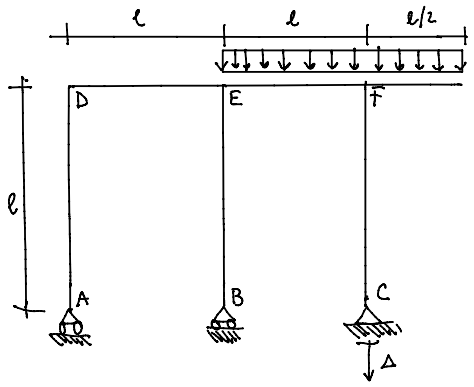
Soluzione compito del 21-01-2021

lunedì 18 gennaio 2021 09:23



$q = 4000\ N/m$

$l = 4\ m$

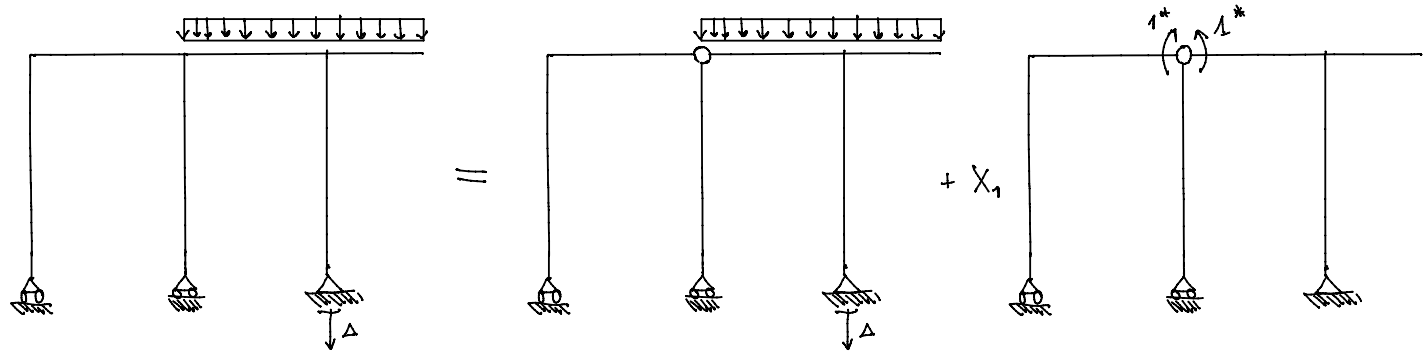
$\Delta = 2\ cm$

$E = 210000\ MPa$

Profilo IPE 180

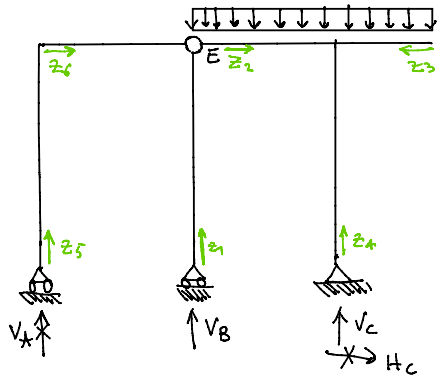
$A = 23.9\ cm^2$ $J = 1317\ cm^4$

Struttura 1 volta iperstatica



Sistema 0 Sistema 1

Sistema 0



$\rightarrow \quad H_C = 0$

$E)_{sx} \quad V_A = 0$

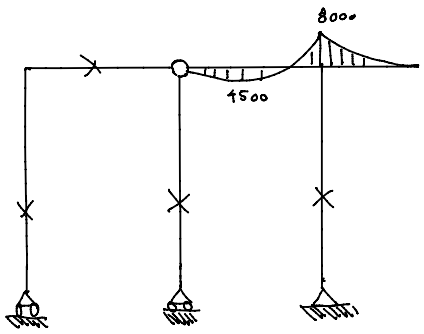
$\uparrow) \quad V_B + V_C = q\left(l + \frac{l}{2}\right) = \frac{3}{2}ql$

$\circlearrowleft)_{dx} \quad -\frac{3}{2}ql \cdot \frac{3}{4}l + V_C \cdot l = 0$

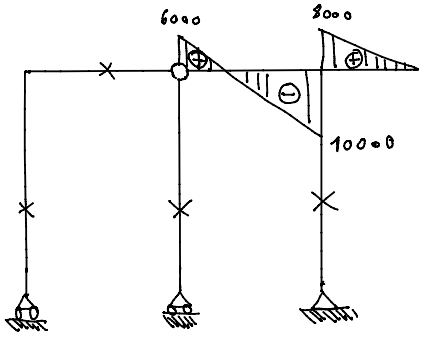
$V_C = \frac{9}{8}ql = 18000\ N$

$V_B = \frac{3}{2}ql - \frac{9}{8}ql = \frac{3}{8}ql = 6000\ N$

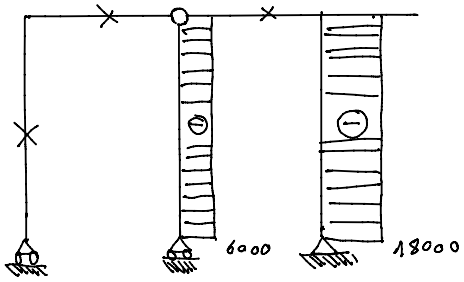
z_1	$M(z_1) = 0$	$T(z_1) = 0$	$N(z_1) = -\frac{3}{8}ql$
z_2	$M(z_2) = \frac{3}{8}ql z_2 - q\frac{z_2^2}{2}$	$T(z_2) = \frac{3}{8}ql - qz_2$	$N(z_2) = 0$
z_3	$M(z_3) = -q\frac{z_3^2}{2}$	$T(z_3) = qz_3$	$N(z_3) = 0$
z_4	$M(z_4) = 0$	$T(z_4) = 0$	$N(z_4) = -\frac{9}{8}ql$
z_5	$M(z_5) = 0$	$T(z_5) = 0$	$N(z_5) = 0$
z_6	$M(z_6) = 0$	$T(z_5) = 0$	$N(z_6) = 0$



M [Nm]

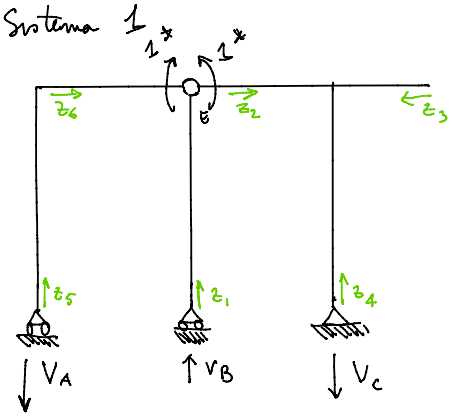


T [N]



N [N]

Sistema 1



$\rightarrow$) $H_C = 0$

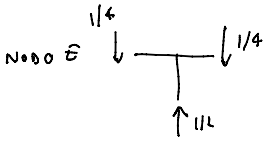
$\uparrow$) $-V_A + V_B - V_C = 0$

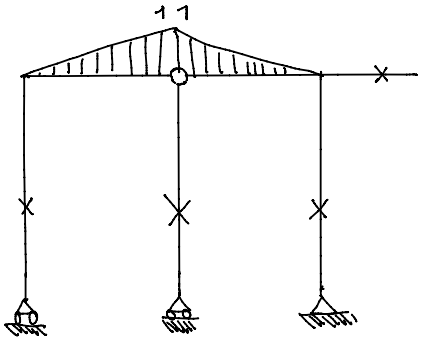
$\curvearrowleft_{SX}$ $V_A \cdot \ell - 1 = 0$ $\qquad V_A = \frac{1}{\ell} = \frac{1}{4}$

$\curvearrowleft_{dx}$ $-V_C \ell + 1 = 0$ $\qquad V_C = \frac{1}{\ell} = \frac{1}{4}$

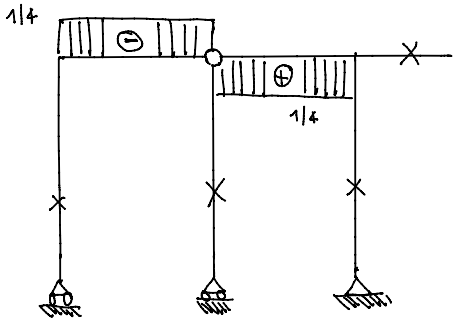
$V_B = \frac{2}{\ell} = \frac{1}{2}$

z_1	$M(z_1) = 0$	$T(z_1) = 0$	$N(z_1) = -\frac{1}{2}$
z_2	$M(z_2) = -1 + \frac{1}{4} z$	$T(z_2) = \frac{1}{4}$	$N(z_2) = 0$
z_3	$M(z_3) = 0$	$T(z_3) = 0$	$N(z_3) = 0$
z_4	$M(z_4) = 0$	$T(z_4) = 0$	$N(z_4) = 1/4$
z_5	$M(z_5) = 0$	$T(z_5) = 0$	$N(z_5) = \frac{1}{4}$
z_6	$M(z_6) = -\frac{1}{4} z$	$T(z_6) = -\frac{1}{4}$	$N(z_6) = 0$

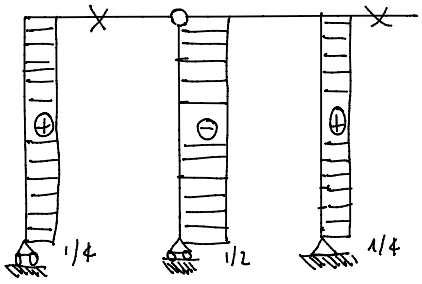




M [Nm]



T [N]



N [N]

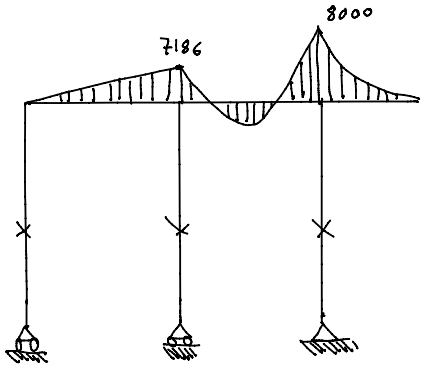
Il cedimento in C va ad aggiungere al lavoro virtuale esterno (L_e)

$L_e = V_C \cdot \Delta_M = \frac{1}{4} \cdot 0.02 \rightarrow \eta_C = \frac{1}{4} \cdot 0.02$

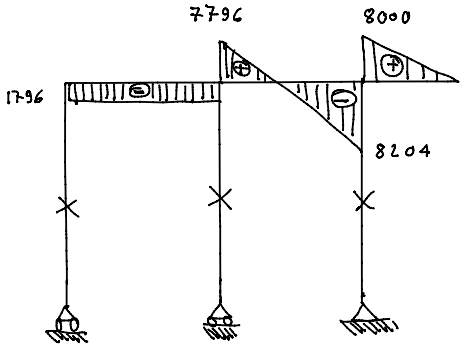
$$\eta_{10} = \frac{1}{EJ}\left[\int_0^l \left(\frac{3}{8}ql z - \frac{q z^2}{2}\right)\left(-1 + \frac{1}{4}z\right) dz\right] = -\frac{16000}{3EJ}$$

$$\eta_{11} = \frac{2}{EJ}\int_0^l \left(-\frac{1}{4}z\right)^2 dz = \frac{8}{3EJ}$$

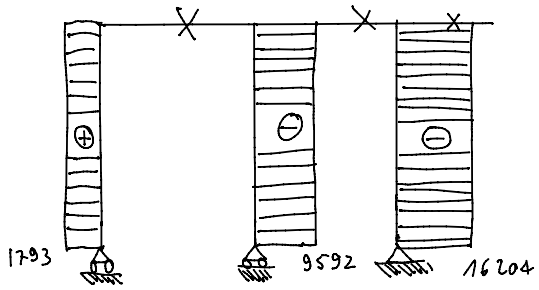
$$\eta_{11} X_1 = -\eta_{10} + \eta_c \longrightarrow X_1 = \frac{-\eta_{10} + \eta_c}{\eta_{11}} = 7186 \ N\cdot m$$



M [Nm]



T [N]



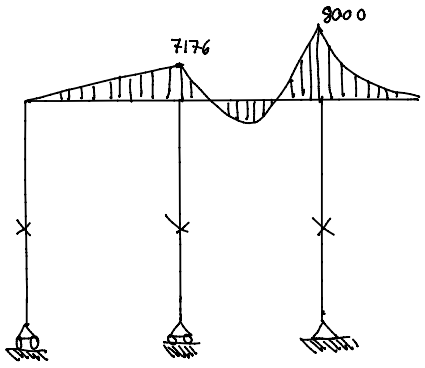
N [N]

2) Considerare la deformazione assiale

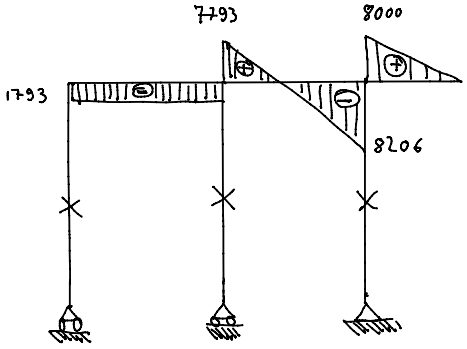
$$\eta_{10}^N = \frac{1}{EA}\left[\int_0^l \left(-\frac{1}{2}\right)\cdot\left(-\frac{3}{8}qC\right) dz + \int_0^l \left(\frac{1}{4}\right)\left(-\frac{9}{8}ql\right) dz\right] = -\frac{6000}{EA}$$

$$\eta_{11}^N = \frac{1}{EA}\left[2\int_0^l \left(+\frac{1}{4}\right)^2 dz + \int_0^l \left(-\frac{1}{2}\right)^2 dz\right] = \frac{3}{2EA}$$

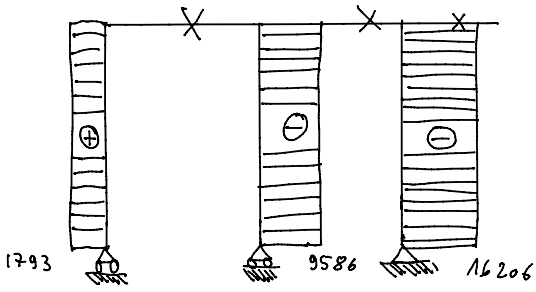
$$\left(\eta_{11} + \eta_{11}^N\right) X_1 = -\left(\eta_{10} + \eta_{10}^N\right) + \eta_c \quad \Rightarrow \quad X_1 = \frac{-(\eta_{10} + \eta_{10}^N) + \eta_c}{\eta_{11} + \eta_{11}^N} = 7176 \ N\cdot m$$



M [Nm]



T [N]



N [N]