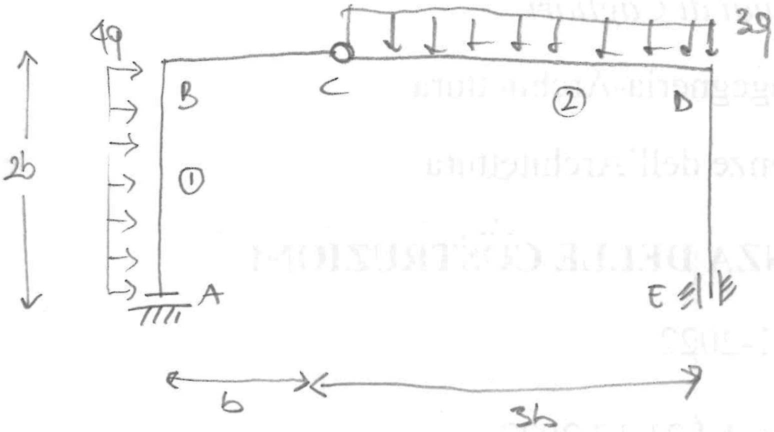


1.) $M_E = ?$

a – determinare C_1, C_2, C_{12} (origine in A)

b – tracciare spostata rigida

c – $u_B = ?$, $v_D = ?$

2) $M_B = ?$

– tracciare spostata rigida

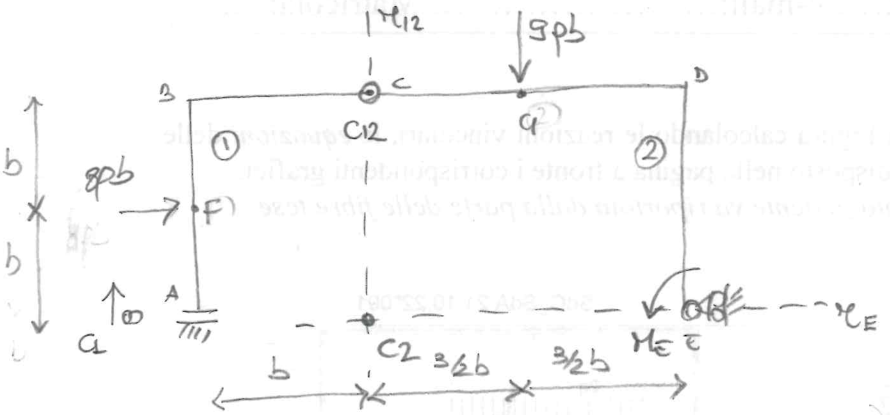
– $u_C = ?$, $v_E = ?$

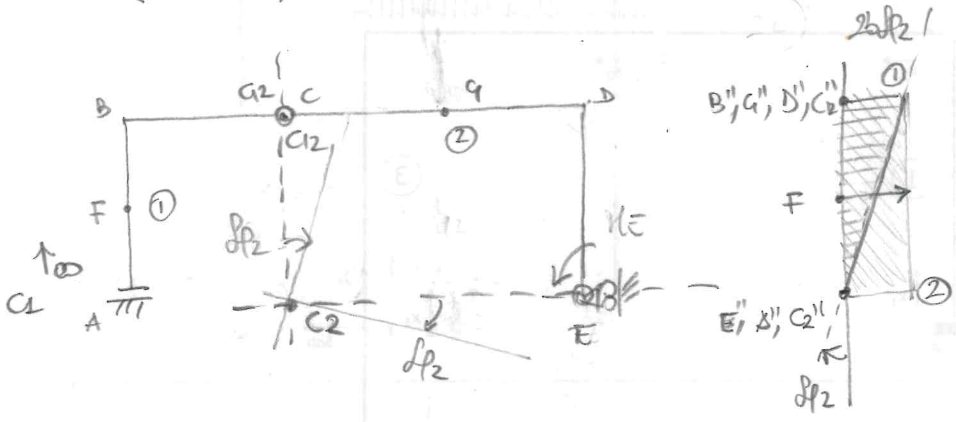
1) Riduciamo di 1 gdv il vincolo in E evidenziando M_E

$C_1 = (\infty, \infty)$

$C_{12} = (b, 2b)$

$$\begin{cases} C_2 \in r_E \\ C_2 \in r_{12} \end{cases} \Rightarrow C_2 = (b, 0)$$

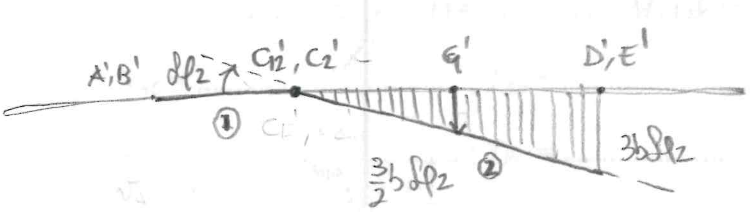




$u_B = u_G = u_D = u_{C12} = 2b\delta\varphi_2$

$u_F = 2b\delta\varphi_2$ $\boxed{u_B = 2b\delta\varphi_2}$

$u_A = 2b\delta\varphi_2$, $u_{C2} = u_E = 0$



PLV:

$$\delta L = 8pb \cdot 2b\delta\varphi_2 + 3pb \cdot \frac{3}{2}b\delta\varphi_2 - M_E\delta\varphi_2 =$$

$$\left[16pb^2 + \frac{27}{2}pb^2 - M_E\right]\delta\varphi_2 = 0 \quad \forall\, \delta\varphi_2$$

$$M_E = 16pb^2 + \frac{27}{2}pb^2 = \frac{32+27}{2}pb^2 = \frac{59}{2}pb^2$$

$v_B = 0$ $v_{C12} = 0$ $v_G = -\frac{3}{2}b\delta\varphi_2$ $v_D = -3b\delta\varphi_2$

$v_E = -3b\delta\varphi_2$

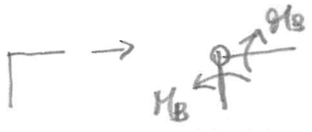
$v_F = 0$ $v_{C2} = 0$

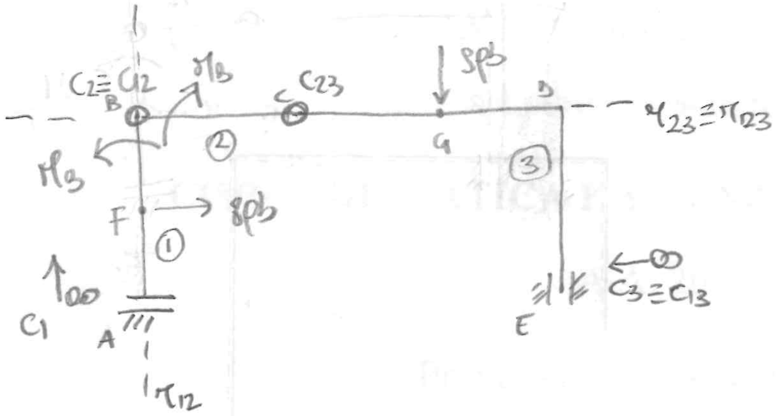
$\boxed{M_E = \frac{59}{2}pb^2}$

$v_A = 0$

$\boxed{v_D = -3b\delta\varphi_2}$

2) INSERISCO UNA CERNIERA INTERNA IN B





$C_1 = (\infty, \infty)$

$C_{12} = (0, 2b)$

$C_{23} = (b, 2b)$

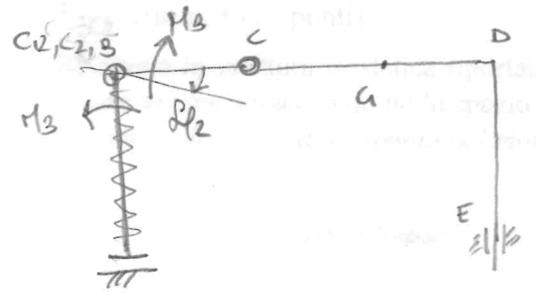
$C_3 = (\infty, 0)$

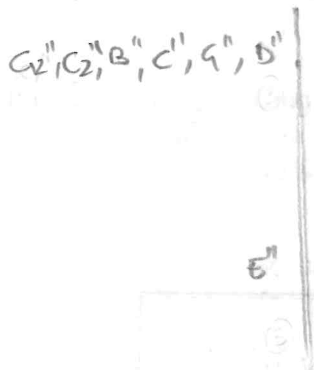
$\begin{cases} C_1 \leftrightarrow C_{12} \leftrightarrow C_2 & C_2 \in \ell_{12} \\ C_2 \leftrightarrow C_{23} \leftrightarrow C_3 & C_2 \in \ell_{23} \end{cases} \Rightarrow C_2 = (0, 2b)$

$\begin{cases} C_1 \leftrightarrow C_{13} \leftrightarrow C_3 & C_{13} \in \ell_\infty \\ C_{12} \leftrightarrow C_{23} \leftrightarrow C_{13} & C_{13} \in \ell_{123} \end{cases} \Rightarrow C_{13} = (\infty, 0)$

① RIMANE FERMO

① E ③ TRASLANO RELATIVAMENTE

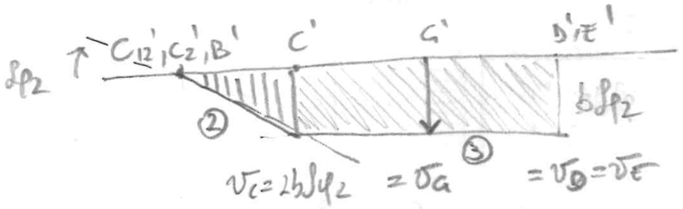




$M_1 = 0$

$\boxed{M_C = 0}$

$\boxed{v_D = -b\,\delta\varphi_2}$

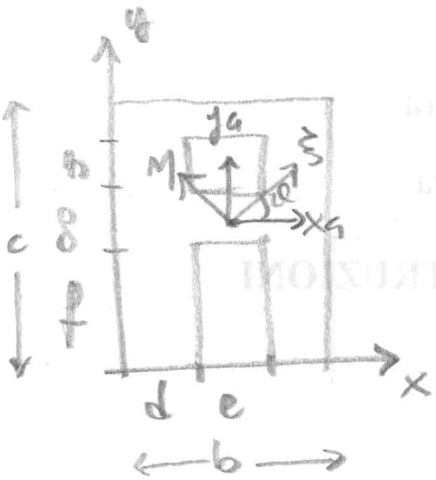


PLV:

$\delta L = 9pb \cdot b\,\delta\varphi_2 + M_B\,\delta\varphi_2 = 0$

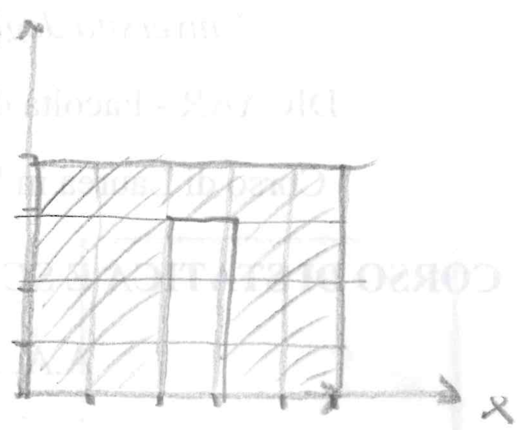
$[9pb^2 + M_B]\,\delta\varphi_2 = 0 \quad \forall\,\delta\varphi_2$

$M_B = -9pb^2$

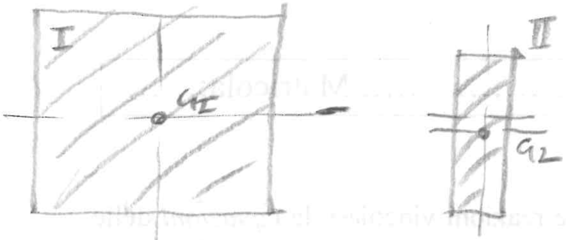


$b = 5e \quad h = 0$

$c = 4e \quad g = e$



$d = 2e \quad e = e$



$A_1 = b \cdot c = 20\,e^2$

$A_2 = e \cdot f = 3\,e^2$

$A = A_1 - A_2 = 17\,e^2$

$G_I = \quad x_{G_I} = \frac{b}{2} = 2{,}5\,e$

$y_{G_I} = \frac{c}{2} = 2\,e$

$G_{II} = \quad x_{G_1} = \frac{e}{2} + d = 2{,}5\,e$

$y_{G_1} = \frac{f}{2} = 1{,}5\,e$

$S_{x1} = A_1 \cdot y_{G_1} = (20\,e)(2e) = 40\,e^3$

$S_{x2} = A_2 \cdot y_{G2} = (3\,e)(1{,}5\,e) = 4{,}5\,e^3$

$S_{y1} = A_1 \cdot x_{G_1} = (20\,e)(2{,}5\,e) = 50\,e^3$

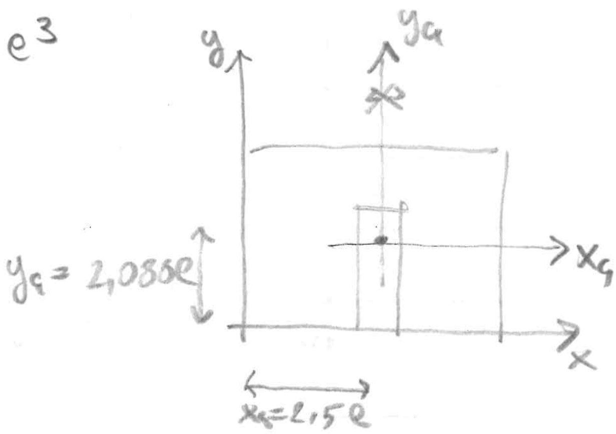
$S_{y2} = A_2 \cdot x_{G2} = (3\,e)(2{,}5\,e) = 7{,}5\,e^3$

$S_x = S_{x1} - S_{x2} = 40\,e^3 - 4{,}5\,e^3 = 35{,}5\,e^3$

$S_y = S_{y1} - S_{y2} = 50\,e^3 - 7{,}5\,e^3 = 42{,}5\,e^3$

$x_G = \frac{S_y}{A} = \frac{42{,}5\,e^3}{17\,e} = 2{,}5\,e$

$y_G = \frac{S_x}{A} = \frac{35{,}5\,e^3}{17\,e} = 2{,}088\,e$



$J_{x_G} = \underbrace{\left[J_{x_1} - J_{x_2}\right]}_{J_{x}} - A\, y_G^2$ $\qquad$ $J_{y_G} = J_{y_{G1}} - J_{y_{G2}}$

$J_{x_1} = \frac{BH^3}{3}$ $\quad B = b \quad H = c \quad$ $J_{x_1} = \frac{b \cdot c^3}{3} = \frac{(5e)(4e)^3}{3} = \frac{(5 \cdot 64)e^4}{3} = \frac{320}{3}e^4$

$J_{x_2} = \frac{BH^3}{3}$ $\quad B = e \quad H = f \quad$ $J_{x_2} = \frac{e \cdot f^3}{3} = \frac{(e)(3e)^3}{3} = \frac{27}{3}e^3$

$J_x = J_{x_1} - J_{x_2} = \frac{320 - 27}{3}e^4 = \frac{293}{3}e^4$

$J_{x_G} = J_x - A\, y_G^2 = \frac{293}{3}e^4 - (17e^2)(2{,}088\, e)^2 = 97{,}6e^4 - 74{,}115\, e^4 = 23{,}551$

$J_{y_G} = J_{y_{G1}} - J_{y_{G2}}$

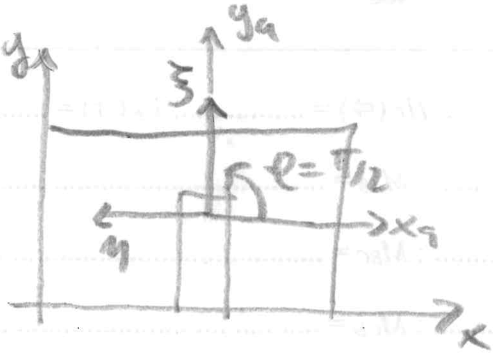
$J_{y_{G1}} = \frac{BH^3}{12}$ $\quad B = c \quad H = b \quad$ $J_{y_{G1}} = \frac{c \cdot b^3}{12} = \frac{(4e)(5e)^3}{12} = \frac{(4 \cdot 125)e^4}{12} = \frac{500}{12}e^4$

$J_{y_{G2}} = \frac{BH^3}{12}$ $\quad B = f \quad H = e \quad$ $J_{y_{G2}} = \frac{f \cdot e^3}{12} = \frac{(3e)(e)^3}{12} = \frac{3}{12}e^4$

$J_{y_G} = \left(\frac{500 - 3}{12}\right)e^4 = \frac{497}{12}e^4 = 41{,}416\, e^4$

N.B. y_G è 1 asse di simmetria $\rightarrow J_{x_G y_G} = 0$

$tg\, 2\varphi = 0 \qquad \varphi = ? \qquad J_{y_G} > J_{x_G} \rightarrow \varphi = \pi/2 = 90°$



$J_\xi = J_{MAX} = J_{y_G} = 41{,}416\, e^4$

$J_\eta = J_{MIN} = J_{x_G} = 23{,}5\_\, e^4$