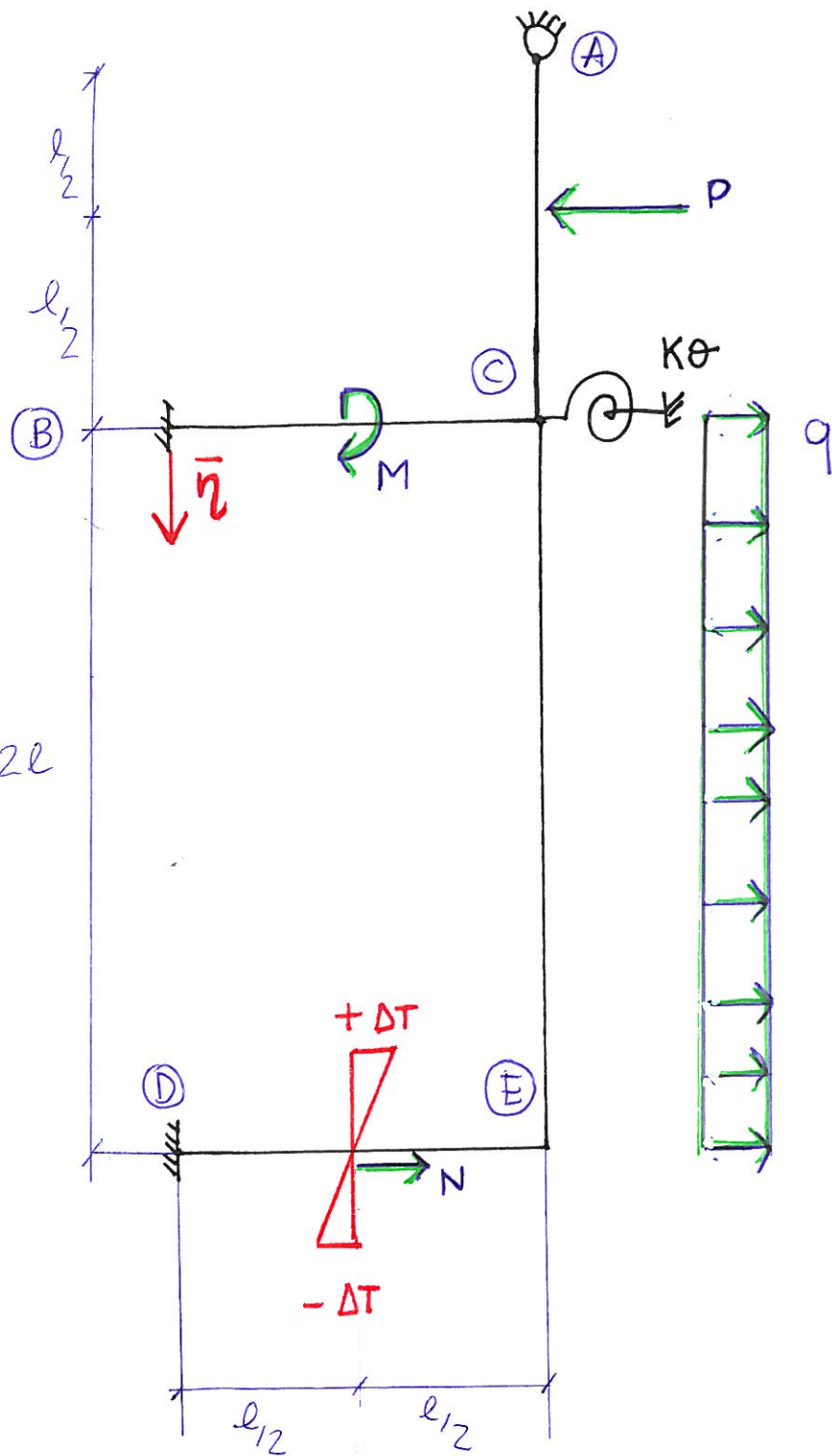




$$N = \frac{5}{2} ql$$

$$P = 8ql$$

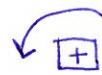
$$M = 6ql^2$$

$$\frac{\alpha \Delta T}{t} = \frac{11}{12} \frac{ql^2}{EJ}$$

$$\bar{q} = \frac{1}{18} \frac{ql^4}{EJ}$$

$$K\theta = \frac{13}{4} \frac{EJ}{l}$$

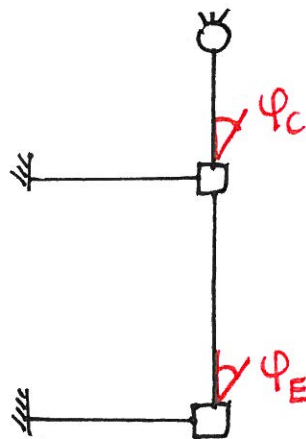
CONVENZIONI DI SEGNO

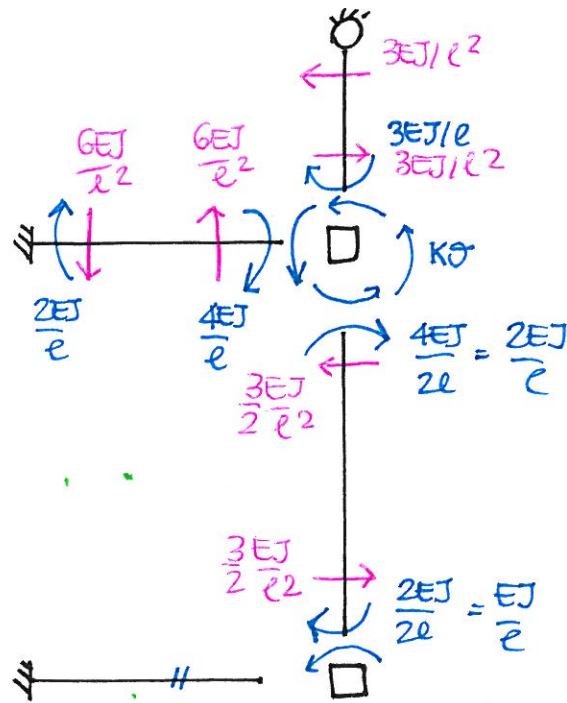
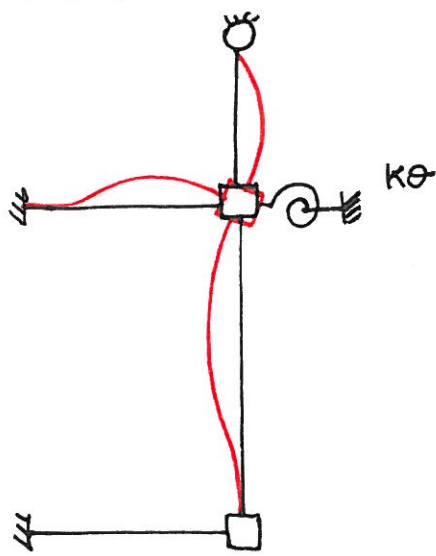


Il sistema è a nodi fissi.

SISTEMA RISOLVENTE

$$\begin{cases} M_{CC} \varphi_C + M_{CE} \varphi_E + M_{C\phi} = 0 \\ M_{EC} \varphi_C + M_{EE} \varphi_E + M_{E\phi} = 0 \end{cases}$$

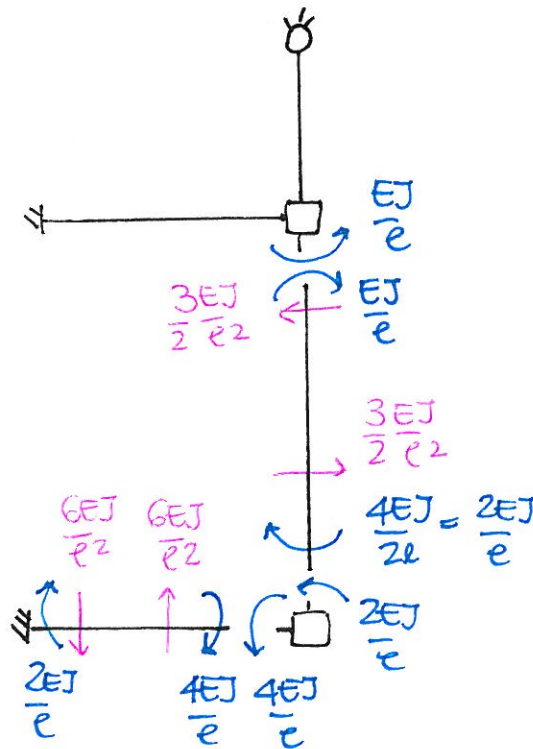
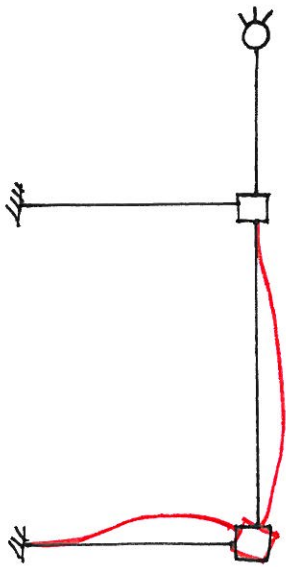




$$M_{CC} = \frac{13EJ}{4l} + \frac{3EJ}{l} + \frac{4EJ}{l} + \frac{2EJ}{l} = \frac{49EJ}{4l}$$

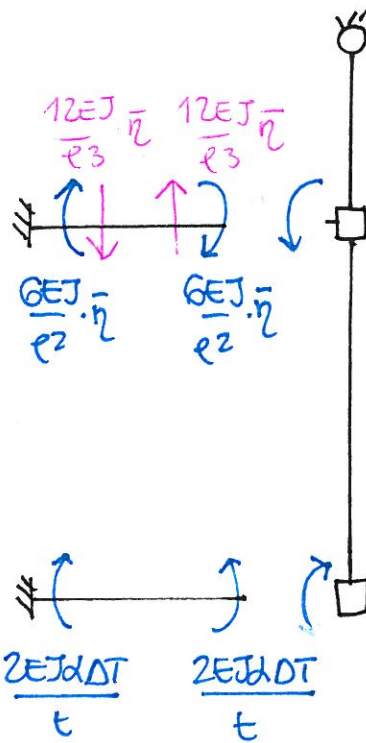
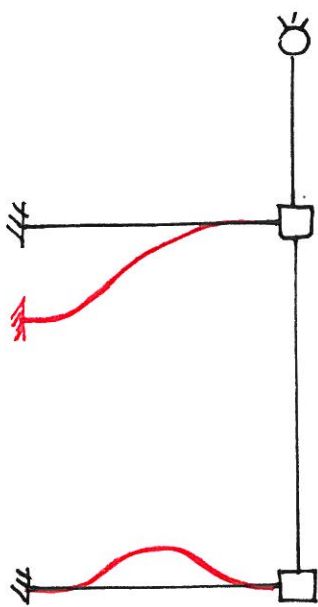
$$M_{EC} = \frac{EJ}{l}$$

CASO 2: $\psi_E \neq 0$; $\psi_E = 1$



$$M_{EE} = \frac{6EJ}{l}$$

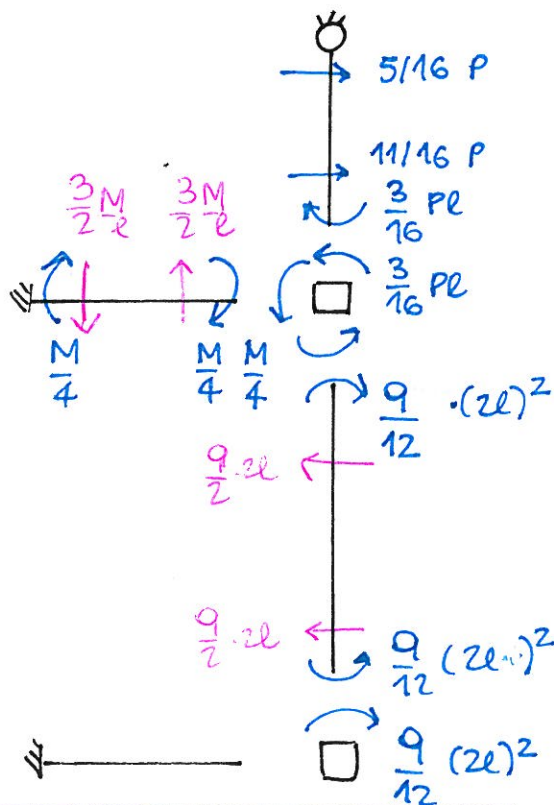
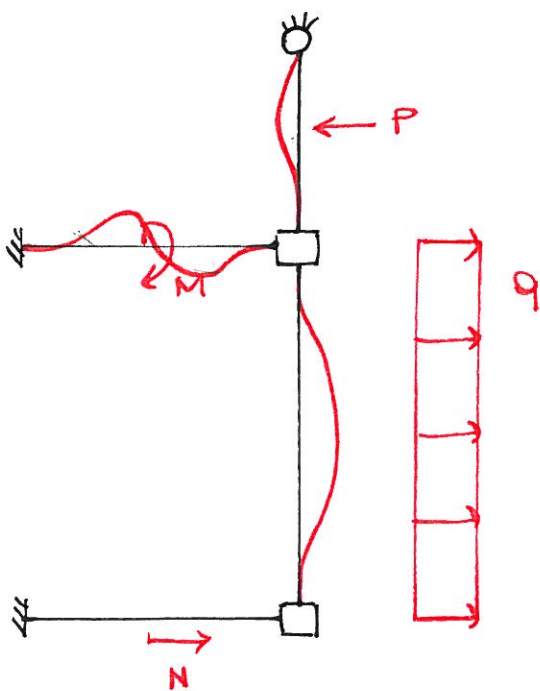
$$M_{CE} = \frac{EJ}{l}$$



$$M_{ch} = \frac{6EJ}{l^2} \cdot \bar{\eta} = \frac{6EJ}{l^2} \cdot \frac{1}{18} \frac{ql^4}{EJ} = \frac{1}{3} ql^2$$

$$M_{EDT} = - \frac{2EJ\delta}{l} = - 2EJ \cdot \frac{11}{12} \frac{ql^2}{EJ} = - \frac{11}{6} ql^2$$

CASO 4: CARICHI $\neq 0$



$$M_{C-CARICHI} = \frac{3}{16} Pl + \frac{M}{4} + \frac{9}{12} (2l)^2 = \frac{3}{16} Pl + \frac{6ql^2}{4} + \frac{4}{12} ql^2 = \frac{3}{2} ql^2 + \frac{3}{2} ql^2 + \frac{1}{3} ql^2$$

$$M_{E-CARICHI} = - \frac{4}{12} ql^2 = - \frac{1}{3} ql^2$$

$$\begin{cases} M_{CC}\varphi_C + M_{CE}\varphi_E + M_{C\varnothing} = 0 \\ M_{EC}\varphi_C + M_{EE}\varphi_E + M_{E\varnothing} = 0 \end{cases}$$

$$\begin{cases} \left(\frac{49}{4} \frac{EJ}{l}\right) \varphi_C + \left(\frac{EJ}{l}\right) \varphi_E + \left(\frac{1}{3} ql^2 + \frac{3}{2} ql^2 + \frac{3}{2} ql^2 + \frac{1}{3} ql^2\right) \\ \frac{EJ}{l} \varphi_C + \left(\frac{6EJ}{l}\right) \varphi_E + \left(-\frac{11}{6} ql^2 - \frac{1}{3} ql^2\right) = 0 \end{cases}$$

$$\begin{cases} \frac{49}{4} \varphi_C + \varphi_E + \frac{ql^3}{EJ} \left(\frac{11}{3}\right) = 0 \quad \cdot 6 \\ \varphi_C + 6\varphi_E - \frac{13}{6} \frac{ql^3}{EJ} = 0 \end{cases}$$

$$\begin{cases} \frac{147}{2} \varphi_C + 6\varphi_E = -22 \frac{ql^3}{EJ} \\ \varphi_C + 6\varphi_E = \frac{13}{6} \frac{ql^3}{EJ} \end{cases} \quad \ominus$$

$$\frac{145}{2} \varphi_C = -\frac{145}{6} \frac{ql^3}{EJ} \quad \varphi_C = -\frac{2}{6} \frac{ql^3}{EJ} = -\frac{1}{3} \frac{ql^3}{EJ}$$

SOSTITUISCO φ_C PER CALCOLARE φ_E .

$$-\frac{1}{3} \frac{ql^3}{EJ} + 6\varphi_E = -\frac{13}{6} \frac{ql^3}{EJ}$$

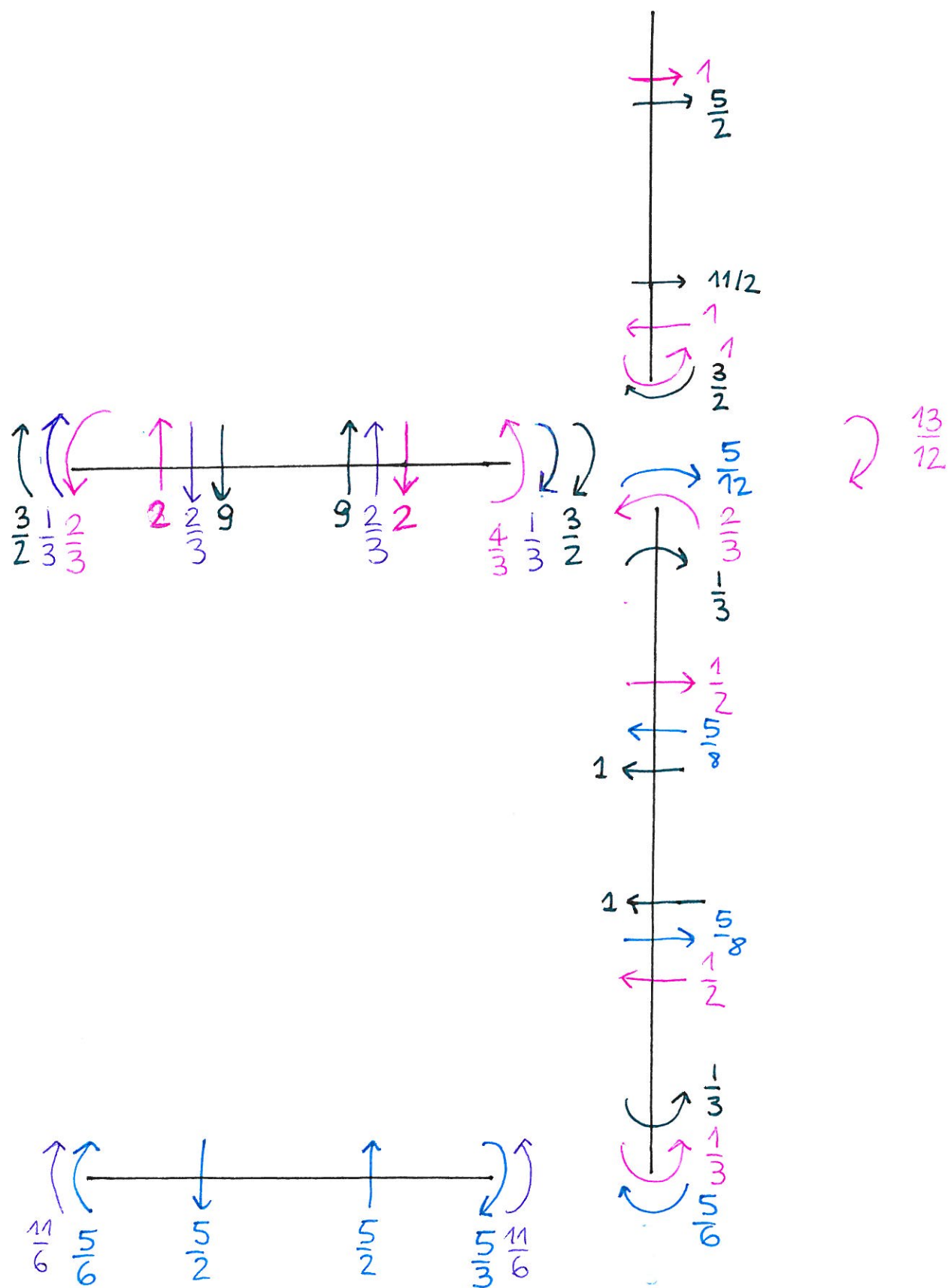
$$6\varphi_E = \left(+\frac{13}{6} + \frac{1}{3}\right) \frac{ql^3}{EJ} = \frac{5}{2} \frac{ql^3}{EJ} \Rightarrow \frac{5}{12} \frac{ql^3}{EJ}$$

$$\boxed{\begin{aligned} \varphi_C &= -\frac{1}{3} \frac{ql^3}{EJ} \\ \varphi_E &= \frac{5}{12} \frac{ql^3}{EJ} \end{aligned}}$$

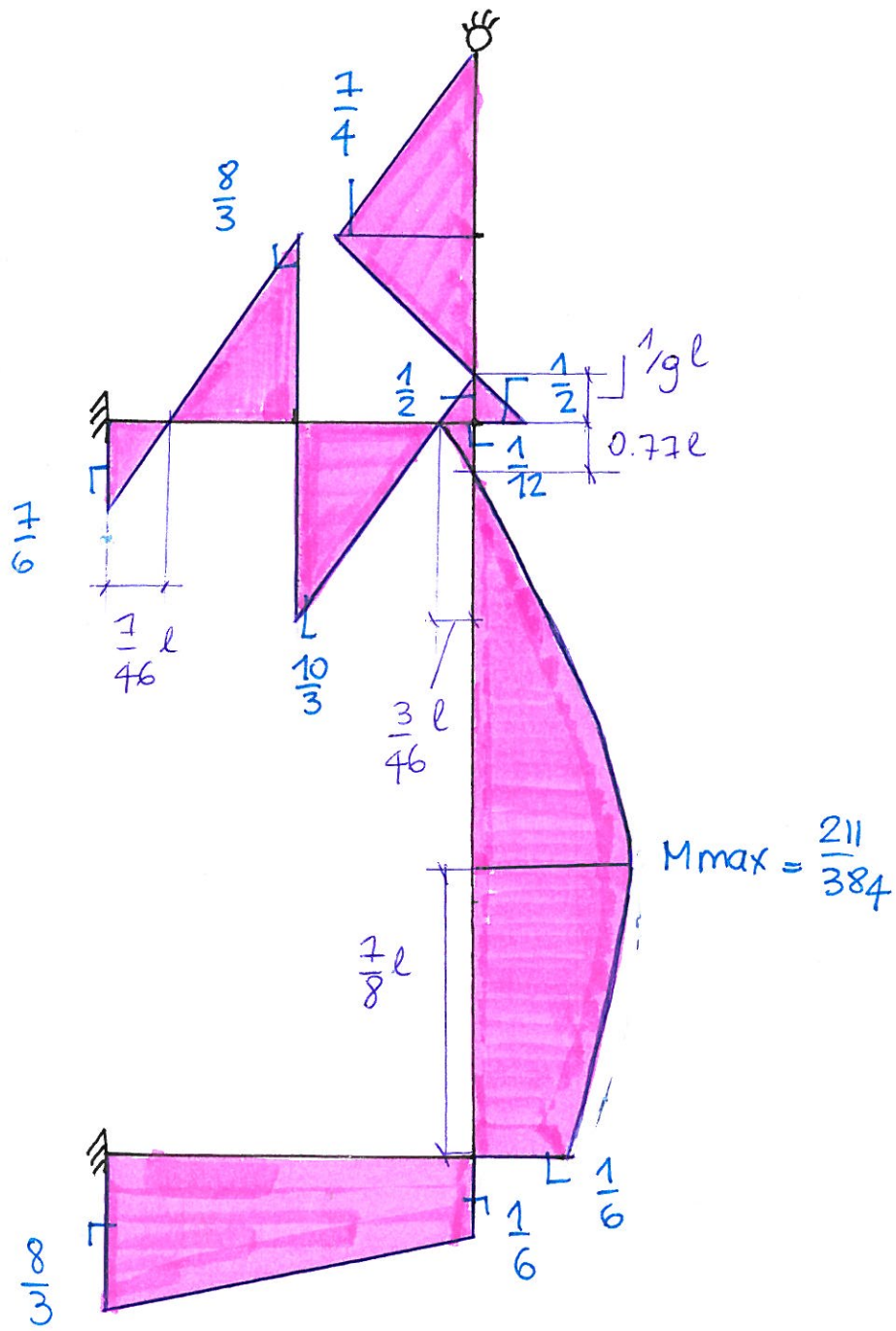
IL MOMENTO ESERCITATO DALLA MOLLA TORSIONALE VALE:

$$\frac{1}{3} \frac{ql^3}{EJ} \cdot \frac{13}{4} \frac{EJ}{l} = \frac{13}{12} ql^2 \quad \text{IN SENSO ORARIO}$$

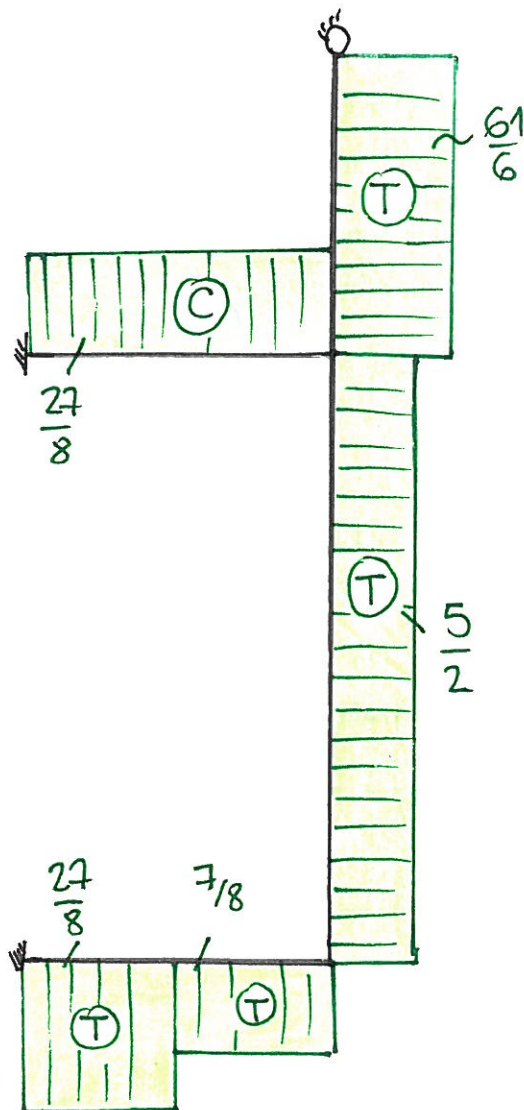
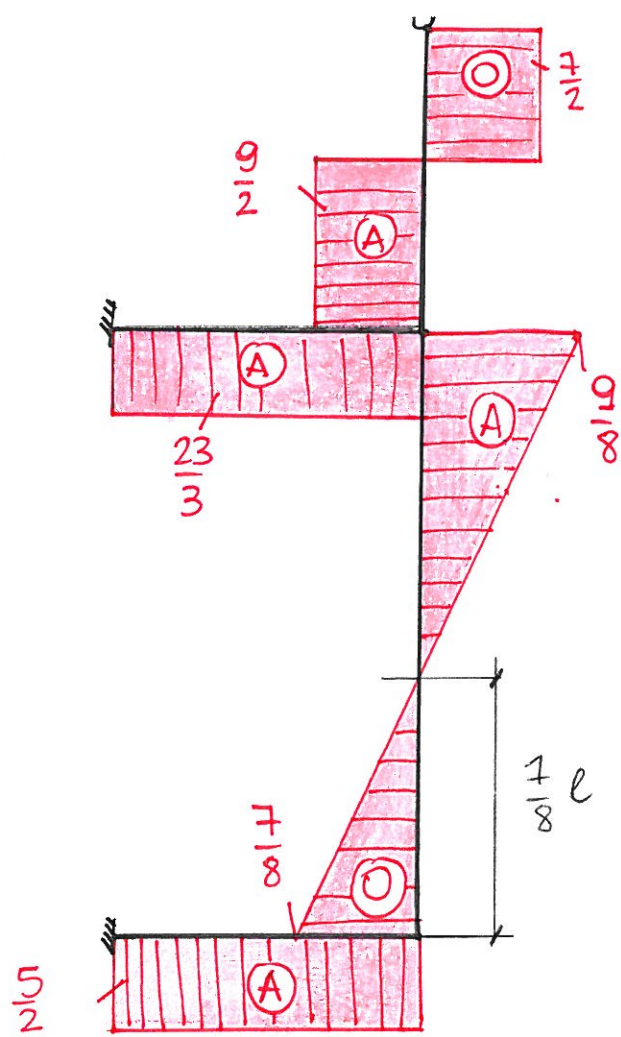




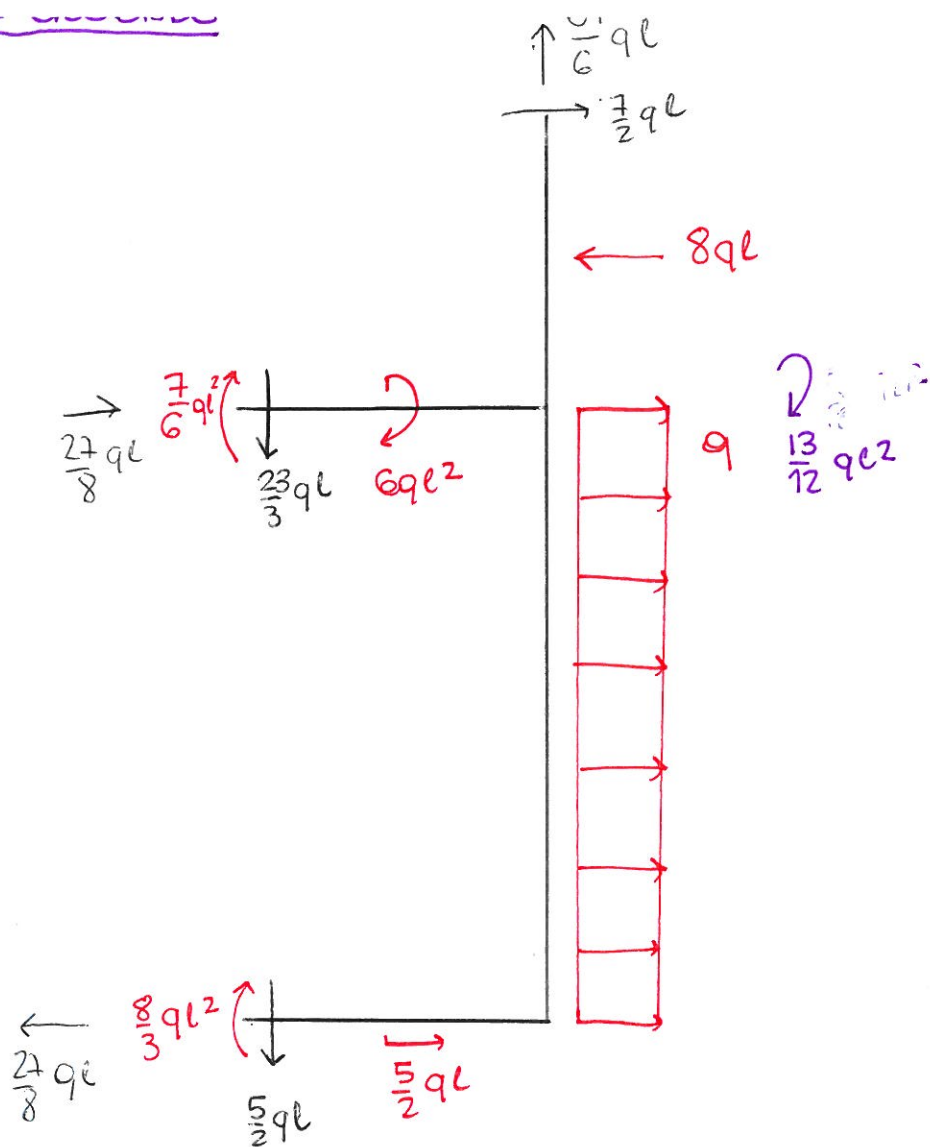
(M) [90°]



6



(7)

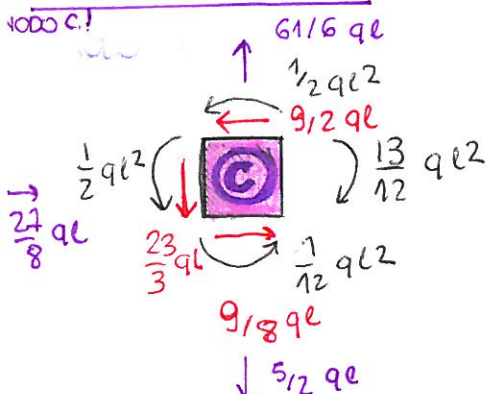


$$\sum F_v = 0 \quad + \uparrow) \quad \frac{61}{6} ql - \frac{23}{3} ql - \frac{5}{2} ql = 0 \quad \text{OK!}$$

$$\sum F_o = 0 \quad + \rightarrow) \quad \frac{7}{2} ql - 8ql + \frac{27}{8} ql + 2ql + \frac{5}{2} ql - \frac{27}{8} ql = 0 \quad \text{OK!}$$

$$\sum M = 0 \quad (\text{PUNTO D}) \quad + \uparrow) \quad \frac{8}{3} ql^2 + 2ql^2 + \frac{7}{6} ql^2 + \frac{27}{8} ql(2l) - 8ql\left(\frac{5}{2}l\right) + 3 \cdot \frac{7}{2} ql^2 - \frac{61}{6} ql^2 + \frac{13}{12} ql^2 + 6ql^2 = 0 \quad \text{OK!}$$

EQUILIBRIO NODI

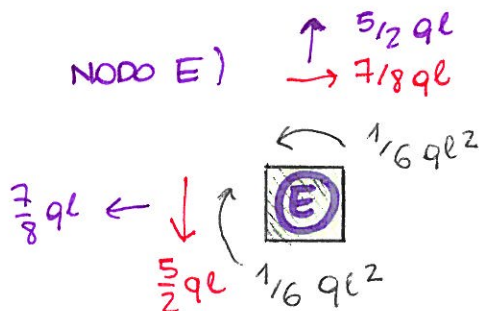


$$\sum M) \left(\frac{1}{2} + \frac{1}{2} + \frac{1}{12} - \frac{13}{12} \right) ql^2 = 0 \quad \text{OK!}$$

$$\sum F_v) \quad \frac{61}{6} ql - \frac{23}{3} ql - \frac{5}{2} ql = 0 \quad \text{OK!}$$

$$\sum F_o) \quad \left(\frac{9}{2} - \frac{9}{8} - \frac{27}{8} \right) ql = 0 \quad \text{OK!}$$

NODO E)

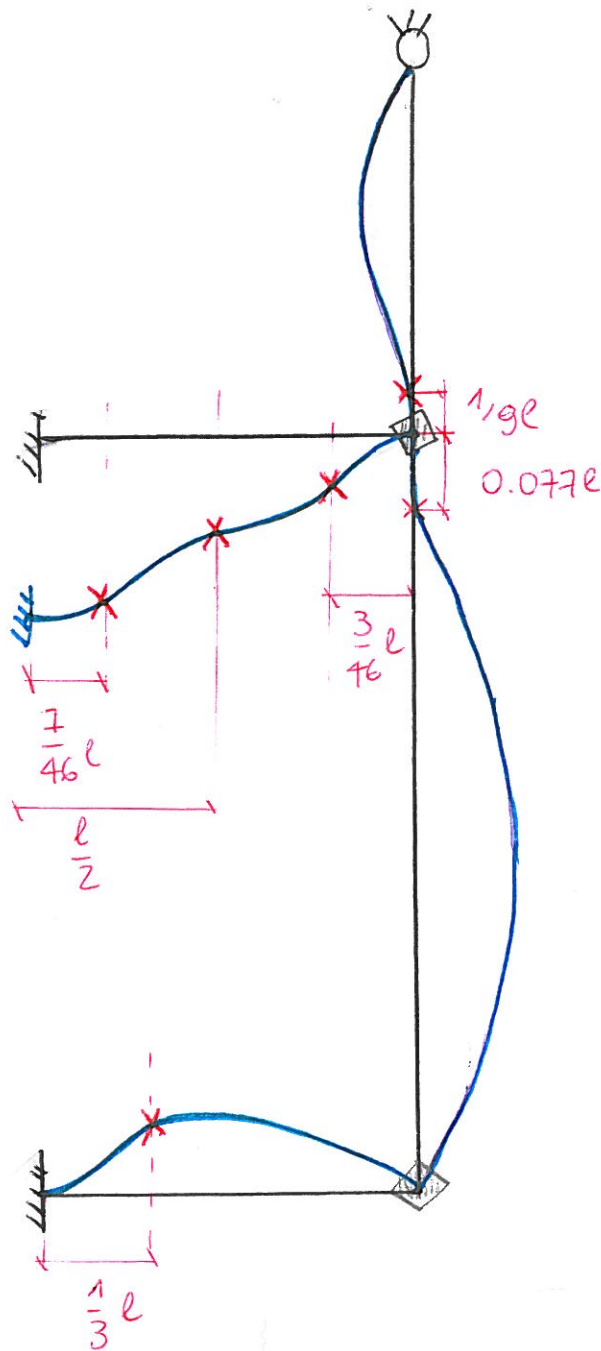


$$\sum M) \quad \frac{1}{6} ql^2 - \frac{1}{6} ql^2 = 0 \quad \text{OK!}$$

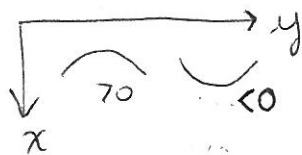
$$\sum F_v) \quad \frac{5}{2} ql - \frac{5}{2} ql = 0 \quad \text{OK!}$$

$$\sum F_o) \quad \frac{7}{8} ql - \frac{7}{8} ql = 0 \quad \text{OK!}$$

DEFORMAZIONE
QUALITATIVA

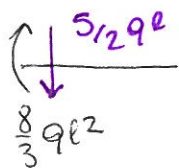


EFFETTO DEL CARICO TERMICO SULLA DEFORMATA
CONVENZIONI CURVATURA



$$y'' = -\frac{M(x)}{EJ} + \frac{2\alpha \Delta T}{t} = 0$$

DA NODO D



$$M(x) = \frac{8}{3} q l^2 - \frac{5}{2} q l x$$

$$y'' = -\frac{1}{EJ} \left(\frac{8}{3} q l^2 - \frac{5}{2} q l x \right) + \frac{2 \cdot 11}{12} \frac{q l^2}{EJ} = 0 \rightarrow \text{ottingo il flesso}$$

$$x = \frac{1}{3} l$$

(A PARTIRE DA
NODO "D")

$$y'' > 0 \quad x > \frac{1}{3} l$$