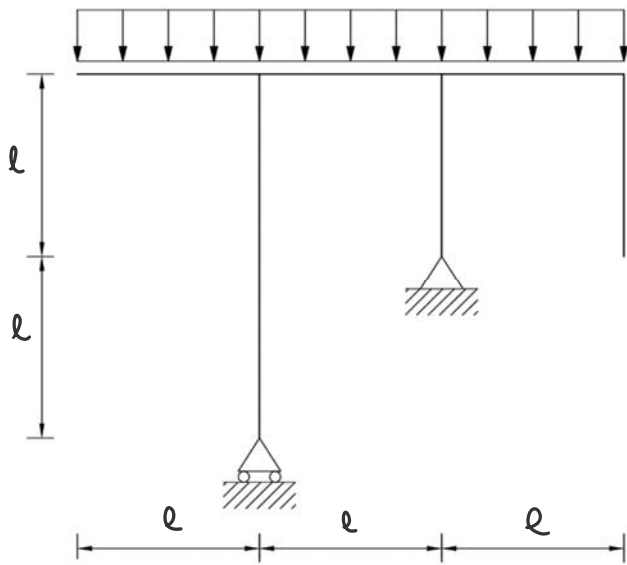
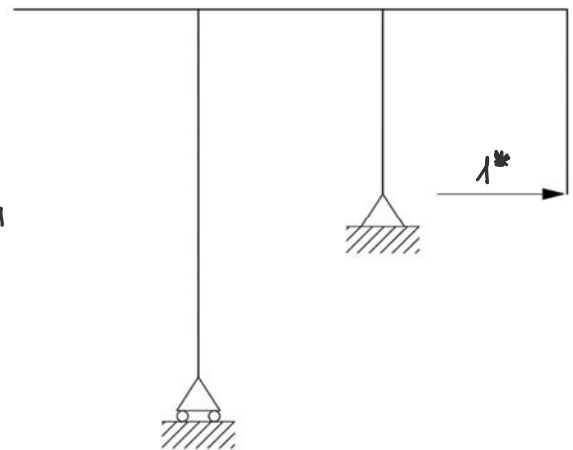
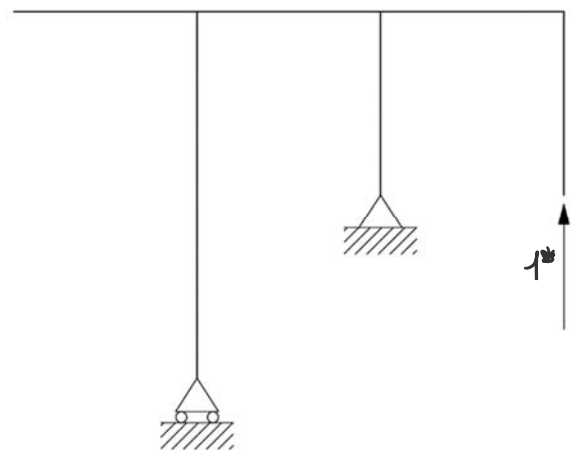




+ X_1

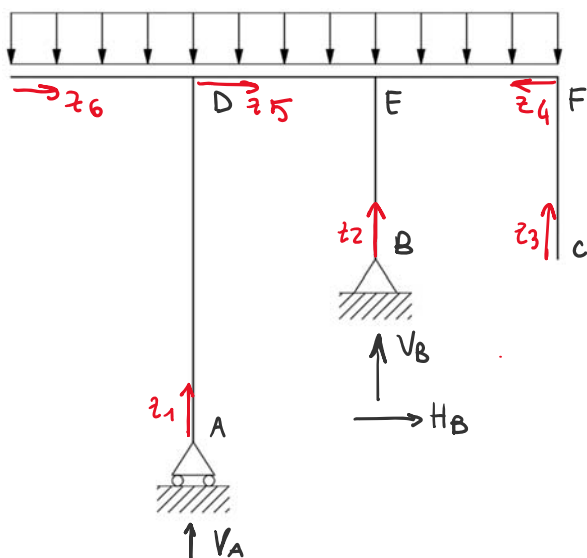


+ X_2



1)

SISTEMA (c)

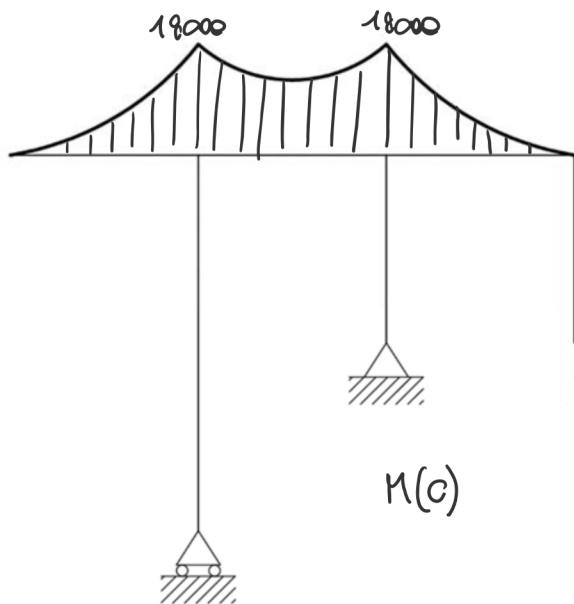
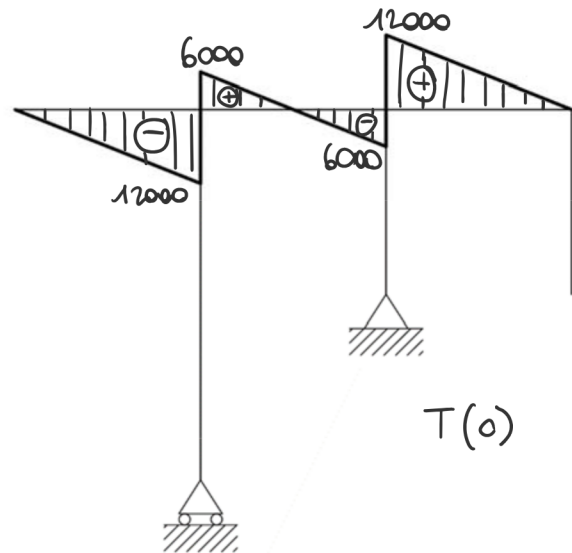
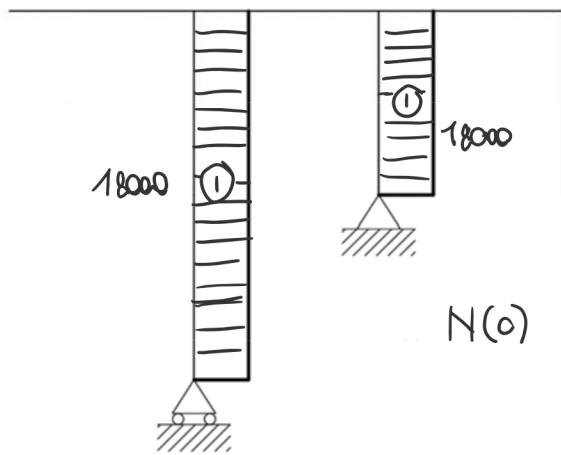


$$\rightarrow) H_B = 0$$

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

$$V_B = \frac{3}{2} ql$$

$$\uparrow) V_A = \frac{3}{2} ql$$



$$N_0(z_1) = -\frac{3}{2}ql$$

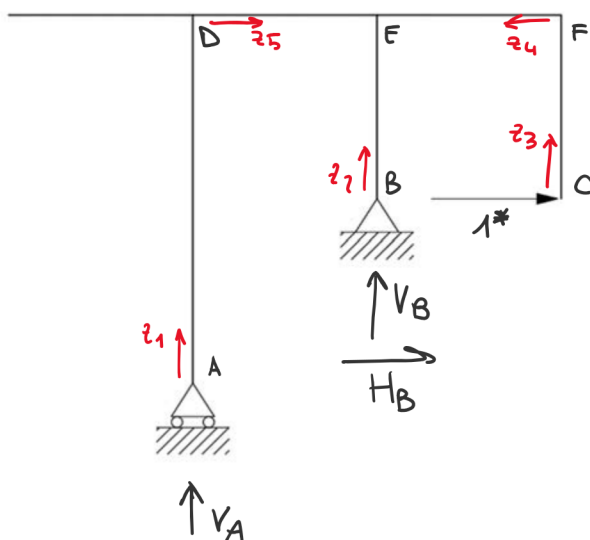
$$N_0(z_2) = -\frac{3}{2}ql$$

$$M_0(z_4) = -\frac{ql^2}{2}$$

$$M_0(z_6) = -\frac{ql^2}{2}$$

$$M_0(z_5) = -\frac{ql}{2}\left(\frac{l}{2}+z\right) - \frac{ql^2}{2} + \frac{3}{2}qlz$$

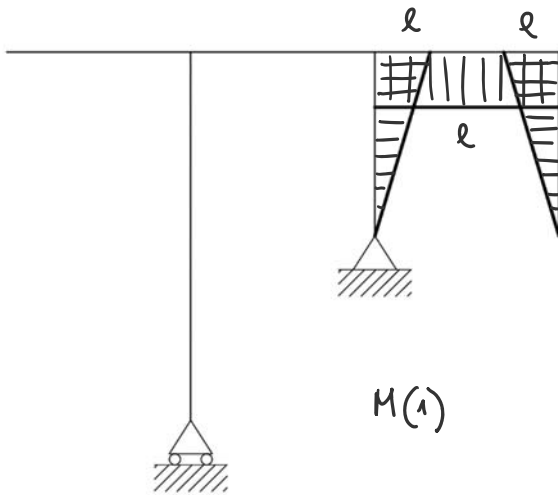
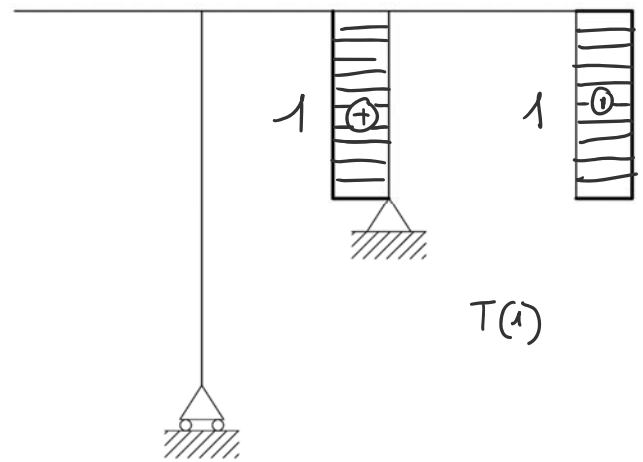
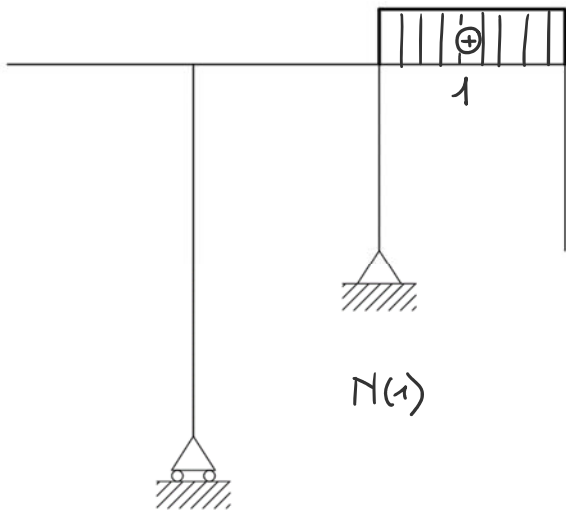
SISTEMA (1)



$$\rightarrow) H_B = -1$$

$$B) V_A = 0$$

$$\uparrow) V_B = 0$$



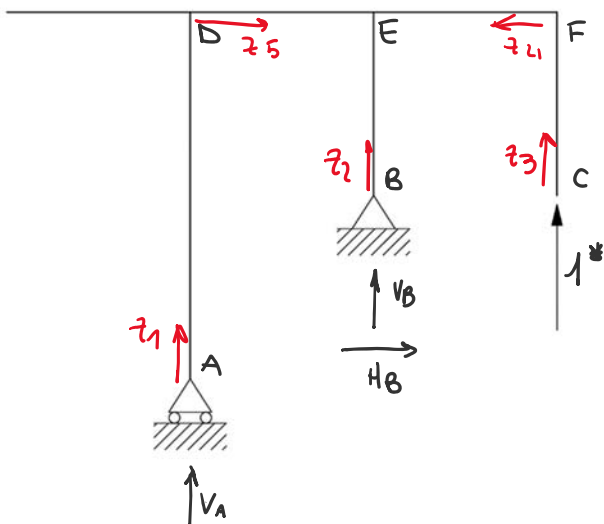
$$N_1(z_4) = 1$$

$$M_1(z_2) = z$$

$$M_1(z_3) = -z$$

$$M_1(z_4) = l$$

SISTEMA (2)

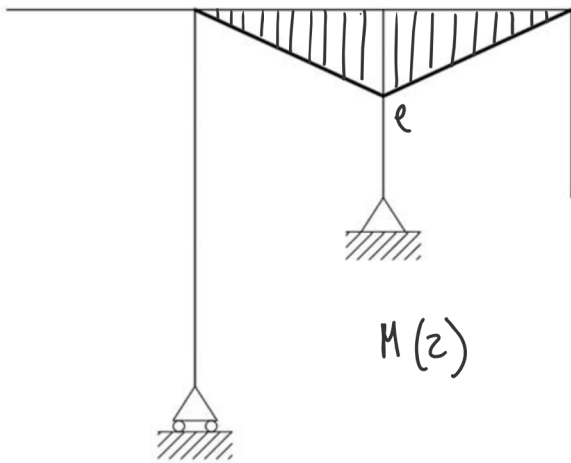
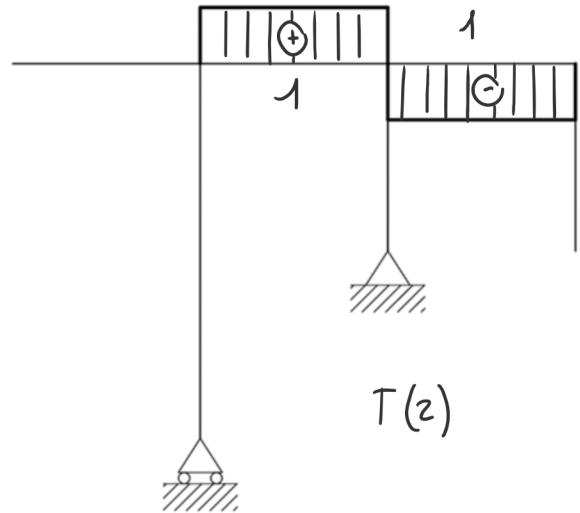
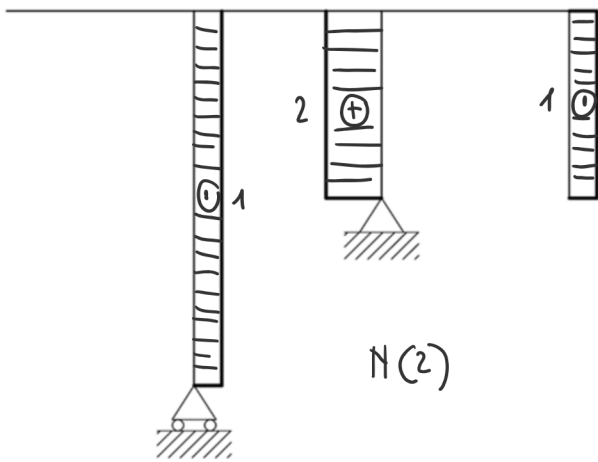


$$\rightarrow) H_B = 0$$

$$B) \quad l \cdot l - V_A \cdot l = 0$$

$$V_A = 1$$

$$\uparrow) V_B = -2$$



$$N_2(z_1) = -1$$

$$N_2(z_2) = 2$$

$$N_2(z_3) = -1$$

$$M_2(z_4) = z$$

$$M_2(z_5) = z$$

$$\eta_{10} = \frac{1}{EJ} \int_0^l \left(-\frac{qz^2}{2}\right) \cdot (1) dz = \frac{ql^4}{6EJ}$$

$$\eta_{20} = \frac{1}{EJ} \int_0^l \left(-\frac{qz^2}{2}\right) (z) dz + \frac{1}{EJ} \int_0^l z \cdot \left(-\frac{qz^2}{2} + \frac{3}{2}qlz - \frac{ql^2}{2}\left(\frac{l}{2} + z\right)\right) dz = -\frac{ql^4}{3EJ}$$

$$\eta_{12} = \frac{1}{EJ} \int_0^l (1)(z) dz = \frac{l^3}{3EJ}$$

$$\eta_{11} = \frac{2}{EJ} \int_0^l z^2 dz + \frac{1}{EJ} \int_0^l l^2 dz = \frac{5l^3}{3EJ}$$

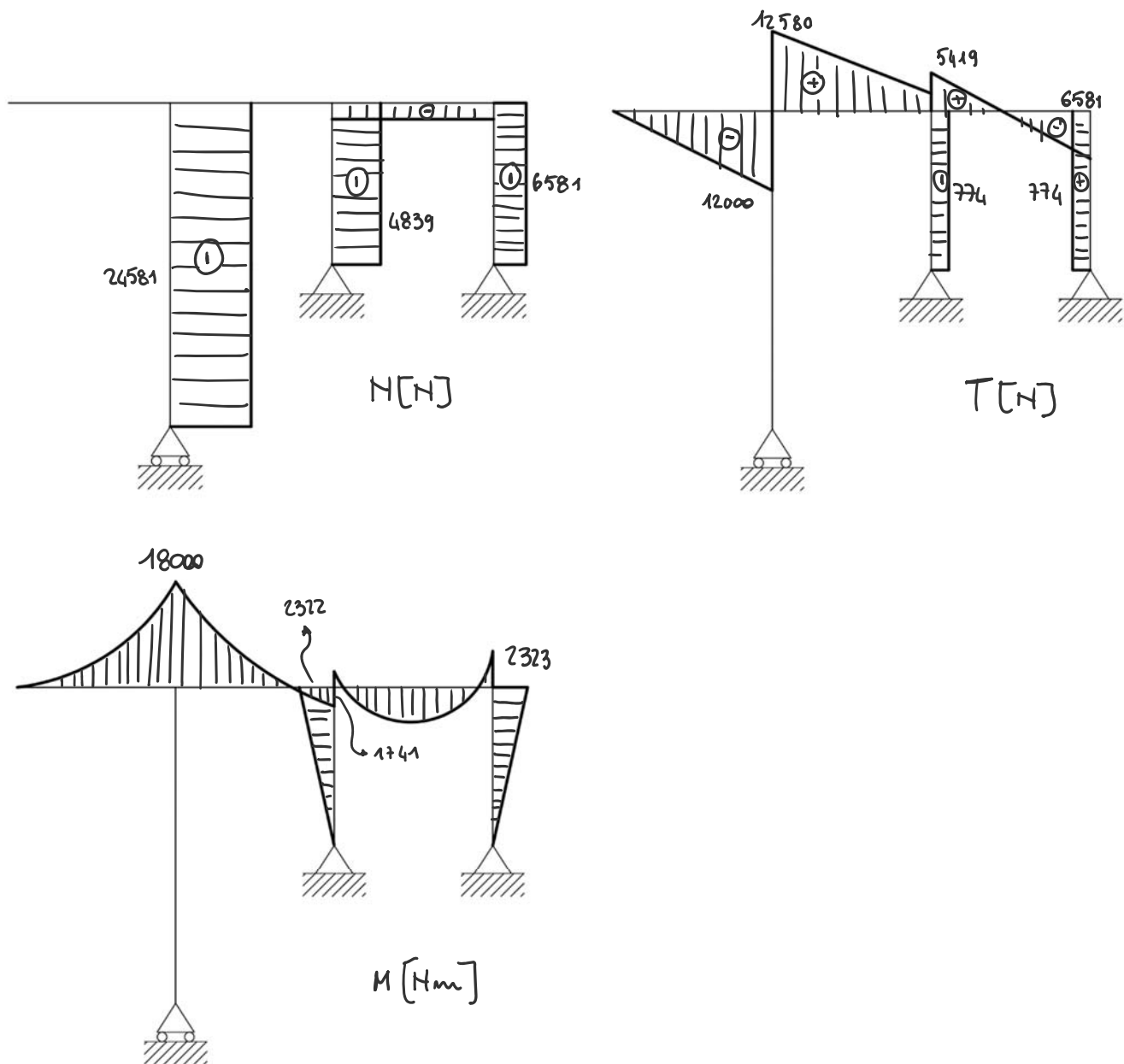
$$\eta_{22} = \frac{2}{EJ} \int_0^l z^2 dz = \frac{2l^3}{3EJ}$$

$$\begin{cases} (1) & \eta_{11} \cdot x_1 + \eta_{12} \cdot x_2 = -\eta_{10} \\ (2) & \eta_{12} \cdot x_1 + \eta_{22} \cdot x_2 = -\eta_{20} \end{cases}$$

$\Rightarrow$

$$x_1 = -774 \text{ N}$$

$$x_2 = 6581 \text{ N}$$



2) $M_{max} = 18000 \text{ Nm}$ $\sigma_{adm} = 190 \text{ MPa}$

$$W_{min} = \frac{M_{max}}{\sigma_{adm}} = \frac{18000 \cdot 1000}{190} = 94 \text{ cm}^3$$

Adatto IPE 160 $W_x = 108,7 \text{ cm}^3$ $A = 20,09 \text{ cm}^2$
 $J_x = 869,3 \text{ cm}^4$

$$\sigma_{max} = \frac{M_{max}}{W_x} = \frac{18000}{869,3} = 165 \text{ MPa} < 190 \text{ MPa}$$

3) $u_c = 2 \text{ cm} = 20 \text{ mm}$ $E = 210000 \text{ MPa}$

$$\eta_{ij}^{TOT} = \eta_{ij}^N + \eta_{ij}^M \quad \eta_{22}^N = \frac{2l}{EA} + \frac{4l}{EA} = \frac{6l}{EA}$$

$$\eta_{20}^N = -\frac{3ql^2}{2EA}$$

1) $\eta_{11} \cdot x_1 + \eta_{12} \cdot x_2 = -\eta_{10}$

2) $\eta_{12} \cdot x_1 + \eta_{22}^{TOT} \cdot x_2 = -\eta_{20}^{TOT} + 1^* \cdot (-20)$

$\Rightarrow x_1 = 19 \text{ N}$

$x_2 = 3938 \text{ N}$

