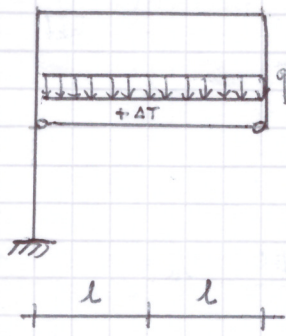


SOLUZIONE COMPITO 24/01/2022



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

$$q = 2000 \text{ N/m}$$

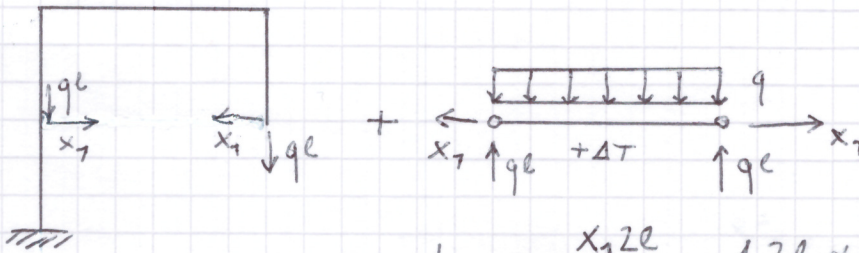
$$E = 210000 \text{ MPa}$$

$$\sigma_{\text{amm}} = 190 \text{ MPa}$$

$$\alpha = 1.2 \cdot 10^{-5} \text{ C}^{-1}$$

$$\Delta T = 20^\circ \text{C}$$

1 volta iperstatica

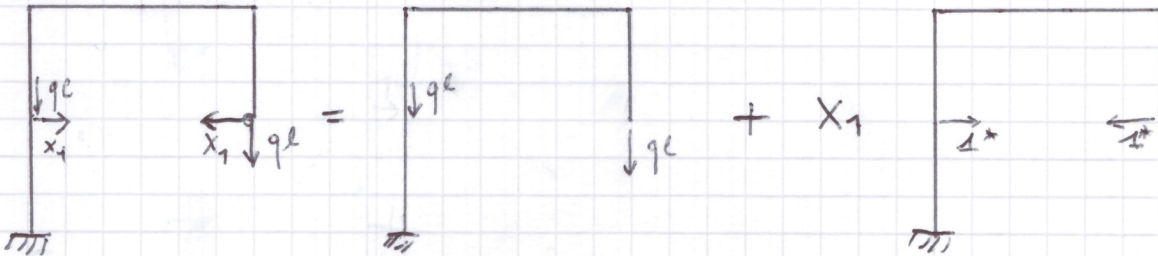


$$M_{\text{max}} = \frac{q(2l)^2}{8} = \frac{q l^2}{2} = 9000 \text{ Nm}$$

$$L v_c = -\frac{X_1 2l}{EA} - 12l \alpha \Delta T$$

$$T = 6000 \text{ N}$$

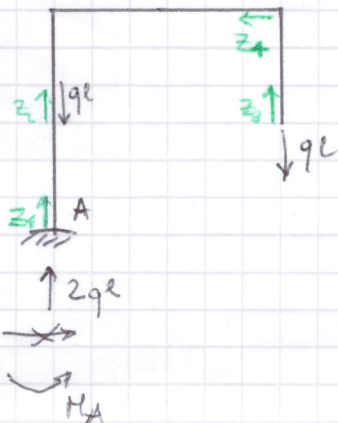
1) Trascurare deformabilità assiale e carico termico



SISTEMA 0

SISTEMA 1

SISTEMA 0



$$V_A = 2ql$$

$$H_A = 0$$

$$M_A = ql \cdot 2l = 2ql^2$$

$$z_1: N = -2ql$$

$$T = 0$$

$$M = -2ql^2$$

$$z_2: N = -2ql + ql = -ql$$

$$T = 0$$

$$M = -2ql^2$$

$$z_3: N = +ql$$

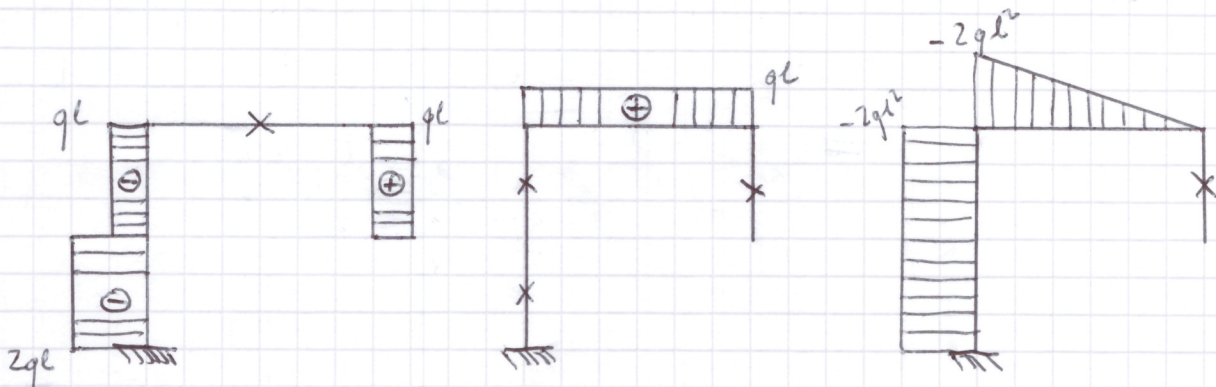
$$T = 0$$

$$M = 0$$

$$z_4: N = 0$$

$$T = +ql$$

$$M = -qlz$$

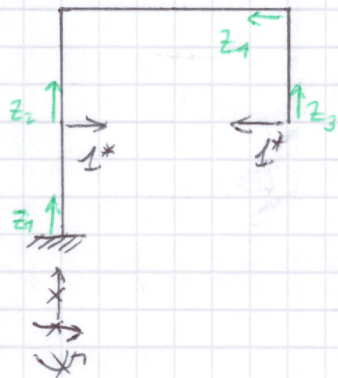


N [N]

T [N]

M [Nm]

SISTEMA 1



$$M_A = 0$$

$$V_A = 0$$

$$H_A = 0$$

$$z_1: N = 0$$

$$T = 0$$

$$M = 0$$

$$z_2: N = 0$$

$$T = -1$$

$$M = -1z$$

$$z_3: N = 0$$

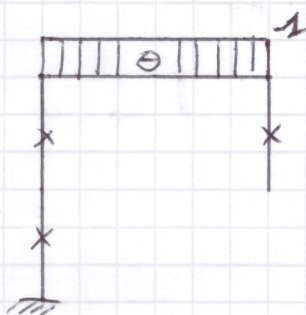
$$T = 1$$

$$M = -1z$$

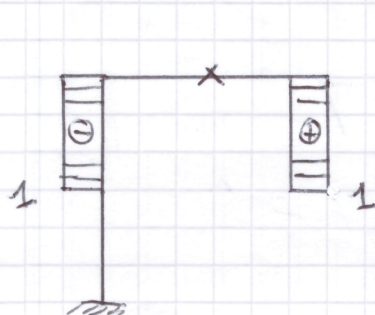
$$z_4: N = -1$$

$$T = 0$$

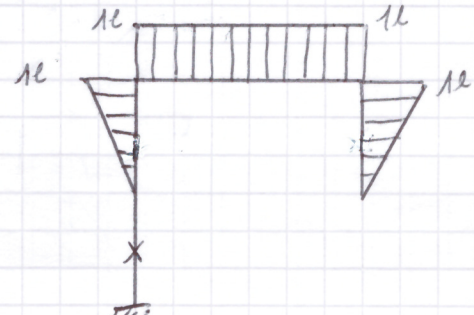
$$M = -1z$$



N [N]



T [N]

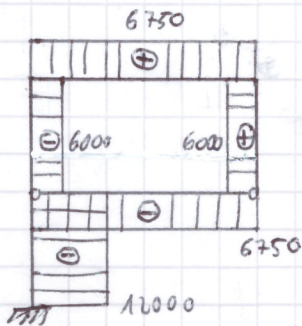


M [Nm]

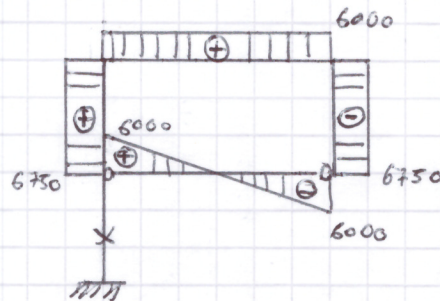
$$\eta_{10} = \frac{1}{EJ} \left[\int_0^L (-2qlz^2)(-lz) dz + \int_0^{2L} (-1l)(-qlz) dz \right] = \frac{486000}{EJ}$$

$$\eta_{11} = \frac{1}{EJ} \left[2 \int_0^L (-lz)^2 dz + \int_0^{2L} (-1l)^2 dz \right] = \frac{72}{EJ}$$

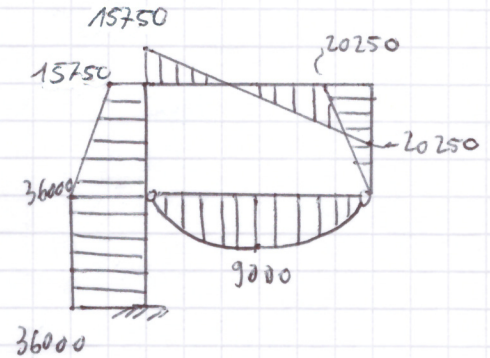
$$X_1 = - \frac{\eta_{10}}{\eta_{11}} = -6750 \text{ N}$$



N [N]



T [N]



M [Nm]

2) Progetto con profilo IPE

$$M_{max} = 36000 \text{ Nm}$$

$$N = -12000 \text{ N}$$

$$W_{min} = \frac{36000 \times 1000}{190} = 189473 \text{ mm}^3 = 189.4 \text{ cm}^3$$

$$\text{ADOTTO IPE 200} \rightarrow A = 28.5 \text{ cm}^2 \quad W_x = 194 \text{ cm}^3 \quad J_x = 1943 \text{ cm}^4$$

$$\text{Verifica} \rightarrow \sigma_z = \frac{N}{A} \pm \frac{M}{W} = - \frac{12000}{2850} \pm \frac{36000 \cdot 10^3}{194 \cdot 10^3}$$

$$= -4.210 \pm 185.59 = \begin{cases} -189.77 \checkmark \\ 181.35 \checkmark \end{cases}$$

3) Deformabilità assiale + carico termico

$$\eta_{10}^{NEW} = \eta_{10} + \eta_{10}^N$$

$$\eta_{11}^{NEW} = \eta_{11} + \eta_{11}^N$$

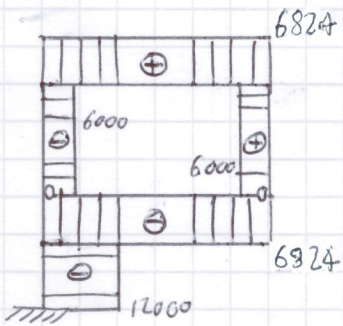
$$\eta_T = \int_0^{2L} 1 \alpha \Delta T dz = 1 \alpha \Delta T 2L = 1.44 \cdot 10^{-3}$$

$$\eta_{10}^N = 0$$

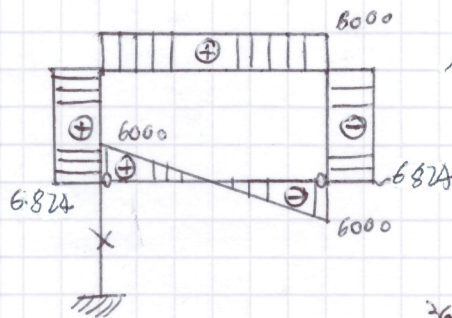
$$\eta_{11}^N = \frac{1}{EA} \left[\int_0^{2L} (-1)^2 dz + \int_0^{2L} (1)^2 dz \right] = \frac{12}{EA}$$

contributo
normale asta con
carico distribuito

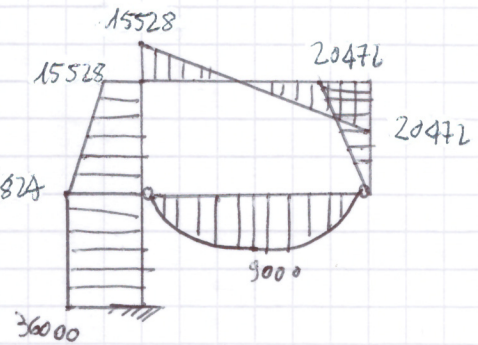
$$X_1 = - \frac{\eta_{10} + \eta_T}{\eta_{11}} = -6824 \text{ N}$$



N [N]



T [N]



M [N/m]