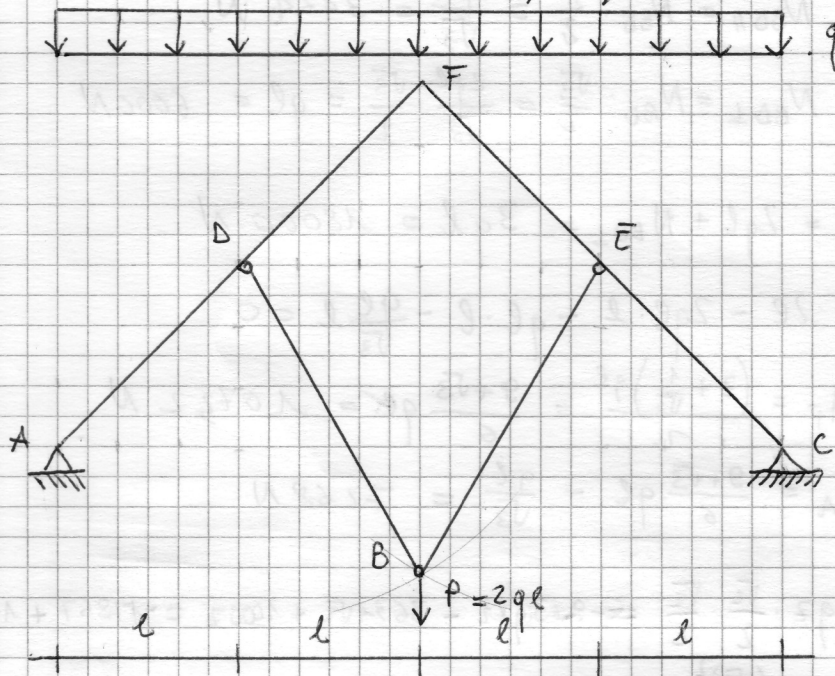




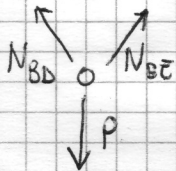
$$l = 3 \text{ m}$$

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

$$P = 2ql = 12000 \text{ N}$$

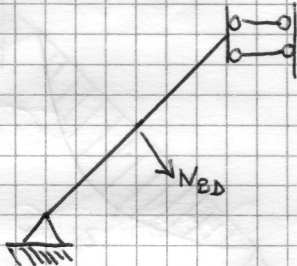
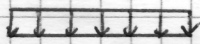
BD e BE sono travi $\rightarrow$ si possono ricavare le azioni dal nodo B

$$N_{BD} = N_{BE}$$

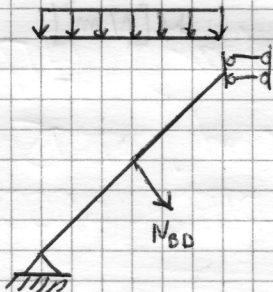


$$2N_{BD} \cos 30 = P \rightarrow N_{BD} = \frac{P}{\sqrt{3}} = \frac{2ql}{\sqrt{3}} = 6928 \text{ N}$$

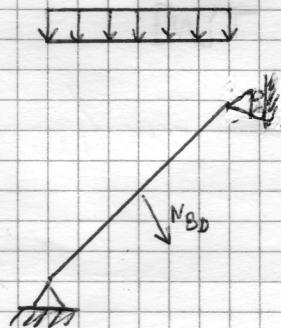
struttura simmetrica posso dividerla



1 volta spostata

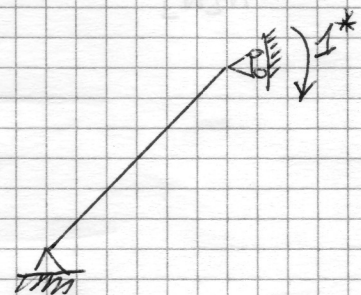


=

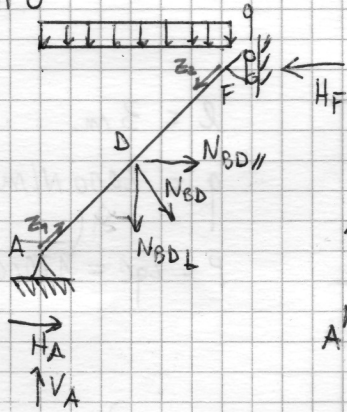


SISTEMA 0

+ X_1



SISTEMA 1



$$N_{BDH} = N_{BD} \cdot \frac{1}{2} = \frac{qL}{\sqrt{3}} = 3464 \text{ N}$$

$$N_{BDL} = N_{BD} \cdot \frac{\sqrt{3}}{2} = \frac{2qL}{\sqrt{3}} \cdot \frac{\sqrt{3}}{2} = qL = 6000 \text{ N}$$

$$\uparrow) V_A = 2qL + N_{BDL} = 3qL = 18000 \text{ N}$$

$$\rightarrow) H_F \cdot 2L - 2qL \cdot L - qL \cdot L - \frac{qL}{\sqrt{3}} \cdot L = 0$$

$$H_F = \frac{(3 + \frac{1}{\sqrt{3}})qL}{2} = \frac{9 + \sqrt{3}}{6} qL = 10732 \text{ N}$$

$$\rightarrow) H_A = \frac{9 + \sqrt{3}}{6} qL - \frac{qL}{\sqrt{3}} = 7268 \text{ N}$$

$$z_1: N(z_1) = -V_A \frac{\sqrt{z_1}}{2} - H_A \frac{\sqrt{z_1}}{2} + qz_1 \cdot \frac{\sqrt{z_1}}{2} \cdot \frac{\sqrt{z_1}}{2} = -9000\sqrt{z_1} - 3634\sqrt{z_1} + 1000z_1 = -17867 + 1000z_1$$

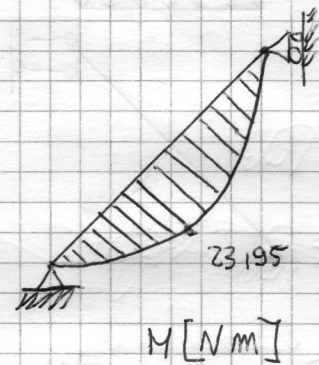
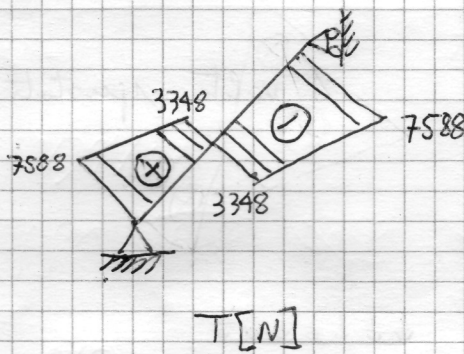
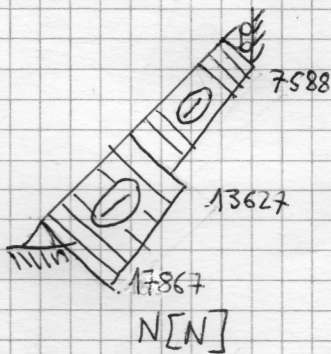
$$T(z_1) = +V_A \frac{\sqrt{z_1}}{2} - H_A \frac{\sqrt{z_1}}{2} - qz_1 \left(\frac{\sqrt{z_1}}{2}\right)^2 = +7588 - 1000z_1$$

$$M(z_1) = V_A \frac{\sqrt{z_1}}{2} z_1 - H_A \frac{\sqrt{z_1}}{2} z_1 - q \frac{z_1^2}{2} \left(\frac{\sqrt{z_1}}{2}\right)^2 = 7588z_1 - 500z_1^2$$

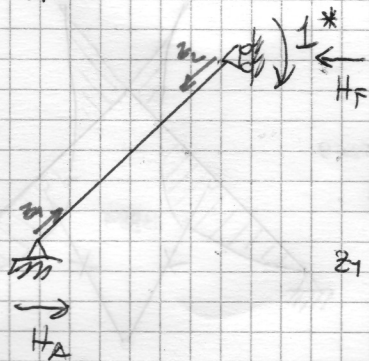
$$z_2: N(z_2) = -H_F \frac{\sqrt{z_2}}{2} - qz_2 \frac{\sqrt{z_2}}{2} \cdot \frac{\sqrt{z_2}}{2} = -7588 - 1000z_2$$

$$T(z_2) = -H_F \frac{\sqrt{z_2}}{2} + qz_2 \left(\frac{\sqrt{z_2}}{2}\right)^2 = -7588 + 1000z_2$$

$$M(z_2) = +H_F \frac{\sqrt{z_2}}{2} z_2 - \frac{qz_2^2}{2} \left(\frac{\sqrt{z_2}}{2}\right)^2 = +7588z_2 - 500z_2^2$$



SISTEMA 1



$$\sum H_F - 1 = 0$$

$$H_F = \frac{1}{2} = 1/6$$

$$H_A = \frac{1}{2} = 1/6$$

$$z_1: M(z_1) = -\left(\frac{1}{6} \cdot \frac{\sqrt{2}}{2}\right) z = -\frac{\sqrt{2}}{12} z$$

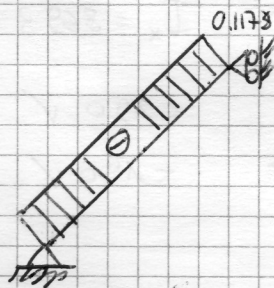
$$T(z_1) = -\frac{\sqrt{2}}{12} = \frac{1}{6} \cdot \frac{\sqrt{2}}{2}$$

$$N(z_1) = -\frac{\sqrt{2}}{12} = \frac{1}{6} \cdot \frac{\sqrt{2}}{2}$$

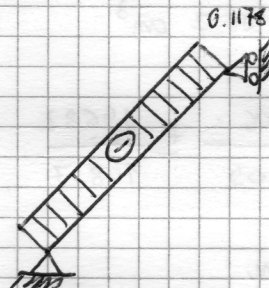
$$z_2: M(z_2) = -1 + \frac{\sqrt{2}}{2} \cdot \frac{1}{6} z = -1 + \frac{\sqrt{2}}{12} z$$

$$T(z_2) = -\frac{\sqrt{2}}{12} = \frac{1}{6} \cdot \frac{\sqrt{2}}{2}$$

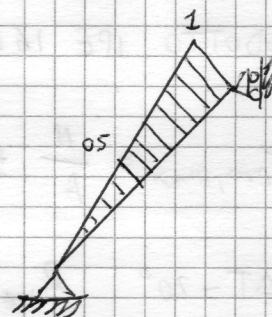
$$M(z_2) = -\frac{1}{6} \cdot \frac{\sqrt{2}}{2} = -\frac{\sqrt{2}}{12}$$



N[N]



T[N]



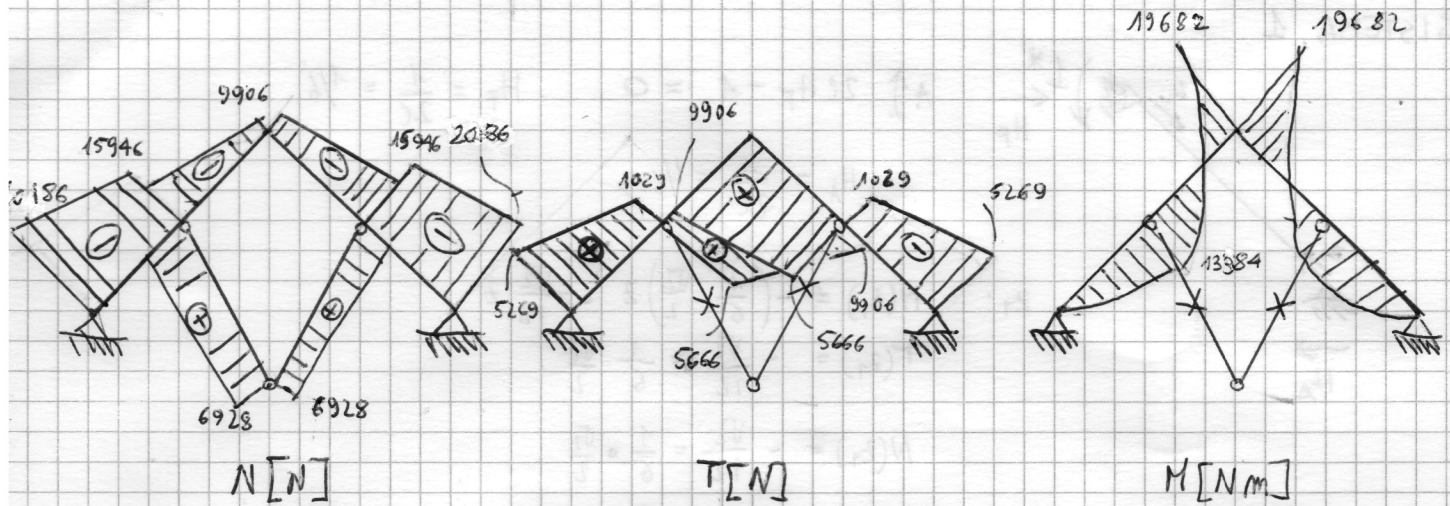
M[Nm]

$$\eta_{10} = \frac{1}{ES} \left[\int_0^{3/(\sqrt{2}/2)} (7588z - 500z^2) \left(-\frac{\sqrt{2}}{12} z\right) dz + \int_0^{3/(\sqrt{2}/2)} (+188z - 500z^2) \left(-1 + \frac{\sqrt{2}}{12} z\right) dz \right]$$

$$= \frac{1}{ES} \left[-17960 \quad -37542 \right] = -\frac{55502}{ES}$$

$$\eta_{11} = \frac{1}{ES} \left[\int_0^{3/(\sqrt{2}/2)} \left(-\frac{\sqrt{2}}{12} z\right)^2 dz + \int_0^{3/(\sqrt{2}/2)} \left(-1 + \frac{\sqrt{2}}{12} z\right)^2 dz \right] = \frac{1}{ES} \left[0.35 + 2.47 \right] = \frac{2.82}{ES}$$

$$X_1 = -\frac{\eta_{10}}{\eta_{11}} = 19682 \text{ Nm}$$



② $M_{max} = 19682 \text{ Nmm}$

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

$N = 9906 \text{ N}$

vering progetto $W_{min} = \frac{M}{\sigma_{adm}} = \frac{19682}{190} = 103.5 \text{ cm}^3$

ADOTTO IPE 160 $W_x = 108.7 \text{ cm}^3$ $A = 20.09 \text{ cm}^2$ $I_x = 869.3 \text{ cm}^4$

$$\sigma_{min, max} = \frac{N}{A} \pm \frac{M}{W} = \frac{9906}{2009} \pm \frac{19682}{108.7} < \begin{matrix} 186 \\ -176 \end{matrix} < \begin{matrix} 190 \checkmark \\ 190 \checkmark \end{matrix}$$

③ $\Delta T = 20^\circ$ $R_{IPE 160} = 0.16 \text{ m}$

$$L_v = L_{w_n} \Rightarrow 0 = \eta_{10} + X \eta_{11} + \underbrace{\int_0^{\sqrt{2}l} \left(-\frac{2\alpha\Delta T}{h} \right) \cdot \left(-\frac{\sqrt{2}}{12} z \right) dz + \int_0^{\sqrt{2}l} \left(-\frac{2\alpha\Delta T}{h} \right) \cdot \left(-1 + \frac{\sqrt{2}}{12} z \right) dz}_{\eta_{10}^T}$$

$$\eta_{10}^+ = \int_0^{\sqrt{2}l} \left(\frac{2\alpha\Delta T}{h} \right) \left(-\frac{\sqrt{2}}{12} z \right) dz + \int_0^{\sqrt{2}l} \left(\frac{2\alpha\Delta T}{h} \right) \left(-1 + \frac{\sqrt{2}}{12} z \right) dz$$

$= -0.0127$

$$X_1 = - \frac{\eta_{10} + \eta_{10}^T}{\eta_{11}} = 27903 \text{ Nmm}$$

