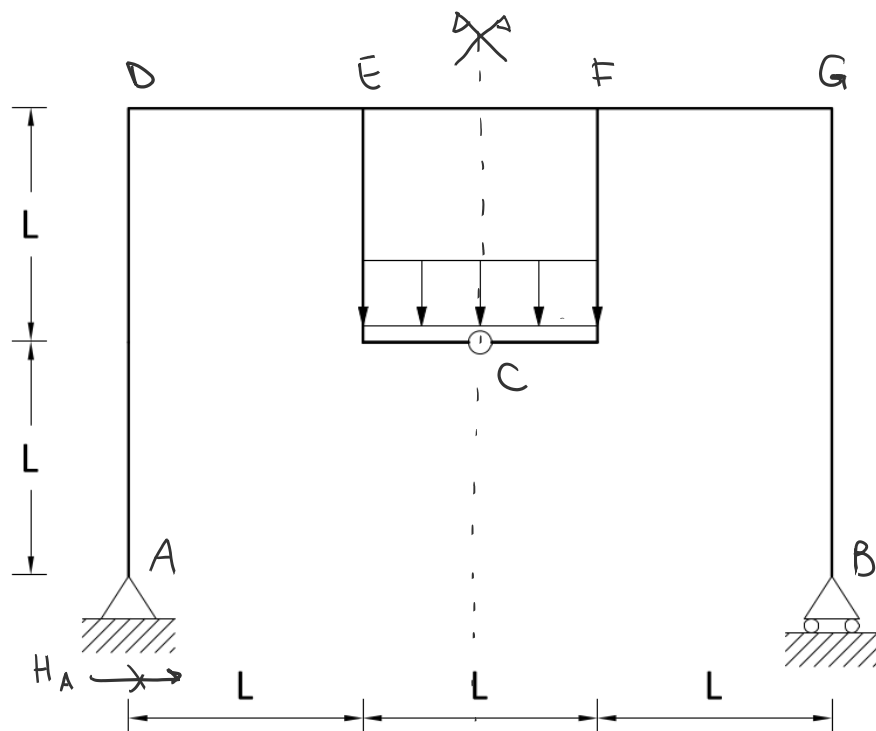


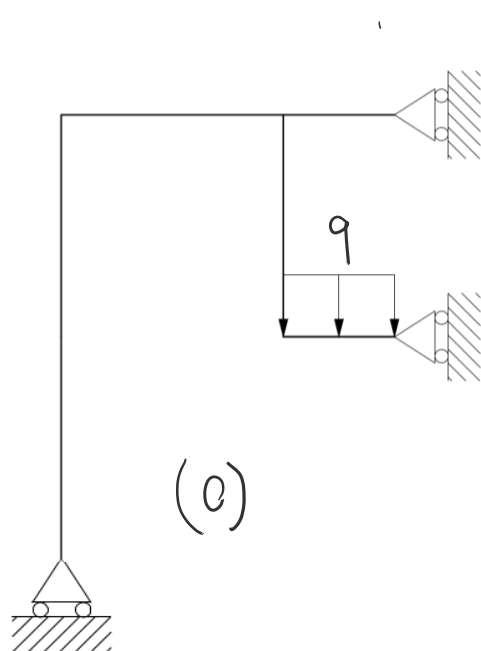


$$q = 10000 \text{ N/m}$$

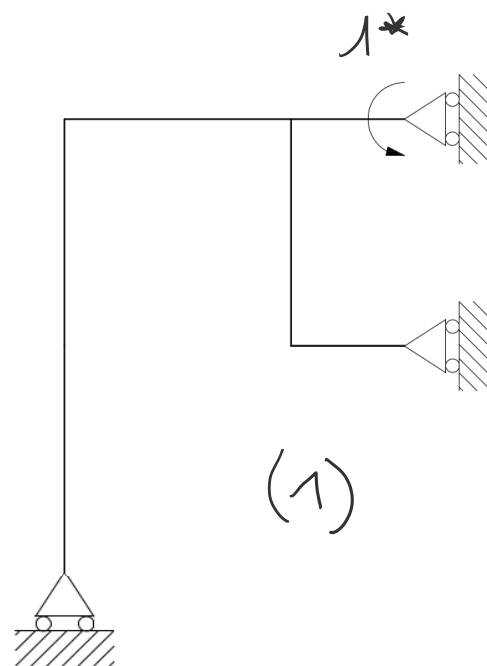
$$L = 3 \text{ m}$$

$$\rightarrow H_A = 0$$

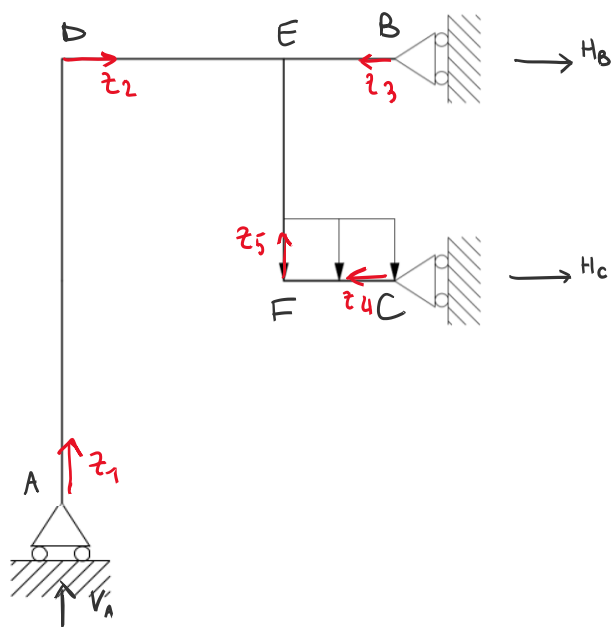
1)



+ X



SISTEMA (0)

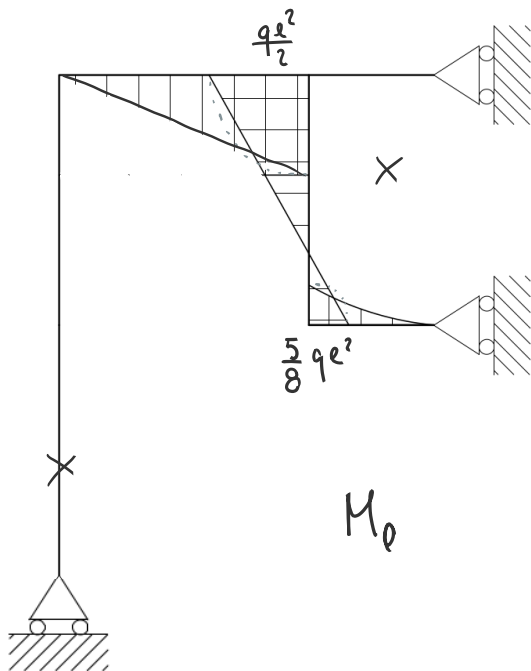
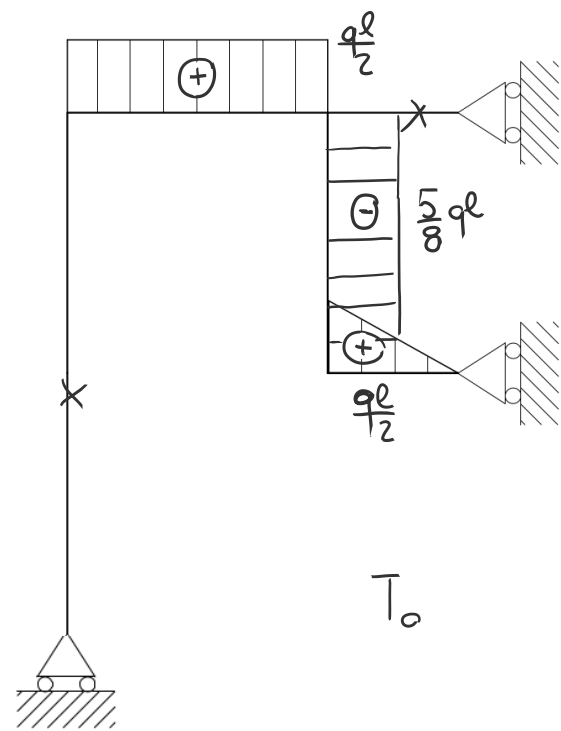
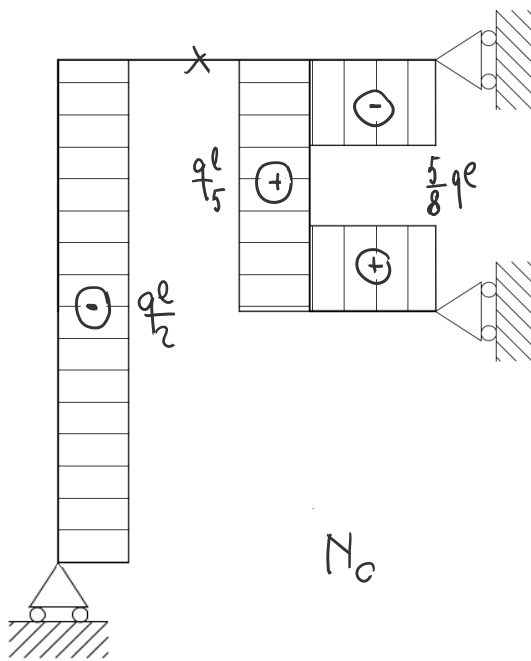


$$\uparrow V_A = \frac{qL}{2}$$

$$\rightarrow H_B = -H_C \quad H_B = -\frac{5}{8} qL$$

$$\circlearrowleft H_C \cdot L - \frac{qL}{2} \cdot \frac{5L}{4} = 0$$

$$H_C = \frac{5}{8} qL$$



$$M_o(z_1) = 0$$

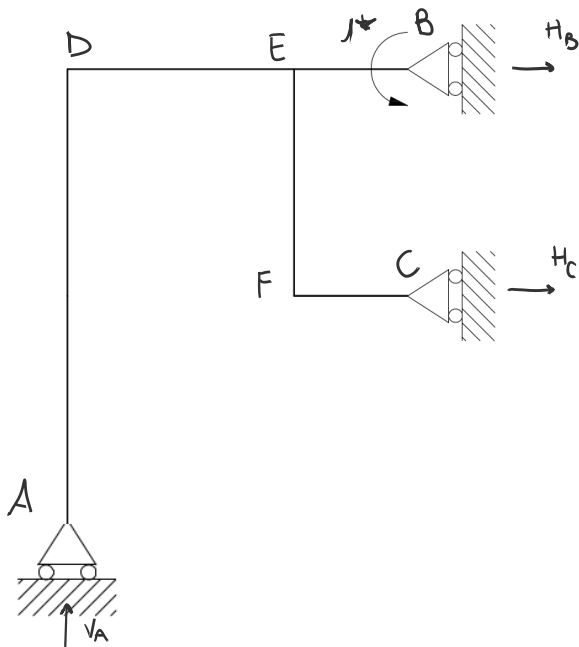
$$M_c(z_2) = \frac{ql}{2} z$$

$$M_c(z_3) = 0$$

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

$$M_o(z_5) = \frac{ql^2}{8} - \frac{5}{8} qlz$$

SISTEMA (1)

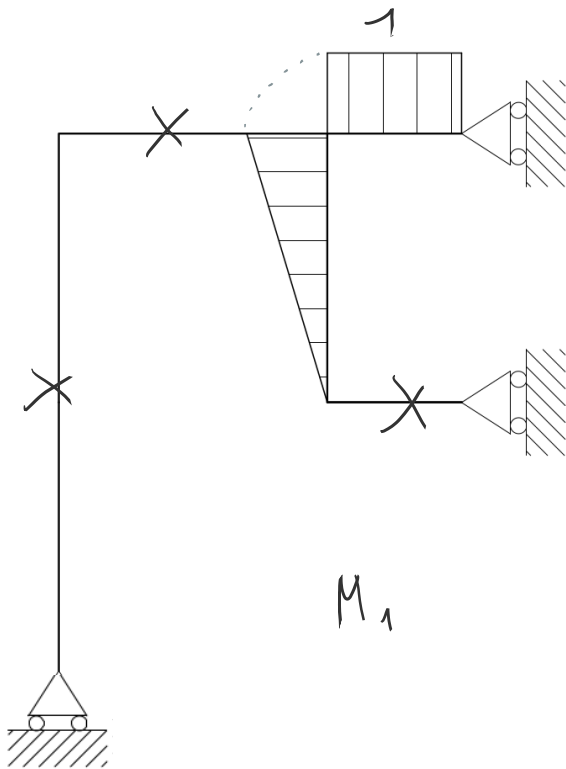
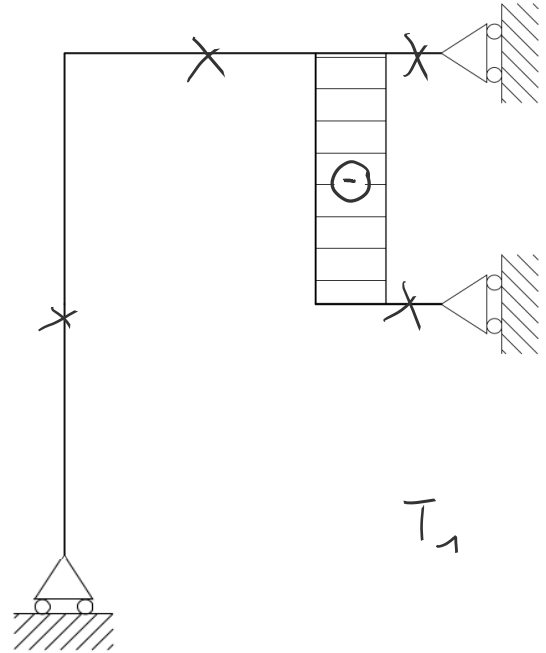
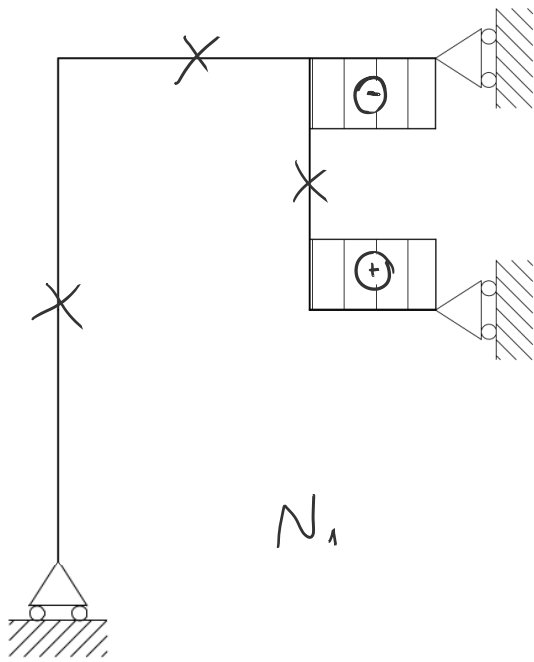


$$\uparrow) V_A = 0$$

$$B) H_c \cdot l - 1 = 0$$

$$H_c = \frac{1}{l}$$

$$\rightarrow) H_b = -\frac{1}{l}$$



$$M_1(z_1) = 0$$

$$M_1(z_2) = 0$$

$$M_1(z_3) = -1$$

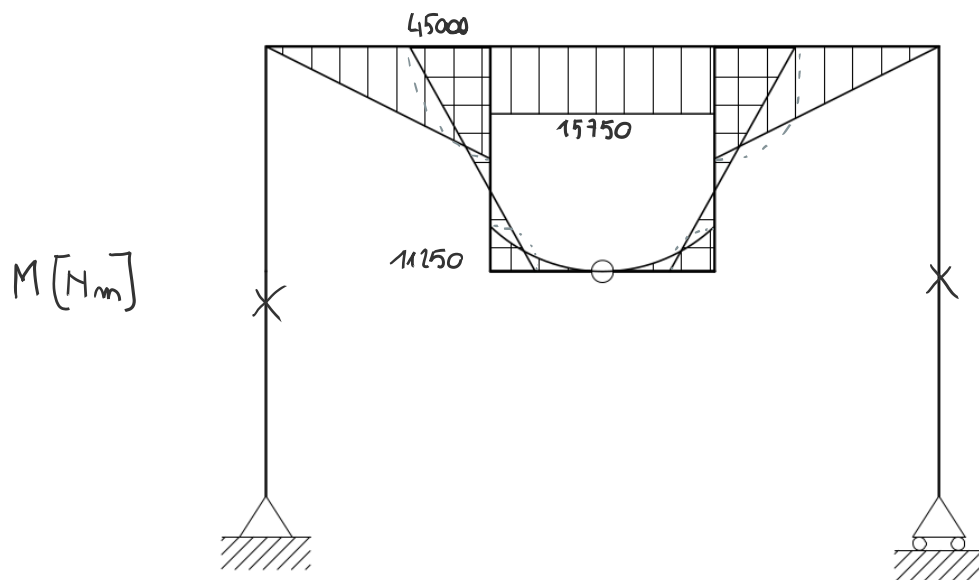
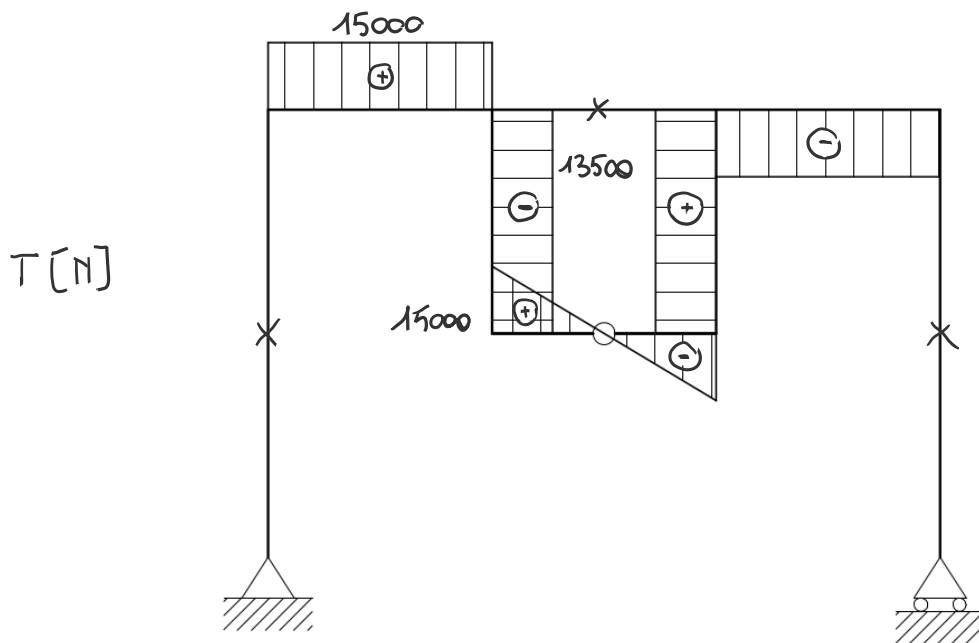
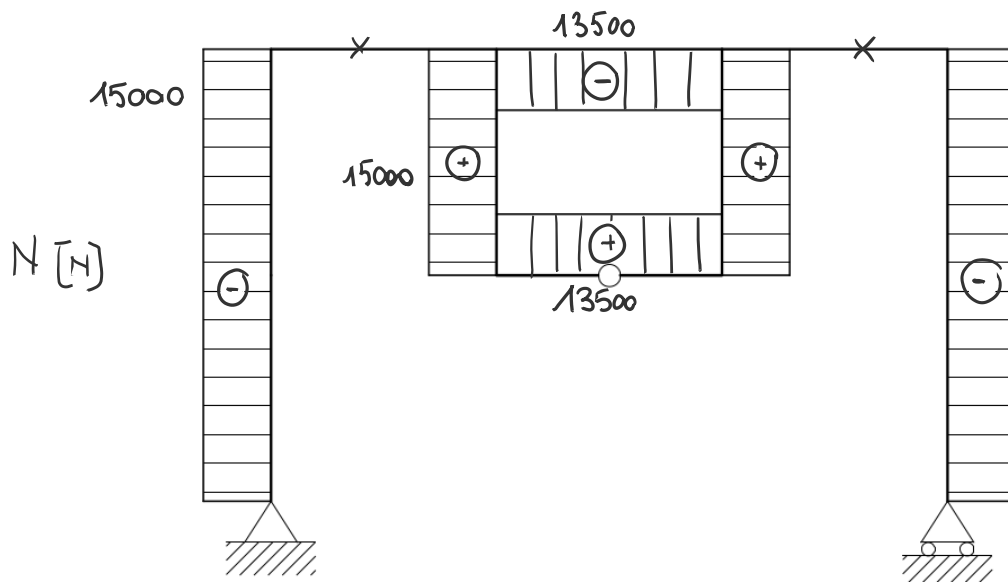
$$M_1(z_4) = 0$$

$$M_1(z_5) = -\frac{z}{l}$$

$$M_{10} = \frac{1}{EI} \int_0^l \left(-\frac{z}{l}\right) \left(\frac{ql^2}{8} - \frac{5}{8}qlz\right) dz = \frac{7ql^3}{48EI}$$

$$M_{11} = \frac{1}{EI} \int_0^l \left(-\frac{z}{l}\right)^2 dz + \int_0^{l/2} 1^2 dz = \frac{5l}{6EI}$$

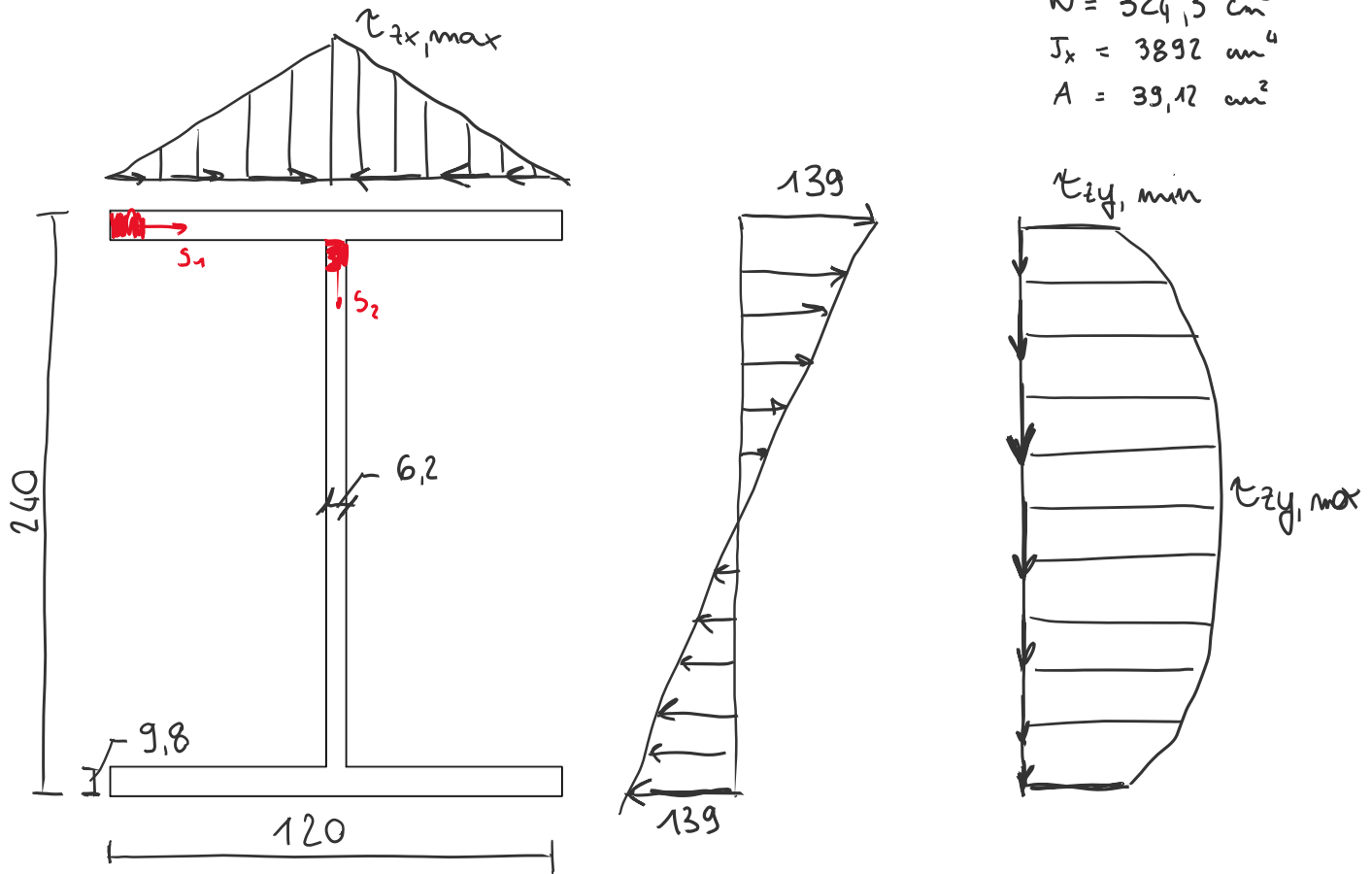
$$\chi = -\frac{M_{10}}{M_{11}} = -\frac{7ql^2}{40}$$



2) $M = 45000 \text{ Nm}$ $E = 210000 \text{ MPa}$
 $N = 0$ $\sigma_{\text{adm}} = 190 \text{ MPa}$
 $T = 15000 \text{ N}$

SEMI PROGETTO $W_{\text{min}} = \frac{M}{\sigma_{\text{adm}}} = \frac{45000}{190} = 237 \text{ cm}^3 \rightarrow$ ADOTTO IPE 240

$W = 324,3 \text{ cm}^3$
 $J_x = 3892 \text{ cm}^4$
 $A = 39,12 \text{ cm}^2$



$$\sigma_z = \frac{M}{W} = \frac{45000}{324,3} = 139 \text{ MPa}$$

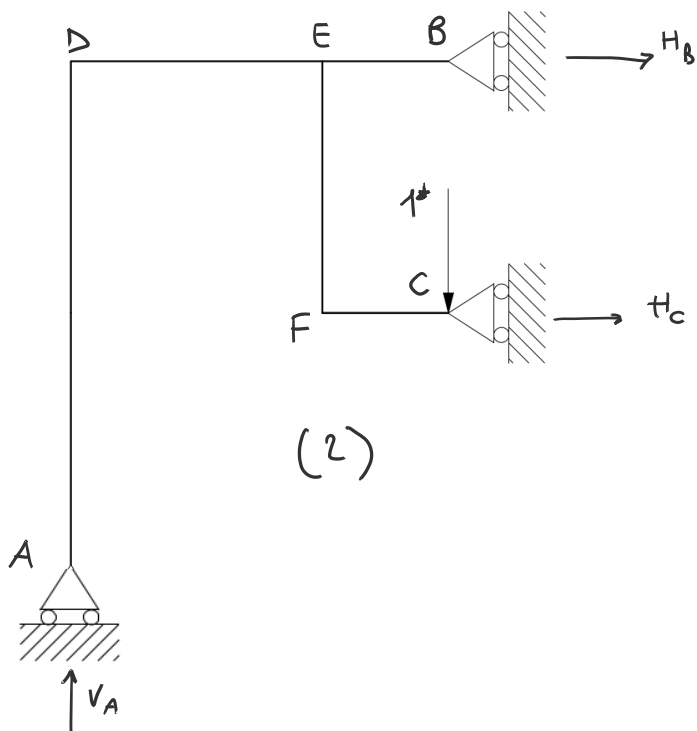
$$\tau_{xz, \text{max}} = - \frac{15000}{9,8} \frac{(9,8 \cdot 60 \cdot (-240 + 9,8) \cdot 0,5)}{38920000} = 2,66 \text{ MPa}$$

$$\tau_{zy, \text{min}} = - \frac{15000}{6,2} \frac{(9,8 \cdot 120 \cdot (-240 + 9,8) \cdot 0,5)}{38920000} = 8,41 \text{ MPa}$$

$$\tau_{zy, \text{max}} = - \frac{15000}{6,2} \frac{(120 \cdot (-240 + 9,8) \cdot 0,5 \cdot 9,8 + 6,2 \cdot (120 - 9,8)^2 \cdot 0,5)}{38920000} = 10,75 \text{ MPa}$$

$$\sigma_{\text{id}} = \sqrt{139^2 + 3 \cdot 8,41^2} = 139,8 < 190 \text{ MPa}$$

3)



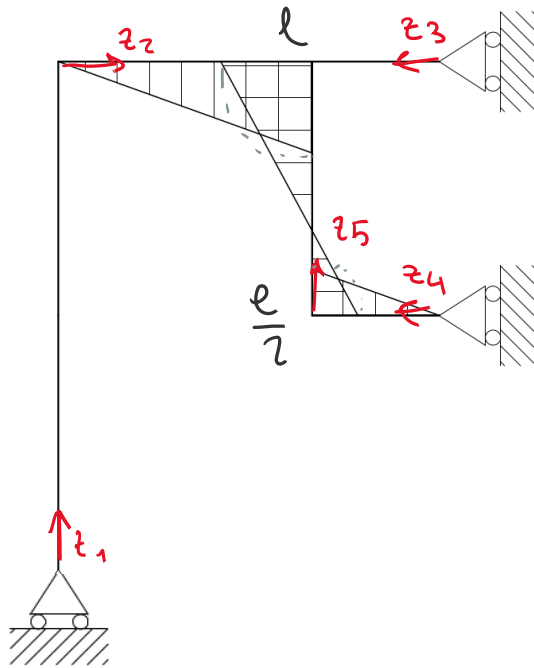
$$\uparrow) V_A = 1$$

$$\circlearrowleft) H_C \cdot e - 1 \cdot \frac{3}{2}e = 0$$

$$H_C = \frac{3}{2}$$

$$\rightarrow) H_B = -\frac{3}{2}$$

(2)



$$M_2(z_1) = 0$$

$$M_2(z_2) = z$$

$$M_2(z_3) = 0$$

$$M_2(z_4) = -z$$

$$M_2(z_5) = \frac{e}{2} - \frac{3}{2}z$$

$$1^* \cdot V_C = \frac{1}{EJ} \int_0^l \left(\frac{z}{2} \right) \left(\frac{q l^2}{2} \right) dz + \frac{1}{EJ} \int_0^{\frac{l}{2}} \left(-\frac{z}{2} \right) \left(-\frac{q l^2}{2} \right) dz + \frac{1}{EJ} \int_0^l \left(\frac{e}{2} - \frac{3z}{2} \right) \left(\frac{q l^2}{8} - \frac{5}{8} q l z - \frac{3z^2}{2} \right) dz$$

$$= 25,3 \text{ mm}$$