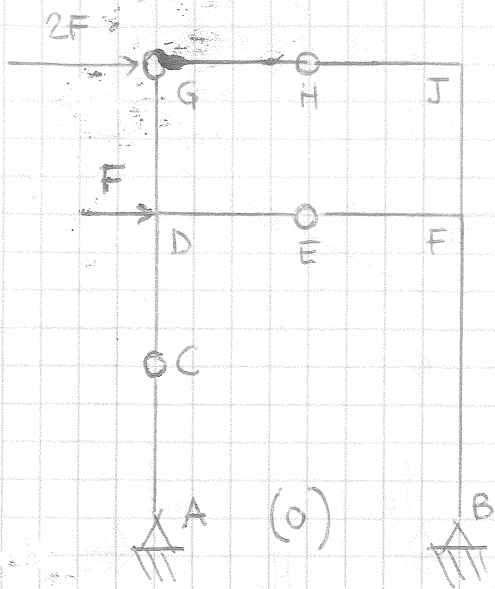
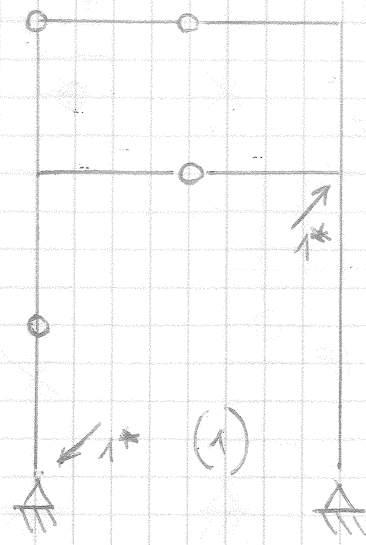
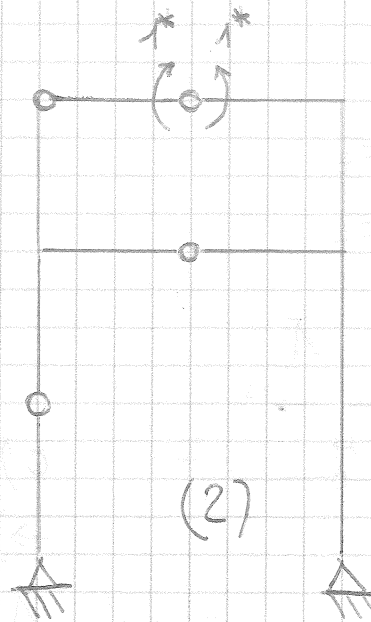




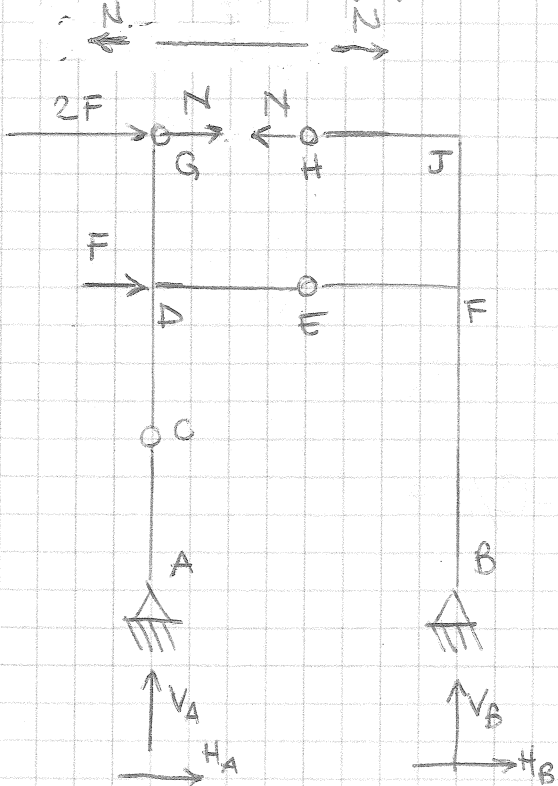
+ X_1



+ X_2



SISTEMA (0)



$$A) F \cdot 2l + 2F \cdot 3l - V_B \cdot 2l = 0$$

$$V_B = 4F$$

$$G) \text{ TRATTO CA} \quad H_A = 0$$

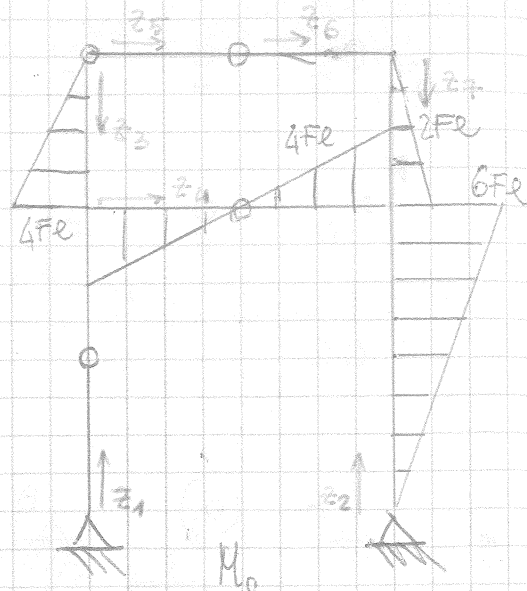
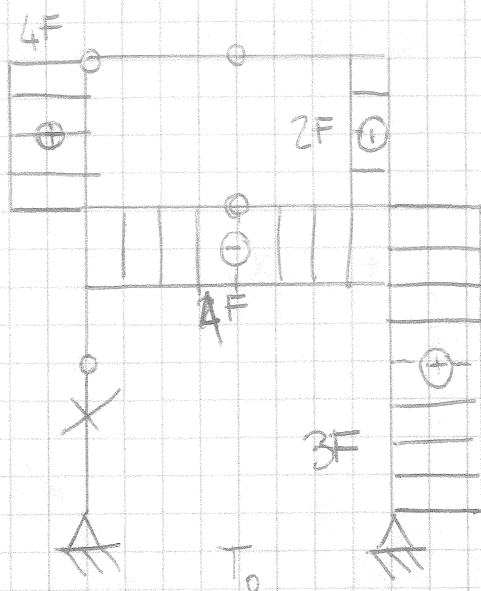
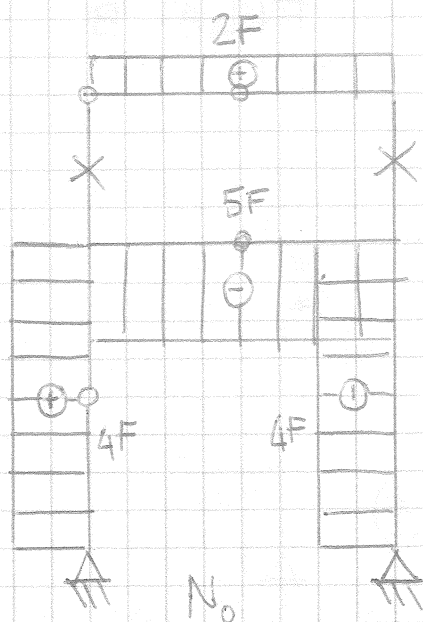
$$\rightarrow) H_B = -3F$$

$$\uparrow) V_A = -V_B = -4F$$

$$E) \text{ PARTE DX}$$

$$N \cdot l + V_B \cdot l + H_B \cdot 2l = 0$$

$$N = 2F$$



$$M(z_1) = 0$$

$$M(z_2) = -3Fz$$

$$M(z_3) = -4Fz$$

$$M(z_4) = 4Fz - 4Fz$$

$$M(z_5) = 0$$

$$M(z_6) = 0$$

$$M(z_7) = -2Fz$$

SISTEMA ↑



$$M(z_1) = 0$$

$$M(z_2) = -\sqrt{2}/2 \cdot z$$

$$M(z_3) = -\sqrt{2}/2 \cdot z$$

$$M(z_4) = \sqrt{2}/2 \cdot l - \sqrt{2}/2 \cdot z$$

$$C) H_A - \frac{\sqrt{2}}{2} l = 0$$

$$H_A = \sqrt{2}/2$$

$$\rightarrow H_B = -\sqrt{2}/2$$

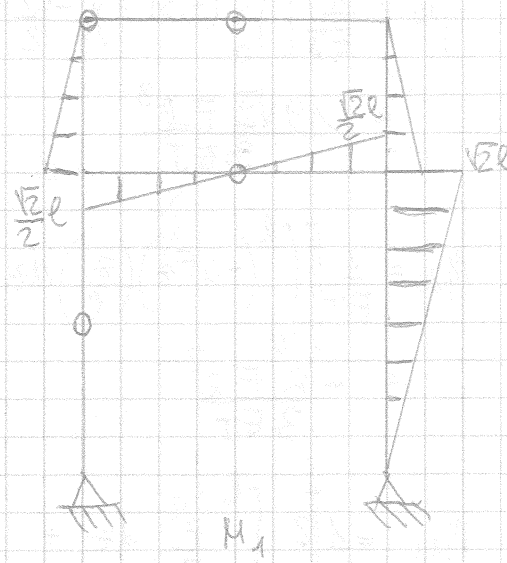
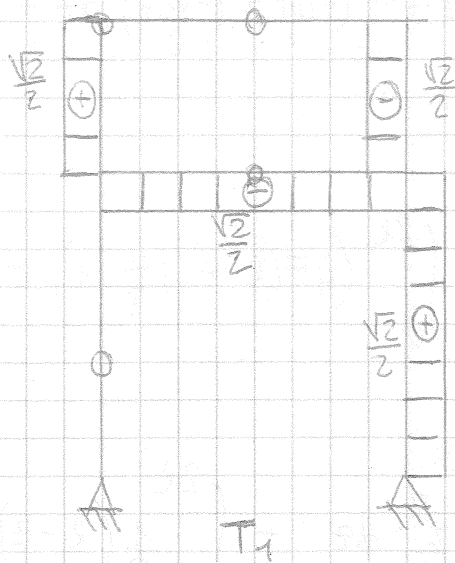
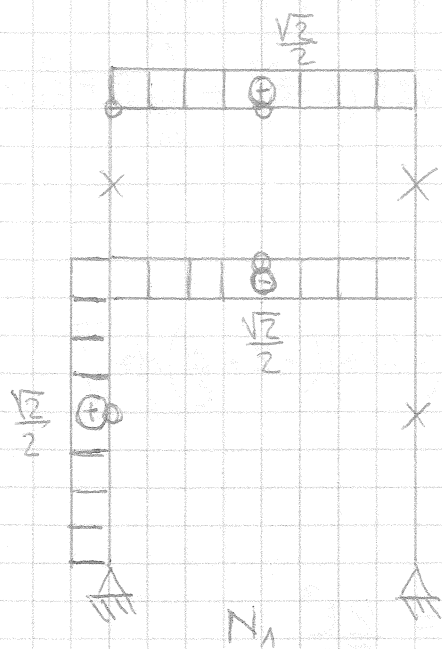
$$A) V_B = 0 \quad V_A = 0$$

$$E) H_B \cdot 2l + N \cdot l = 0$$

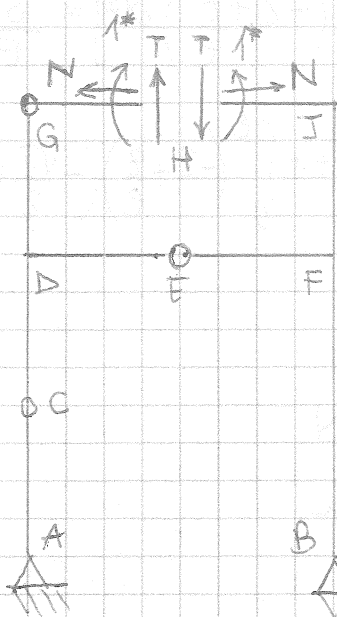
$$M(z_5) = 0$$

$$M(z_6) = 0$$

$$M(z_7) = -\sqrt{2}/2 \cdot z$$



SISTEMA 2



$$C) H_A = 0 \quad H_B = 0$$

$$A) V_B = 0$$

$$E) \text{ TRATTO DX}$$

$$1 - N \cdot l = 0 \quad N = 1/l$$

$$G) -1 + T \cdot l = 0 \quad T = 1/l$$

$$M(z_1) = 0$$

$$M(z_3) = z/l$$

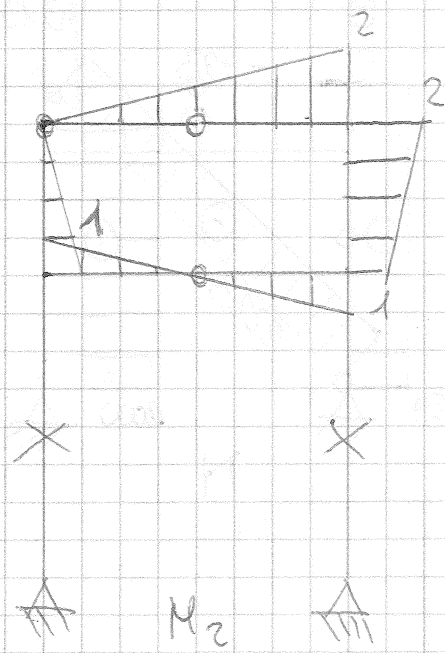
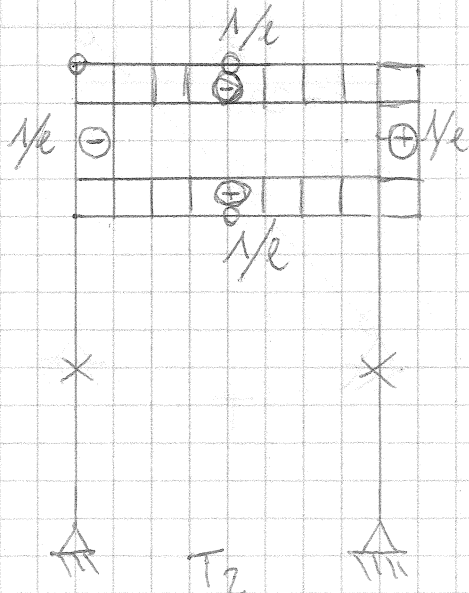
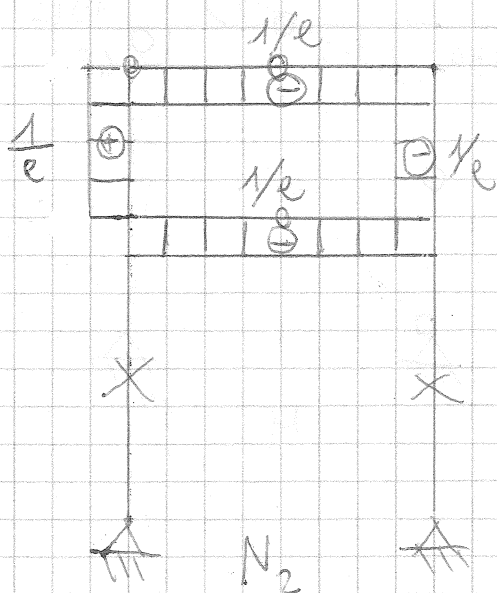
$$M(z_2) = 0$$

$$M(z_4) = -1 + z/l$$

$$M(z_5) = -1 + z/l$$

$$M(z_6) = -1 + z/l$$

$$M(z_7) = -2 + z/l$$



$$M_{10} = \frac{1}{EI} \left[\int_0^{2l} (-3Fz) \left(-\frac{\sqrt{2}z}{2} \right) dz + \int_0^l (-4Fz) \left(-\frac{\sqrt{2}z}{2} \right) dz + \int_0^{2l} 2\sqrt{2}F(l-z)^2 + \int_0^l \sqrt{2}Fz^2 dz \right]$$

$$= \frac{19\sqrt{2}Fl^3}{3EI}$$

$$M_{20} = \frac{1}{EI} \left[\int_0^l (-4Fz) \left(\frac{z}{l} \right) dz + \int_0^{2l} (4F(l-z)) \left(\frac{z}{l} - 1 \right) + \int_0^l (-2Fz) \left(-2 + \frac{z}{l} \right) dz \right]$$

$$= -\frac{8Fl^2}{3EI}$$

$$M_{11} = \frac{1}{EI} \left[2 \int_0^l \frac{z^2}{2} dz + \int_0^{2l} \frac{z^2}{2} dz + \int_0^{2l} \frac{1}{2} (l-z)^2 dz \right] = \frac{2l^3}{EI}$$

$$M_{22} = \frac{1}{EI} \left[\int_0^l \frac{z^2}{l^2} dz + \int_0^{2l} \left(\frac{z}{l} - 1 \right)^2 + \int_0^{2l} \frac{z^2}{l^2} dz + \int_0^l \left(-2 + \frac{z}{l} \right)^2 dz \right] = \frac{6l}{EI}$$

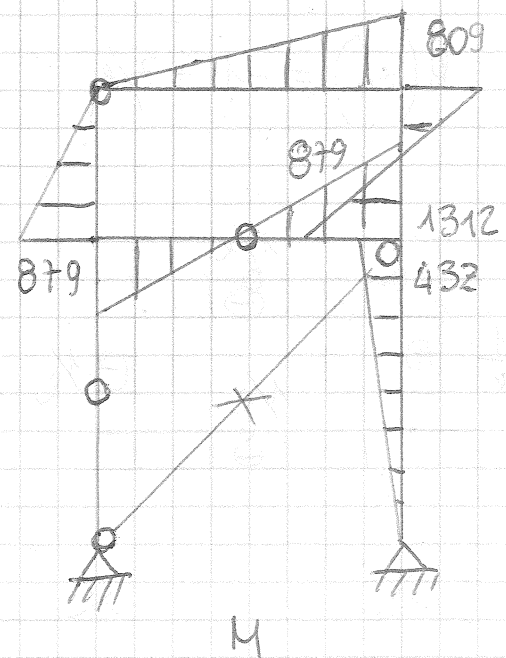
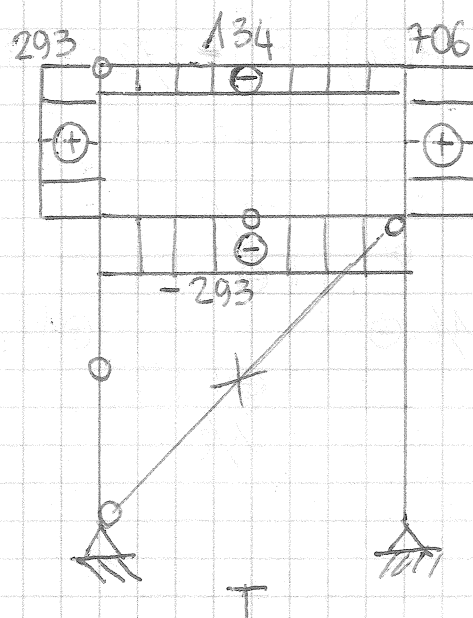
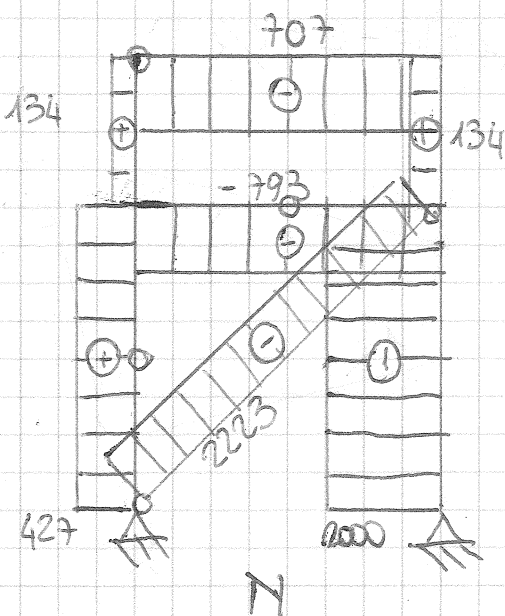
$$M_{12} = \frac{1}{EI} \left[\int_0^l \left(\frac{z}{l} \right) \left(-\frac{\sqrt{2}z}{2} \right) dz + \int_0^{2l} \left(-1 + \frac{z}{l} \right) \left(\frac{\sqrt{2}}{2} (l-z) \right) dz + \int_0^l \left(-2 + \frac{z}{l} \right) \left(-\frac{\sqrt{2}z}{2} \right) dz \right]$$

$$= -\frac{\sqrt{2}l^2}{6EI}$$

$$\begin{cases} M_{11} \cdot X_1 + M_{12} \cdot X_2 = -M_{10} \\ M_{12} \cdot X_1 + M_{22} \cdot X_2 = -M_{20} \end{cases}$$

$$X_1 = -2223 \text{ N}$$

$$X_2 = 405 \text{ Nm}$$



PROGETTO

$$M_{\max} = 1312 \text{ Nm}$$

$$W_{\text{mix}} = \frac{M}{\sigma} = \frac{1312 \cdot 1000}{390} = 336 \text{ mm}^3 = 3,36 \text{ cm}^3$$

$$\text{IPE 80} \quad W_y = 20,03 \text{ cm}^3 \quad I_y = 80,14 \text{ cm}^4 \quad A = 7,64 \text{ cm}^2$$

VERIFICA

$$N = 134 \text{ N}$$

$$M = 1312 \text{ Nm}$$

$$\sigma_{\max} = \frac{134}{7,64 \cdot 100} + \frac{1312 \cdot 1000}{20,03 \cdot 1000} = 66 < 390 \text{ ok!}$$

$$M_{11}^N = \frac{2l^3}{EJ} + \int_0^{\sqrt{2}l} \frac{1}{EA_{\text{biella}}} dz = \frac{2l^3}{EJ} + \frac{\sqrt{2}l}{EA_{\text{biella}}}$$

$$A_{\text{biella}} = 11 \cdot 100^2$$

$$\begin{cases} \eta_{11}^N \cdot x_1 + \eta_{12} \cdot x_2 = -\eta_{10} \\ \eta_{12} \cdot x_1 + \eta_{22} \cdot x_2 = -\eta_{20} \end{cases}$$

$$x_1 = -2223 \text{ N}$$

$$x_2 = 405 \text{ Nm}$$

Tener conto della def. assiale della biella non cambia le sollecitazioni finali