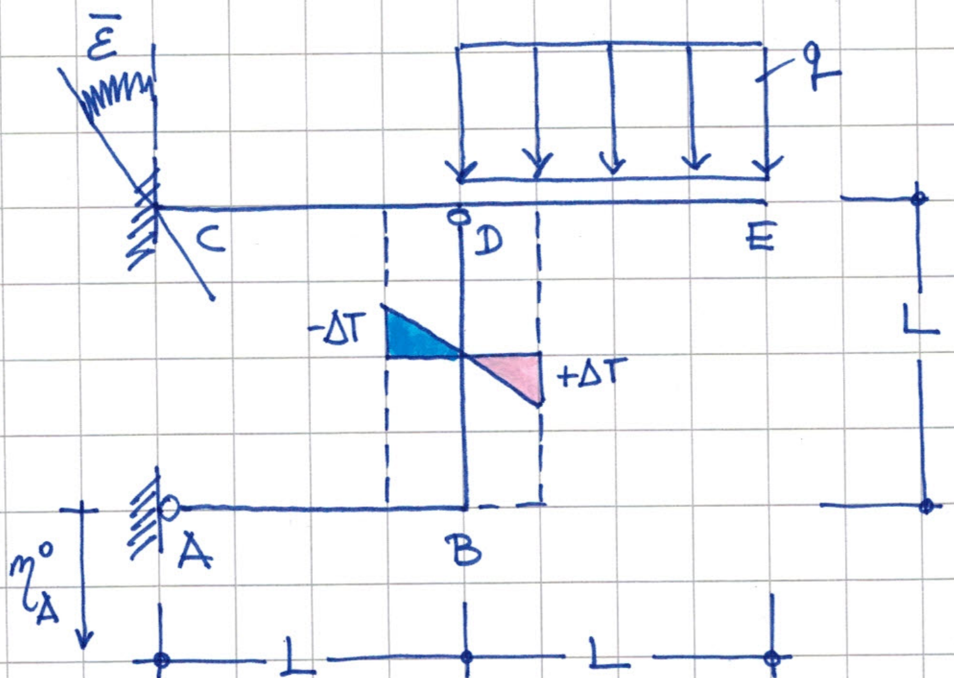
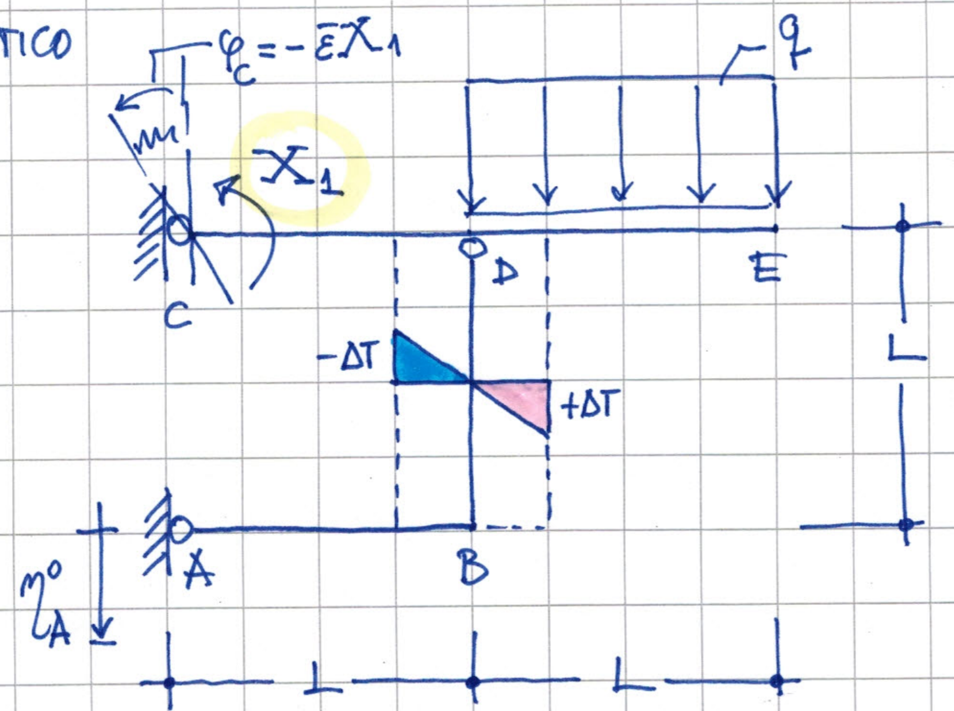
ES. #7 RISOLVERE LA STRUTTURA 1 VOLTA IPERSTATICA RIPORTATA NELLA FIGURA SEGUENTE.



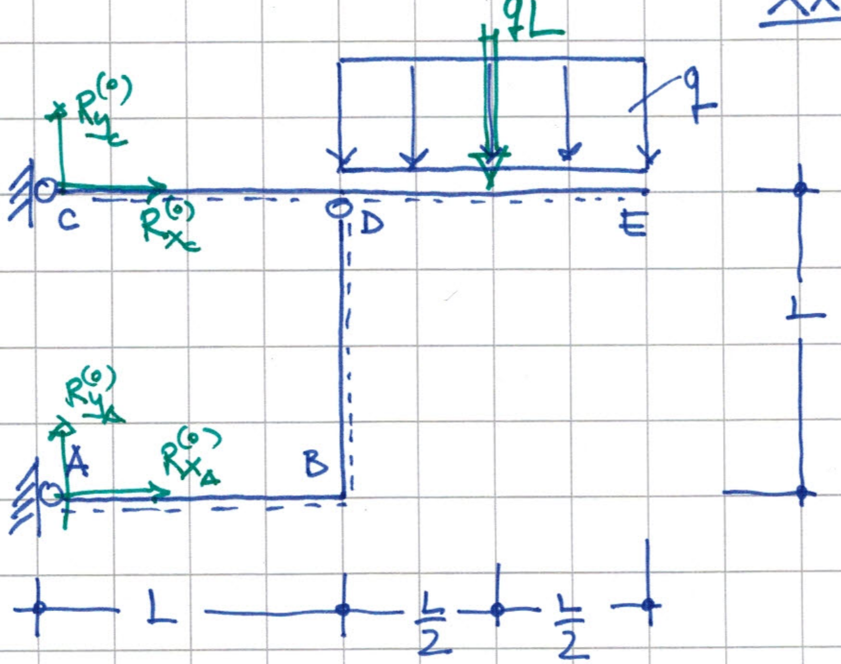
SISTEMA PRINCIPALE ISOSTATICO

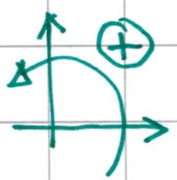


$$\underbrace{\varphi_C = -\bar{\varepsilon} X_1}$$

SCHEMA [0]

solo carichi ESTERNI





Calcolo RV:

$\sum F_x = 0 \quad R_{x_A} + R_{x_C} = 0$

$\sum F_y = 0 \quad R_{y_A} + R_{y_C} - qL = 0$

$\sum M_A = 0 \quad -R_{x_C} \cdot \cancel{L} - \frac{3}{2} qL^{\cancel{2}} = 0 \quad \Rightarrow \quad \boxed{R_{x_C} = -\frac{3}{2} qL}$ *

$\sum M_D^{(ABD)} = 0 \quad R_{x_A} \cdot \cancel{L} - R_{y_A} \cancel{L} = 0$

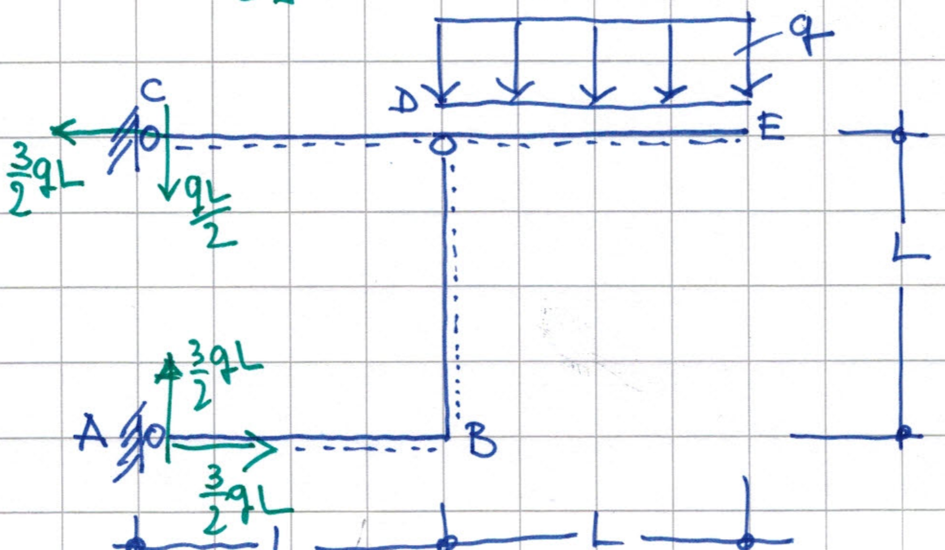
$\Rightarrow \quad \boxed{R_{x_A} = \frac{3}{2} qL}$

$\boxed{R_{y_A}} = R_{x_A} = \boxed{\frac{3}{2} qL}$

dalla seconda:

$\boxed{R_{y_C}} = qL - R_{y_A} = qL - \frac{3}{2} qL = \boxed{-\frac{qL}{2}}$ *

Le RV dello schema [0] sono in definitiva:



Determiniamo $M^{(0)}(z)$:

TRATTO AB $0 \le z \le L$

$$M^{(0)}(z) = \frac{3}{2} qL \cdot z \quad \begin{cases} M_A = \phi \\ M_B = \frac{3}{2} qL^2 \end{cases}$$

TRATTO BD $0 \le z \le L$

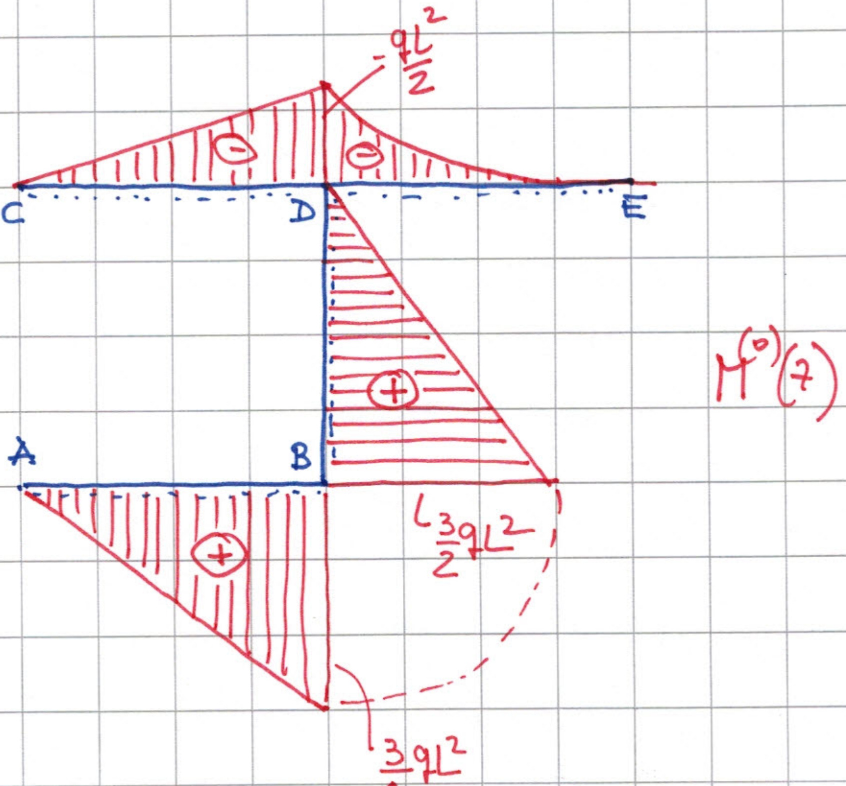
$$M^{(0)}(z) = \frac{3}{2} qL^2 - \frac{3}{2} qL \cdot z \quad \begin{cases} M_B = \frac{3}{2} qL^2 \\ M_D = \phi \end{cases}$$

TRATTO CD $0 \le z \le L$

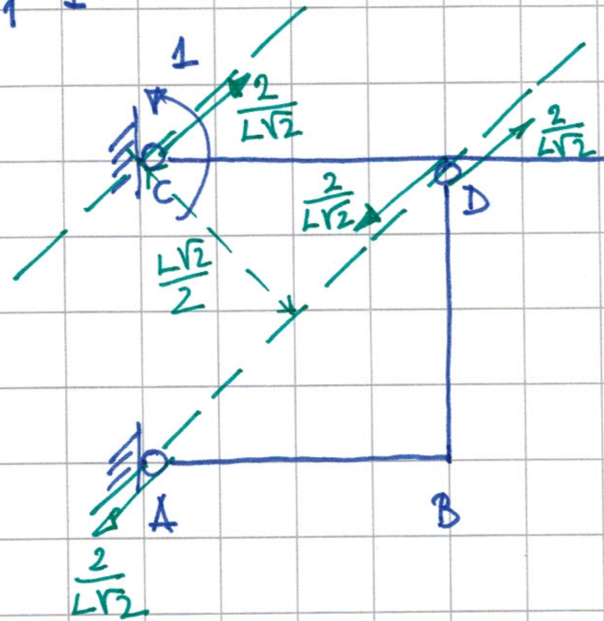
$$M^{(0)}(z) = -\frac{qL}{2} z \quad \begin{cases} M_C = \phi \\ M_D = -\frac{qL^2}{2} \end{cases}$$

TRATTO DE $L \le z \le 2L$

$$M^{(0)}(z) = -q \frac{(2L-z)^2}{2} \quad \begin{cases} M_D = -\frac{qL^2}{2} \\ M_E = \phi \end{cases}$$



SCHEMA [1]
solo $X_1 = 1$

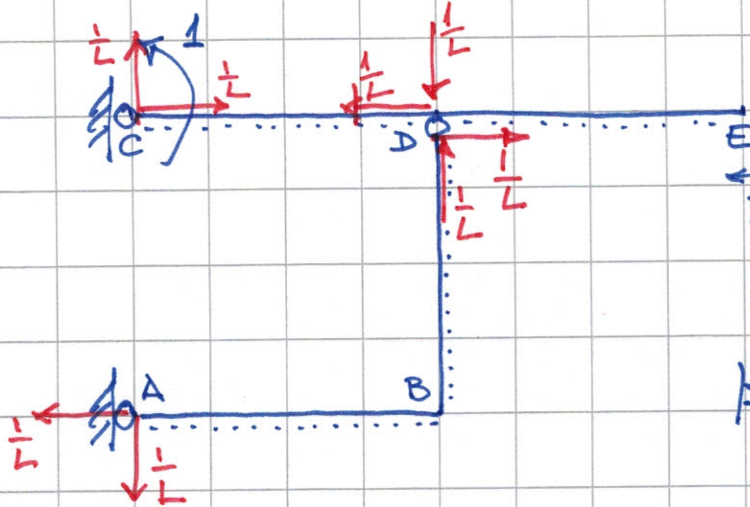


RV metodo grafico!
⇓
tratto ABD SCARICO!

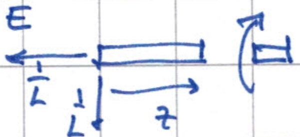
RV di A e D sulla congiungente AD

Risolvo CDE e poi ABD!

Considerando le componenti ⊥ e // agli assi si ha:

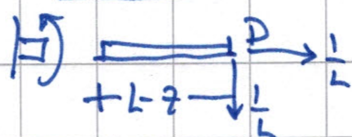


TRATTO AB $0 \le z \le L$



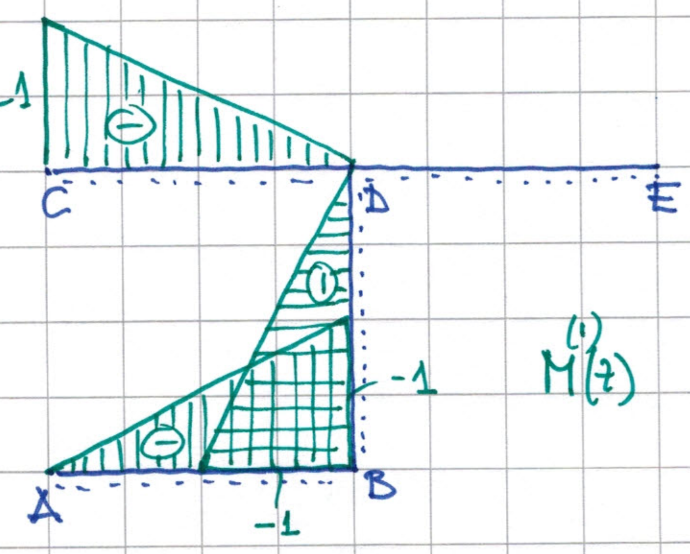
$$\underline{M^{(1)}(z) = -\frac{z}{L}} \quad \begin{cases} M_A = \phi \\ M_B = -1 \end{cases}$$

TRATTO BD $0 \le z \le L$

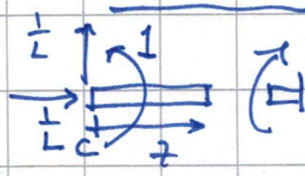


$$\underline{M^{(1)}(z) = -\frac{1}{L}(L-z)}$$

$M_B = -1 ; \; M_D = \phi$



TRATTO CD $0 \le z \le L$



$$\underline{M^{(1)}(z) = -1 + \frac{z}{L}} \quad \begin{cases} M_C = -1 \\ M_D = \phi \end{cases}$$

TRATTO DE

scarico!

Applicando il PLV, scriviamo l'unica equazione di Müller-Breslau corrispondente all'unica incognita iperstatica X_1 assumendo a tal uopo come sistema fittizio operante lo SCHEMA [1] e come sistema reale la STRUTTURA IPERSTATICA DATA. Si ha:

$$X_1^{(f)} = 1$$

$$L_{ve} = 1 \cdot \eta_i^{(r)} + \sum_j R_j^{(f)} \eta_j^{(r)} =$$

$$= 1 \cdot \varphi_C^{(r)} + \underbrace{R_{y_A}^{(1)}}_{\text{verso il basso}} \cdot \underbrace{\eta_A^{o}}_{\text{verso il basso}} = -\bar{\varepsilon} X_1 + \frac{\eta_A^{o}}{L}$$

CONCORDI

$$-\bar{\varepsilon} M_C^{(r)} \equiv X_1$$

RN sovrabb. scelta come incognita iperstatica

$$M^{(r)} = M^{(0)} + M^{(1)} X_1$$

$$L_{vi} = \int_{Str} M^{(f)} \frac{M^{(r)}}{EI} dStr + \int_{Str} M^{(f)} \frac{\alpha \Delta T}{h} dStr =$$

$$= \int_{Str} M^{(1)} \frac{M^{(0)}}{EI} dStr + X_1 \int_{Str} \frac{[M^{(1)}]^2}{EI} dStr + \int_{Str} M^{(1)} \frac{\alpha \Delta T}{h} dStr =$$

$$-\frac{3}{2} q z^2 \qquad \frac{3}{2} qLz - \frac{3}{2} q z^2 - \frac{3}{2} q L^2 + \frac{3}{2} q z L$$

$$= \frac{1}{EI} \int_{\overline{AB}} \left(-\frac{z}{\cancel{L}}\right)\left(\frac{3}{2} q \cancel{L} z\right) dz + \frac{1}{EI} \int_{\overline{BD}} -\frac{1}{\cancel{L}} \underbrace{(L-z)}_{(z-L)} \left[\frac{3}{2} q L^{\cancel{2}} - \frac{3}{2} q \cancel{L} z\right] dz +$$

$$\frac{qL}{2} z - \frac{q}{2} z^2$$

$$+ \frac{1}{EI} \int_{\overline{CD}} \left(-1 + \frac{z}{\cancel{L}}\right)\left(-\frac{q\cancel{L}}{2} z\right) dz + \frac{X_1}{EI} \left\{ \int_{\overline{AB}} \left(-\frac{z}{L}\right)^2 dz + \int_{\overline{BD}} \left[-\frac{1}{L}(L-z)\right]^2 dz + \right.$$

$$\left(-1 + \frac{z}{L}\right)^2 = 1 + \frac{z^2}{L^2} - \frac{2z}{L}$$

$$\left. + \int_{\overline{CD}} \left(\frac{z}{L} - 1\right)^2 dz \right\} + \int_{\overline{BD}} \underbrace{\left(\frac{z}{L} - 1\right)}_{\text{negativo}} \underbrace{\left(+\frac{\alpha \Delta T}{h}\right)}_{\text{positivo}} dz =$$

$$\frac{z^2}{L^2} + 1 - \frac{2z}{L}$$

$$= -\frac{\cancel{3}q}{2EI}\left[\frac{z^3}{\cancel{3}}\right]_0^L + \frac{3q}{2EI}\left[L\left[\frac{z^2}{2}\right]_0^L - \left[\frac{z^3}{3}\right]_0^L - L^2\left[z\right]_0^L + \left[\frac{z^2}{2}\right]_0^L L\right] +$$

$$+ \frac{q}{2EI}\left[L\left[\frac{z^2}{2}\right]_0^L - \left[\frac{z^3}{3}\right]_0^L\right] + \frac{X_1}{EI}\left[+\frac{1}{L^2}\left[\frac{z^3}{3}\right]_0^L + \left[z\right]_0^L + \frac{1}{L^2}\left[\frac{z^3}{3}\right]_0^L - \frac{\cancel{2}}{L}\left[\frac{z^2}{\cancel{2}}\right]_0^L\right.$$

$$\left. + \frac{1}{L^2}\left[\frac{z^3}{3}\right]_0^L + \left[z\right]_0^L - \frac{\cancel{2}}{L}\left[\frac{z^2}{\cancel{2}}\right]_0^L\right] + \frac{\alpha\Delta T}{h}\left[\frac{1}{L}\left[\frac{z^2}{2}\right]_0^L - \left[z\right]_0^L\right] =$$

$$= -\frac{qL^3}{3EI} - \frac{qL^3}{2EI} + \frac{qL^3}{6EI} + \frac{X_1 L}{EI} - \frac{\alpha\Delta T L}{2h} =$$

$$= -\frac{2}{3}\frac{qL^3}{EI} + \frac{X_1 L}{EI} - \frac{\alpha \Delta T L}{2h}$$

Si ha in definitiva:

$$-\bar{\varepsilon} X_1 + \frac{\mathcal{M}_A^0}{L} = -\frac{2}{3}\frac{qL^3}{EI} + \frac{X_1 L}{EI} - \alpha\frac{\Delta T L}{2h}$$

$$X_1 = \frac{\left[\frac{\mathcal{M}_A^0}{L} + \frac{2}{3}\frac{qL^3}{EI} + \alpha\frac{\Delta T L}{2h}\right]}{\bar{\varepsilon} + \frac{L}{EI}} > 0$$ verso ipotizzato CORRETTO!