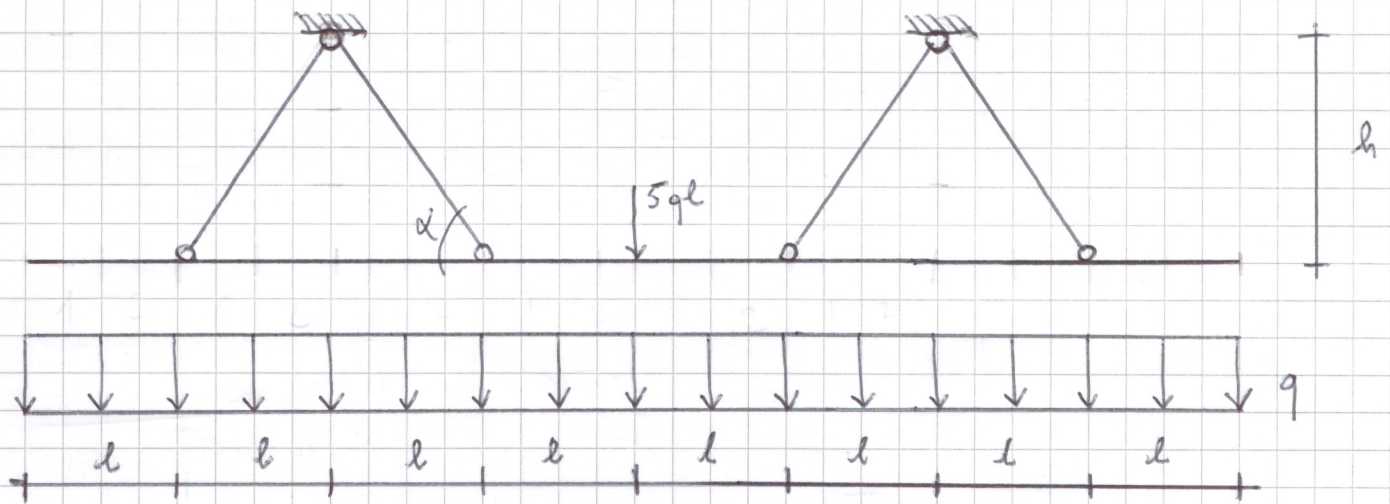
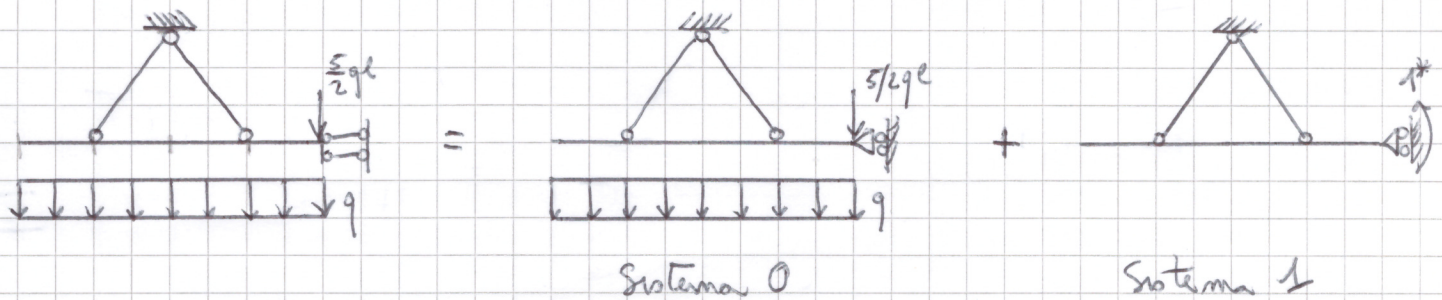
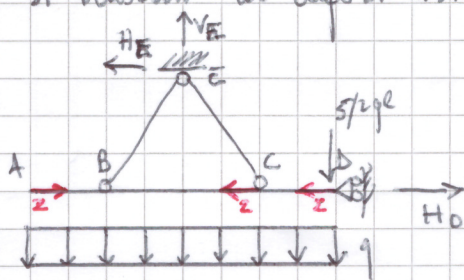




$l = 2 \text{ m}$ $h = 3 \text{ m}$ $q = 2000 \text{ N/m}$ $\alpha = \tan^{-1}\left(\frac{3}{2}\right) = 56.31^\circ$
 $E = 210'000 \text{ MPa}$ $\sigma_{\text{amm}} = 190 \text{ MPa}$



1) Si trascuri la deformabilità assiale



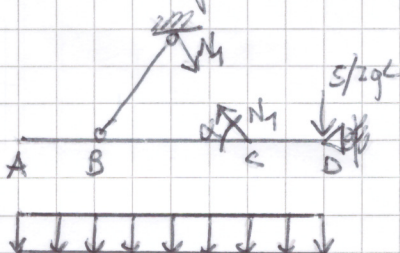
SISTEMA 0

1) $V_A = 4ql + \frac{5}{2}ql = \frac{13}{2}ql = 26000 \text{ N}$

2) $H_D = H_E$

3) $H_D h - \frac{5}{2}ql \cdot 2l = 0 \quad H_D = \frac{5ql^2}{h} = 13333 \text{ N}$

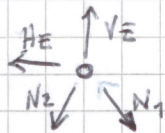
Ricavo sforzi assiali nelle tralce EC e BE



4) $N_1 \sin \alpha \cdot 2l - \frac{5}{2}ql \cdot 3l - 3ql \cdot \frac{3}{2}l + ql \cdot \frac{l}{2} = 0$

$N_1 = \frac{(15 + 9 - 1)ql^2}{4l \sin \alpha} = \frac{23}{4} \frac{ql^2}{\sin \alpha} = 27642.55 \text{ N}$

modo E



$$\rightarrow -N_2 \cos \alpha - H_D + N_1 \cos \alpha = 0$$

$$N_2 = \frac{N_1 \cos \alpha - H_D}{\cos \alpha} = 3605.55 \text{ N}$$

Tratto AB

$$N(z) = 0$$

$$T(z) = -qz$$

$$M(z) = -\frac{qz^2}{2}$$

$$T(l) = -ql = -4000 \text{ N}$$

$$M(l) = -4000 \text{ N.m}$$

Tratto BE

$$N(z) = 3605.55 \text{ N}$$

$$T(z) = 0 \text{ N}$$

$$M(z) = 0 \text{ N.m}$$

Tratto EC

$$N(z) = 27642.55 \text{ N}$$

$$T(z) = 0 \text{ N}$$

$$M(z) = 0 \text{ N.m}$$

Tratto DC

$$N(z) = 13333 \text{ N}$$

$$T(z) = \frac{5}{2}ql + qz$$

$$M(z) = -\frac{5}{2}qlz - q\frac{z^2}{2}$$

$$T(l) = 14000 \text{ N}$$

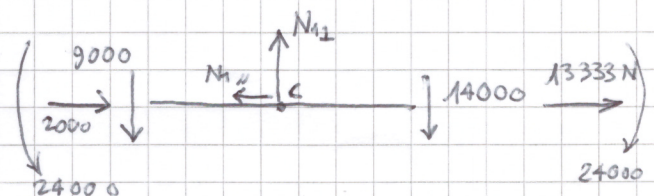
$$M(l) = -24000 \text{ N.m}$$

Tratto CB

$$N_{1\perp} = N_1 \sin \alpha = 23000 \text{ N}$$

$$N_{2\parallel} = N_1 \cos \alpha = 15293 \text{ N}$$

punto C



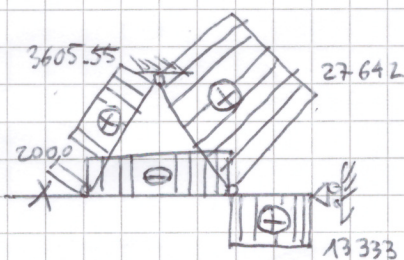
$$N(z) = -2000 \text{ N}$$

$$T(z) = -9000 + qz$$

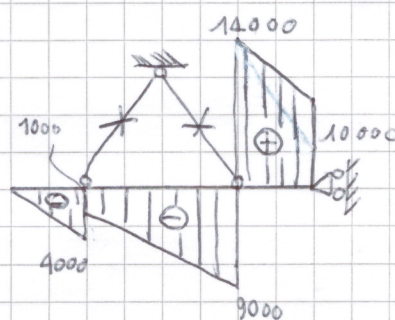
$$M(z) = -24000 + 9000z - q\frac{z^2}{2}$$

$$T(l) = -1000 \text{ N}$$

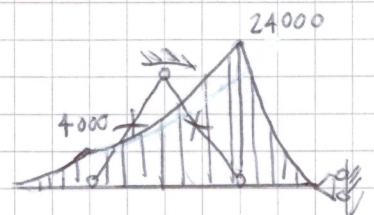
$$T(l) = -4000 \text{ N.m}$$



$N[N]$

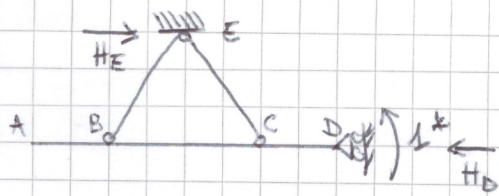


$T[N]$



$M[N.m]$

SISTEMA 1

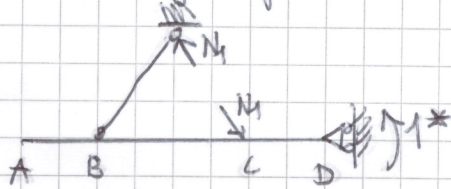


$$V_E = 0$$

$$H_E = H_D$$

$$\sum \rightarrow 1 - H_D h = 0 \quad H_D = \frac{1}{h} = \frac{1}{3} = 0.33$$

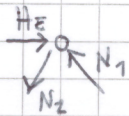
Ricavo gli sforzi normali nelle travi EC e BE



$$\sum \uparrow -N_1 \sin \alpha \cdot 2l + 1 = 0$$

$$N_1 = \frac{1}{2l \sin \alpha} = \frac{1}{4 \sin \alpha} = 0.300$$

Modello E



$$\rightarrow H_E - N_2 \cos \alpha - N_1 \cos \alpha = 0$$

$$N_2 = \frac{H_E - N_1 \cos \alpha}{\cos \alpha} = 0.300$$

Tratto AB

$$N(z) = 0$$

$$T(z) = 0$$

$$M(z) = 0$$

Tratto BE

$$N(z) = 0.3$$

$$T(z) = 0$$

$$M(z) = 0$$

Tratto EC

$$N(z) = -0.3$$

$$T(z) = 0$$

$$M(z) = 0$$

Tratto DC

$$N(z) = -0.33$$

$$T(z) = 0$$

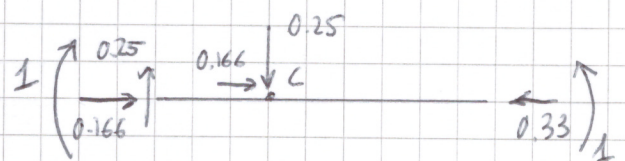
$$M(z) = 1$$

Tratto CB

$$N_{1\perp} = N_1 \sin \alpha = 0.25$$

$$N_{2\parallel} = N_2 \cos \alpha = 0.166$$

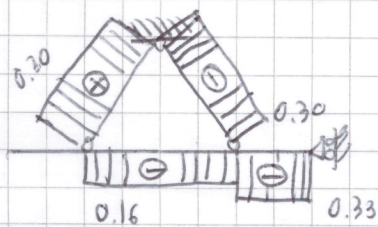
punto C



$$N(z) = -0.166$$

$$T(z) = 0.25$$

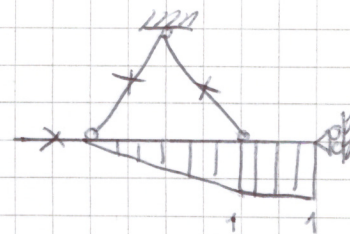
$$M(z) = 1 - 0.25z$$



$N[N]$



$T[N]$



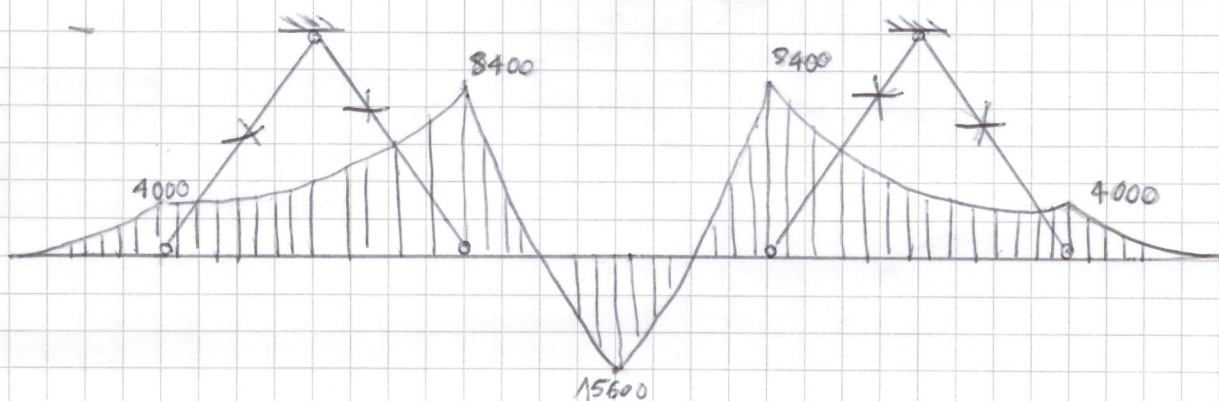
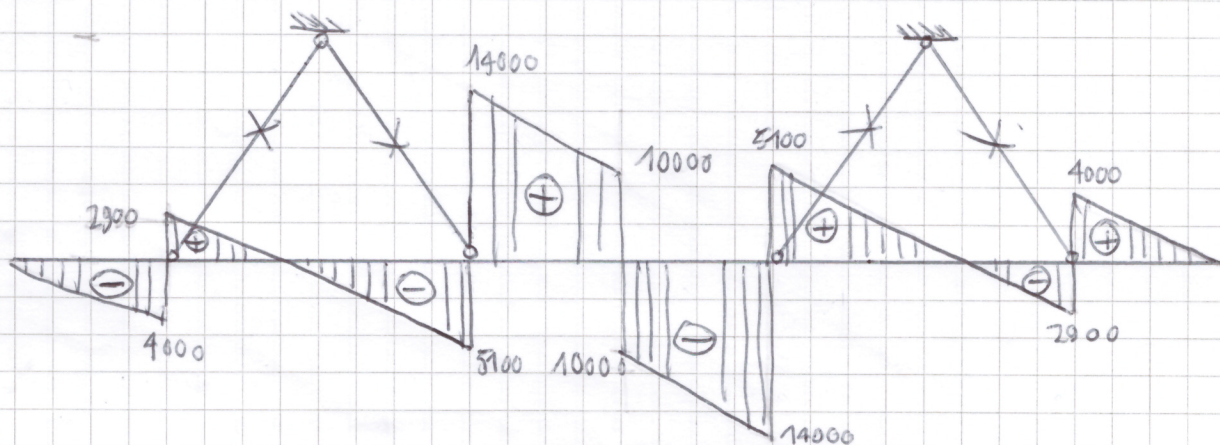
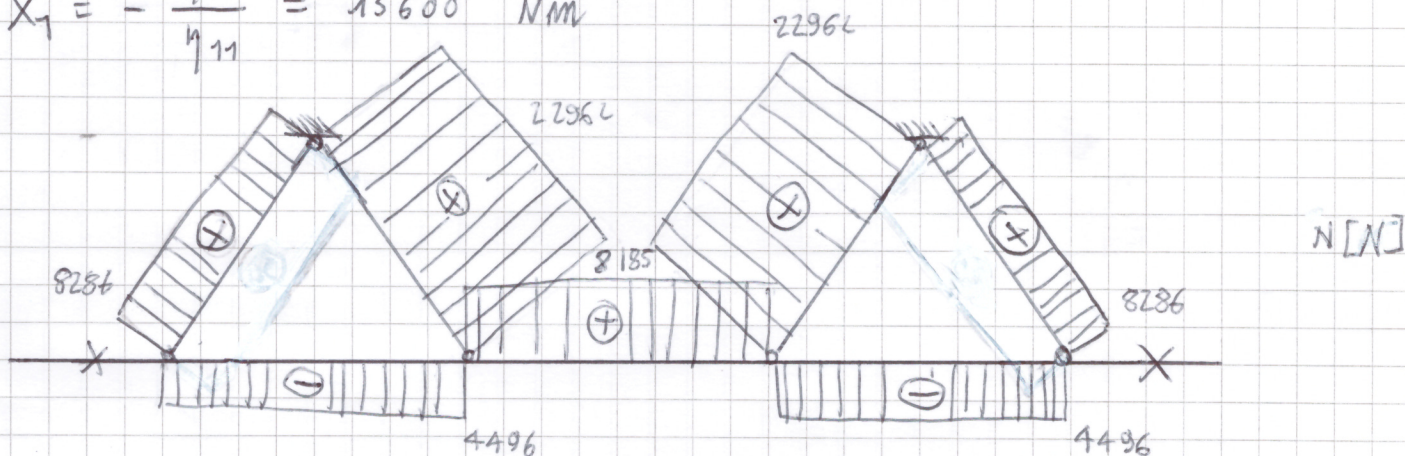
$M[Nm]$

$$\eta_{10} = \frac{1}{ET} \left[\int_0^4 (-24000 + 9000z - 1000z^2)(1 - 0.25z) dz + \int_0^2 (-10000z - 1000z^2)(1) dz \right]$$

$$= -\frac{52000}{ET}$$

$$\eta_{11} = \frac{1}{ET} \left[\int_0^4 (1 - 0.25z)^2 dz + \int_0^2 (1^2) dz \right] = \frac{10}{3ET}$$

$$X_1 = -\frac{\eta_{10}}{\eta_{11}} = 15600 \text{ Nm}$$



2) Progetto profilo

trave AD

$$M_{\max} = 15606 \text{ Nm}$$

$$N = 8185 \text{ N}$$

$$\frac{M_{\max}}{W} < \sigma_{\text{amm}} \rightarrow W_{\text{min}} = \frac{M_{\max}}{\sigma_{\text{amm}}} = 92.10 \text{ cm}^3$$

Adatto profilo IPE 160 ($A = 20.1 \text{ cm}^2$ $I_x = 869 \text{ cm}^4$ $W_x = 109 \text{ cm}^3$)

$$\sigma_{m, \max} = \frac{N}{A} \pm \frac{M}{W_x} \rightarrow \begin{cases} \sigma_{\max} = 147 < 190 \checkmark \\ \sigma_{\min} = -139 < 190 \checkmark \end{cases}$$

trave

$$\sigma_{\text{amm}} = \frac{N}{A} \rightarrow A_{\text{min}} = \frac{N}{\sigma_{\text{amm}}} = \frac{22962}{190 \cdot 100} = 1.20 \text{ cm}^2$$

Adatto profilo IPE 80 ($A = 7.64 \text{ cm}^2$ $I_x = 80.1 \text{ cm}^4$)

$$\sigma_{\max} = \frac{N}{A} = 30 < 190 \checkmark$$

3) Deformabilità omale solo aste

$$\eta_{10}^a = \frac{1}{EA} \left[\int_0^{\sqrt{2}+0.1} (3605.55)(0.3) dz + \int_0^{\sqrt{2}+0.1} (27642)(-0.30) dz \right]$$

$$= \frac{1}{EA} \cdot (-25999)$$

$$\eta_{11}^a = \frac{2}{EA} \int_0^{\sqrt{2}+0.1} (0.3)^2 dz = \frac{0.65}{EA}$$

$$X_1 = - \frac{\eta_{10} + \eta_{10}^a}{\eta_{11} + \eta_{11}^a} = 15599 \text{ N}$$

