_0^{\sqrt{2}e} (-1) x \cdot \Delta t dz \end{cases} \\
 X_1 & = -152 \text{ N} & X_2 & = 9743
 \end{aligned}$$

