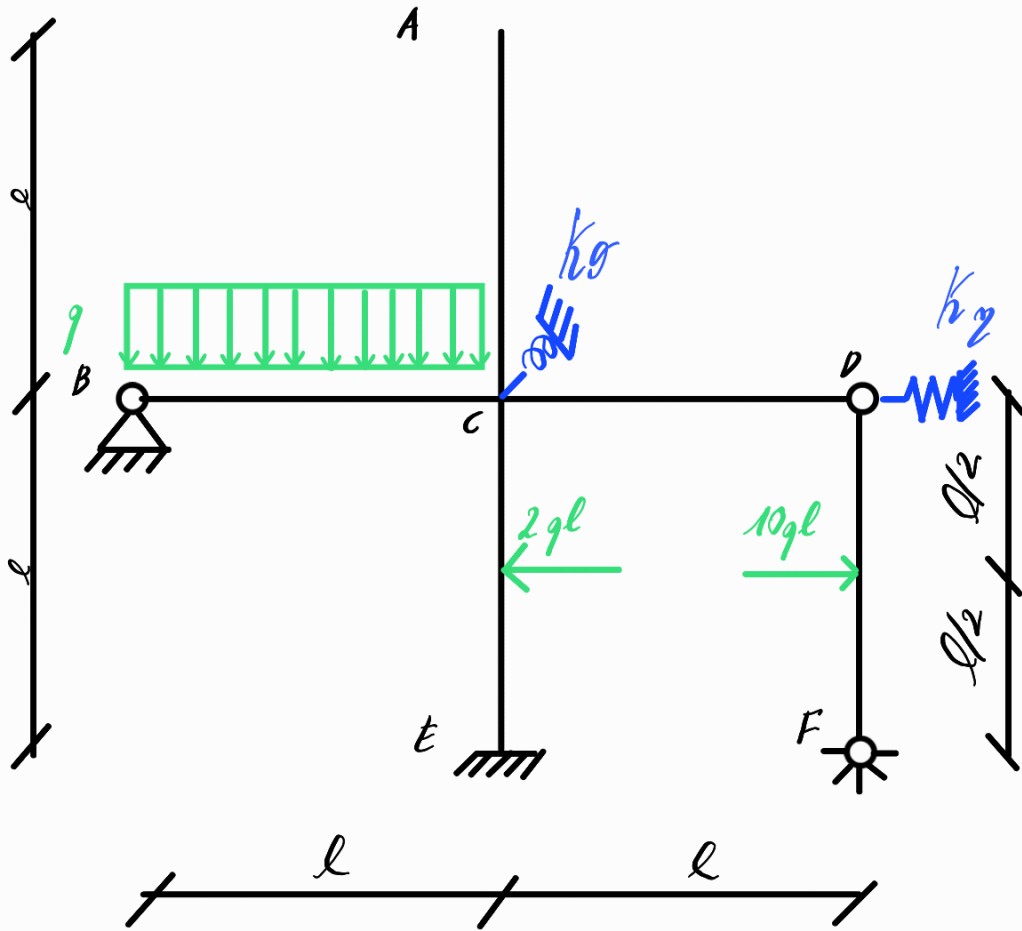


TEMA D'ESAME 11/01/2023

TECNICA DELLE COSTRUZIONI



DATI:

$$K_g = 16 \frac{EI}{l}$$

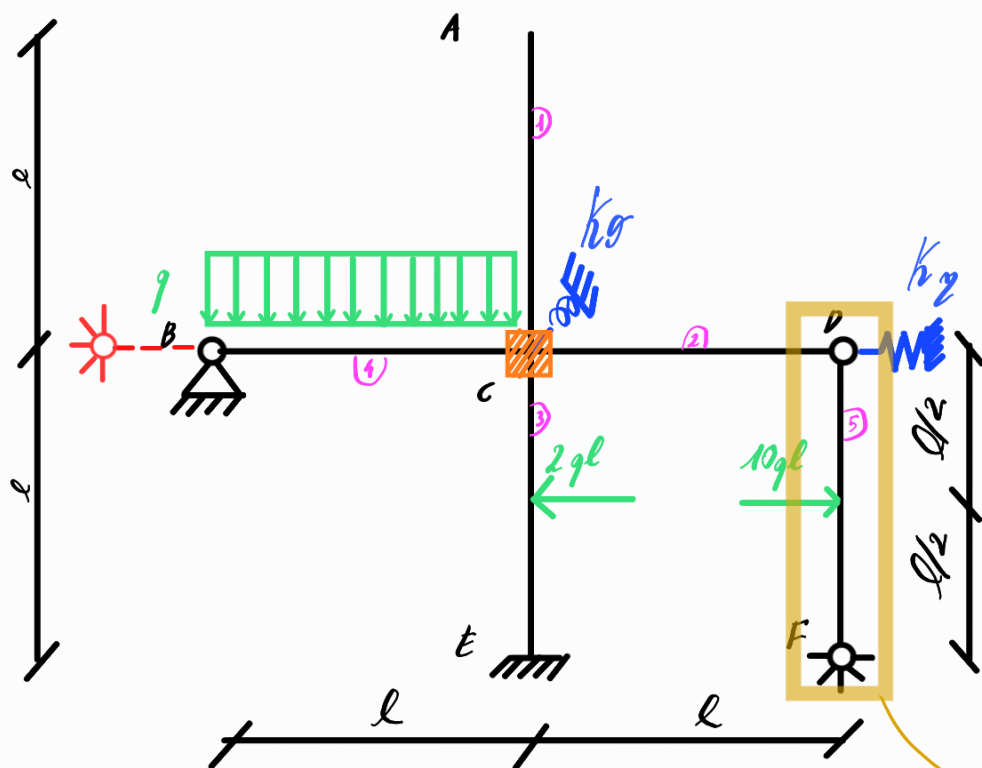
$$K_v = \frac{11}{2} \frac{EI}{l^3}$$

RISOLUZIONE

Telaio a nodi spostabili orizzontalmente

Immagino la trave fittizia in "B" e immagino il "blochetto" in "C"

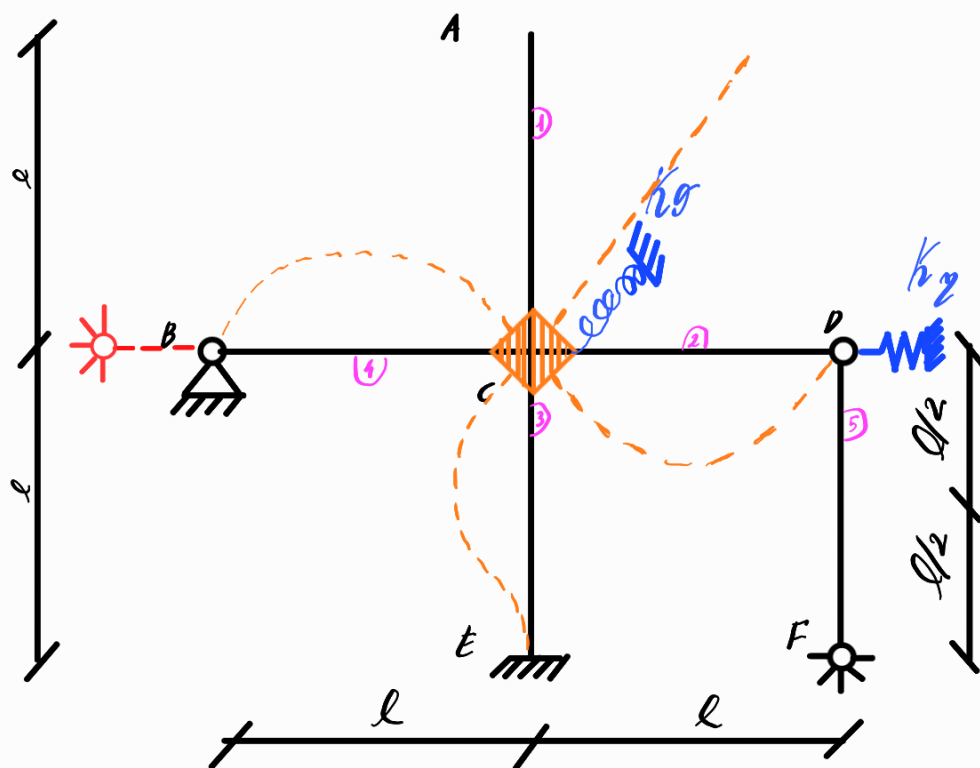
Numero le aste da 1 a 5



Eq. di congruenza:

$$\begin{cases} m_{ac} \cdot \varphi_c + m_{cb} \cdot \eta_B + m_{cd} \cdot \phi = 0 \\ h_{bc} \cdot \varphi_c + h_{bb} \cdot \eta_B + h_{bd} \cdot \phi = 0 \end{cases}$$

Pongo $\varphi_c = 1$ $\eta_B = 0$; $\phi = 0$



a.B.

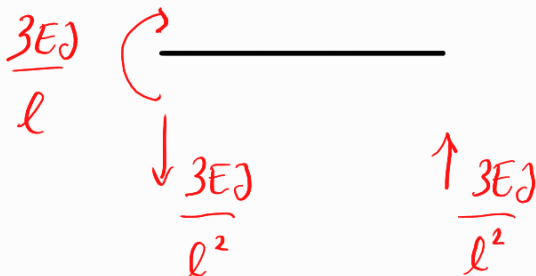
*Attenzione!
da posso vedere come
una liccia, cinematicamente
è possibile sostituirla con
un carrello verticale e studiarla
a parte.*

*BISOGNA PERÒ
RICORDARSI LE REAZIONI
E DI CONSIDERARLA
NEI DIAGRAMMI*

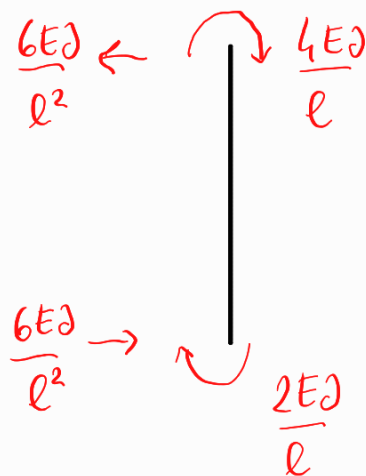
ASTA 1 = CASO V



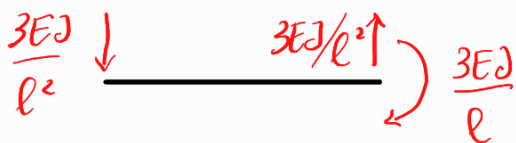
ASTA 2 = CASO II



ASTA 3 = CASO I



ASTA 4 = CASO II

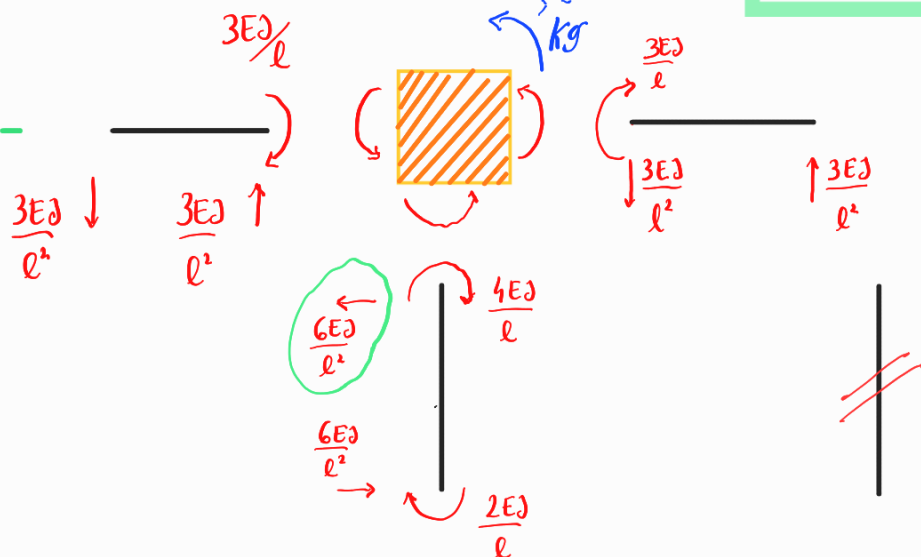


ASTA 5

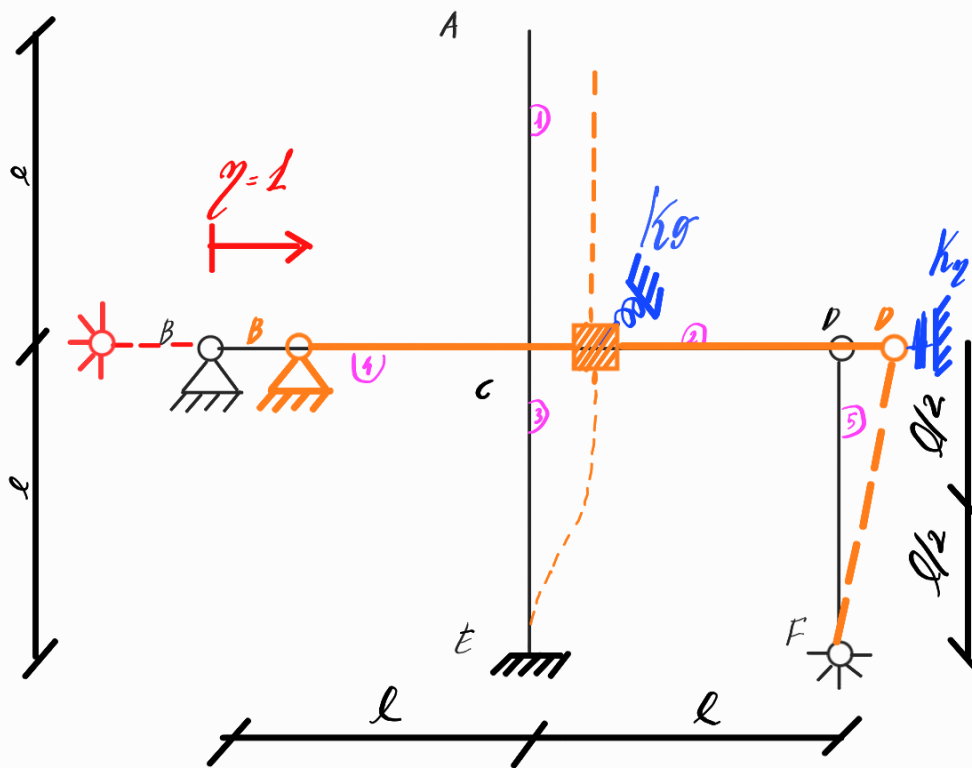


$$M_{CC} = + \frac{3EJ}{l} + \frac{4EJ}{l} + \frac{3EJ}{l} + K_{\theta} = 26 \frac{EJ}{l}$$

$$K_{\theta} = - \frac{6EJ}{l^2}$$



longer $\eta_B = 1$ $f_c = 0; P = 0.$



ASTA 1 = CASO V

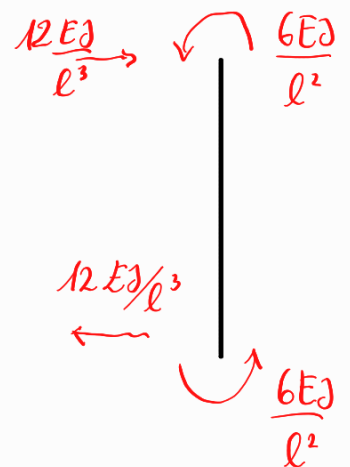
ASTA 2 = CASO II

ASTA 3 = CASO I

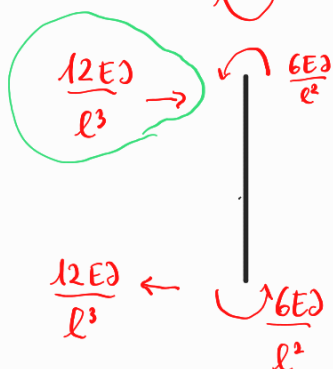


ASTA 4 = CASO II

ASTA 5



biella
fittizia



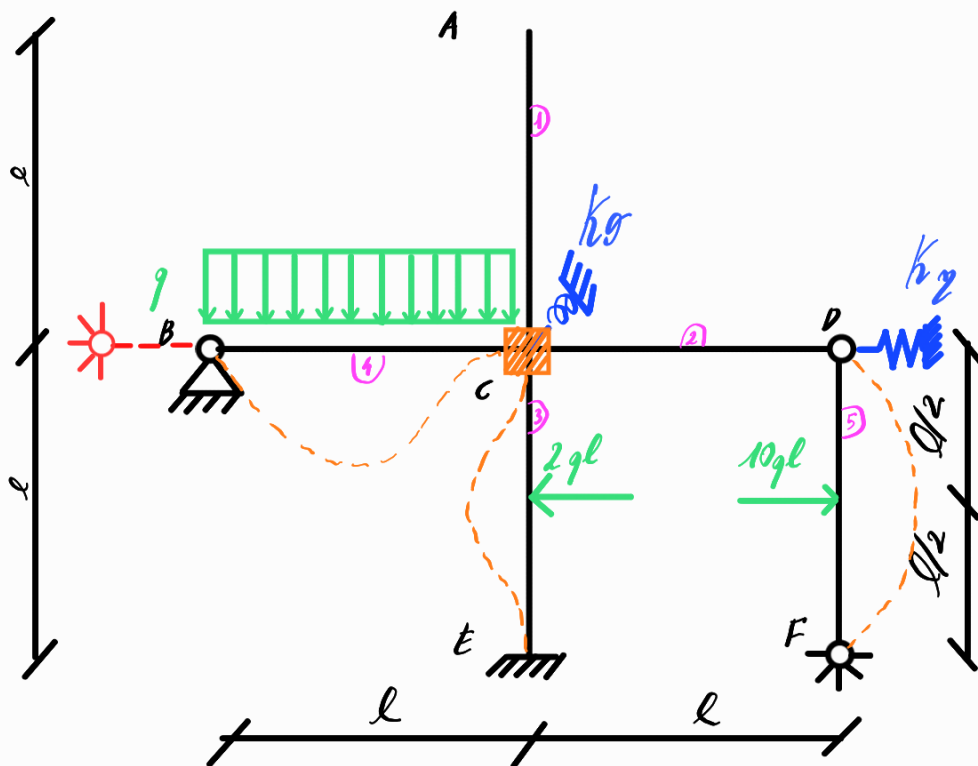
$$m_{ca} = -\frac{6EJ}{l^2}$$

$$r_{BC} = 12 \frac{EJ}{l^3} + k_2 = \frac{35}{2} \frac{EJ}{l^3}$$

$$\parallel$$

$$\frac{11}{2} \frac{EJ}{l^3}$$

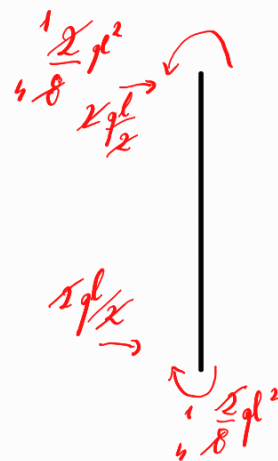
Longo P/O $\varphi_c = 0; \eta_B = 0.$



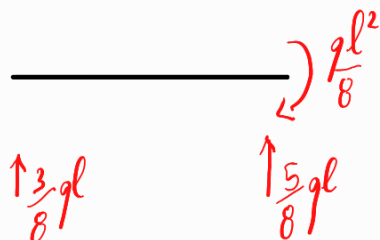
ASTA 1 = CASO V

ASTA 2 = CASO II

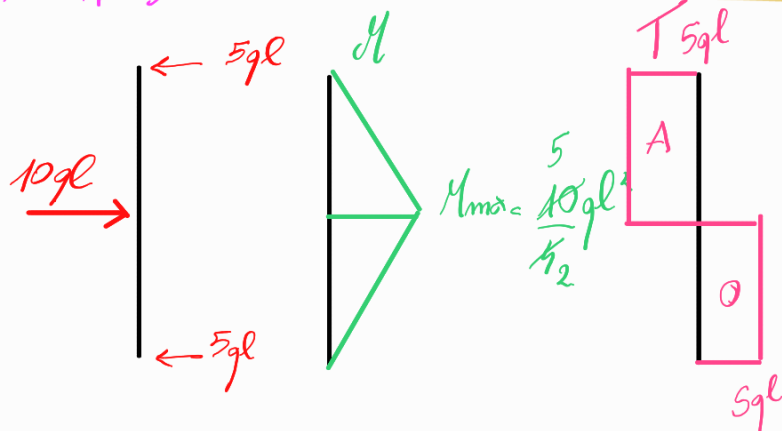
ASTA 3 = CASO I



ASTA 4 = CASO II



ASTA 5





$$h_{BC} = +9l - 59l = -49l$$

$$\begin{cases} 26 \frac{EI}{l} f_c - \frac{6EI}{l^2} \cdot \eta_B - \frac{1}{8} q l^2 = 0 \\ - \frac{6EI}{l^2} f_c + \frac{35}{2} \frac{EI}{l^3} \eta_B - 4 q l = 0 \end{cases}$$

$$\psi_c = \left(\frac{6EJ}{l^2} \cdot \eta_B + \frac{1}{8} q l^2 \right) \cdot \frac{l}{26EJ}$$

$$-\frac{\cancel{6}^3 E\cancel{D}}{\cancel{l}^2} \left(\frac{6E\cancel{D}}{\cancel{l}^2} \eta_B + \frac{1}{8} q l^2 \right) \frac{\cancel{l}}{\cancel{26}E\cancel{D}} + \frac{35}{2} \frac{E\cancel{D}}{\cancel{l}^3} - 4ql = 0$$

$$\boxed{-\frac{18}{13} \frac{E\cancel{D}}{\cancel{l}^3} \eta_B} - \frac{3}{104} ql + \boxed{\frac{35}{2} \frac{E\cancel{D}}{\cancel{l}^3} \eta_B} - 4ql = 0$$

$$36 \quad 455$$

$$\frac{36 - 455}{26} \frac{E\cancel{D}}{\cancel{l}^3} \eta_B = \frac{+3 + 416}{104} ql$$

$$\frac{419}{26} \frac{E\cancel{D}}{\cancel{l}^3} \eta_B = + \frac{419}{104} ql$$

$$\eta_B = + \frac{\cancel{419}}{\cancel{104}} ql \cdot \frac{\cancel{26}}{\cancel{419}} \frac{\cancel{l}^3}{E\cancel{D}}$$

$$\eta_B = \frac{1}{4} \frac{ql^4}{E\cancel{D}}$$

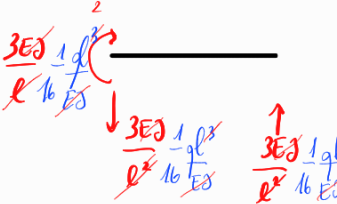
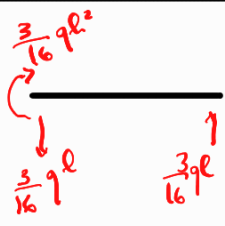
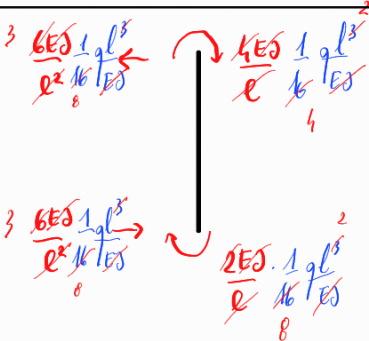
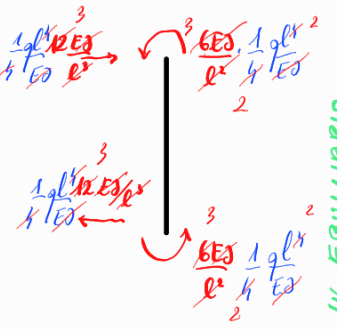
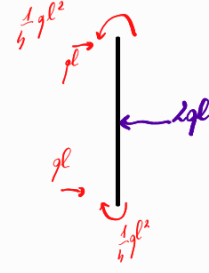
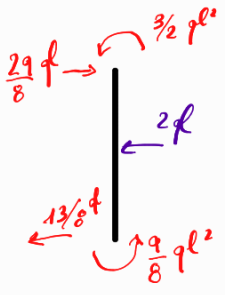
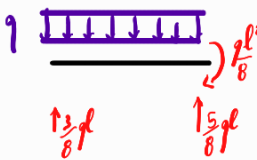
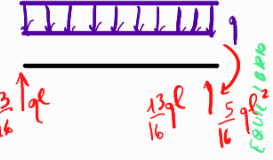
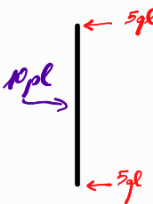
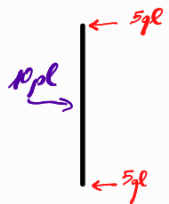
$$\psi_C = \left(\frac{\cancel{6}^3 E\cancel{D}}{\cancel{l}^2} \cdot \frac{1}{\cancel{4}} \frac{ql^4}{\cancel{E\cancel{D}}} + \frac{1}{8} ql^2 \right) \cdot \frac{\cancel{l}}{\cancel{26}E\cancel{D}}$$

$$\psi_C = \frac{3}{52} \frac{ql^3}{E\cancel{D}} + \frac{1}{208} \frac{ql^3}{E\cancel{D}}$$

$$\frac{12 + 1}{208} = \frac{\cancel{13}^1}{\cancel{208}^{16}} \frac{ql^3}{E\cancel{D}}$$

$$\psi_C = \frac{1}{16} \frac{ql^3}{E\cancel{D}}$$

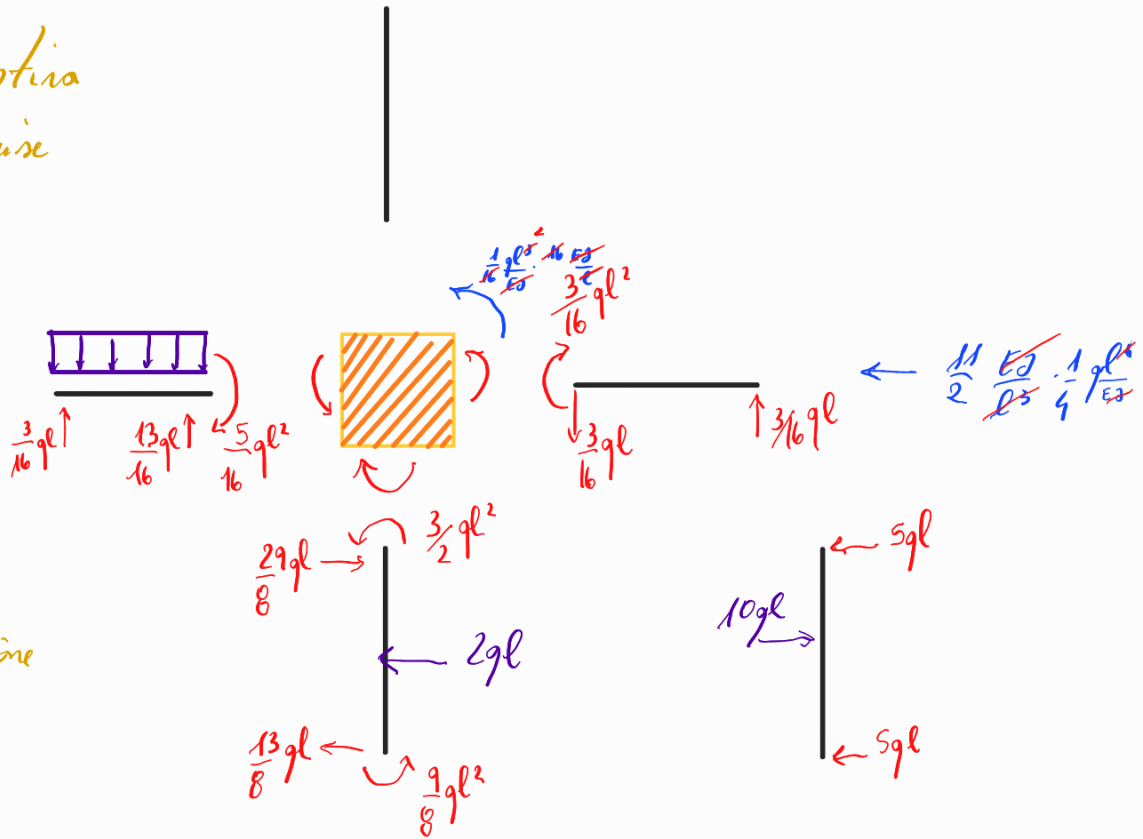
Tout le monde

ASTE	f_c	η_B	P	Résultante
1				
2				
3				
4				
5				

N.B

• Si ha una rotazione positiva per cui la molla restituisce un momento pari a $k\theta \cdot l$

• Si ha una trazione positiva che comprime la molla in "D" la quale restituisce un'azione pari a $k\eta \cdot l$



Eseguo la verifica al NODO C

$$\frac{5}{16} ql^2 - \frac{3}{2} ql^2 + \frac{3}{16} ql^2 + ql^2$$

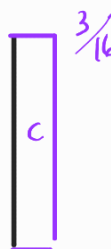
$$\frac{5 - 24 + 3 + 16}{16} = 0 \quad \text{Verificato}$$

Verifico alla trazione orizzontale

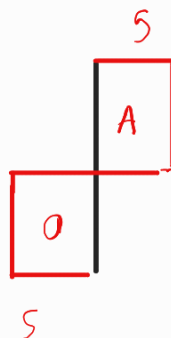
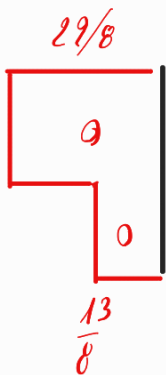
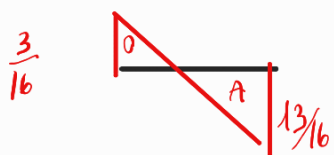
$$-\frac{13}{8} ql - 5ql - 29ql + 10ql - \frac{11}{8} ql = \frac{-13 - 40 - 16 + 80 - 11}{8} = 0$$

Verificato

GRAFICI



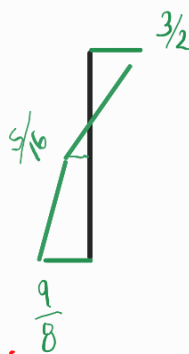
$$\frac{5 \times 10^9}{\frac{1}{8}}$$



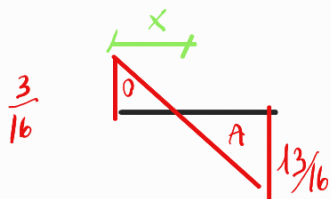
M



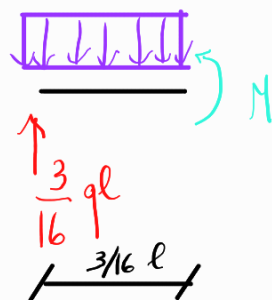
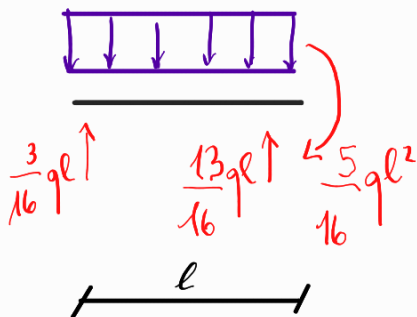
$$M_{\max} = \frac{9}{512} q l^2$$



Calcolo il momento massimo sull'asta 4
Devo determinare il punto in cui si annulla il taglio



$$\frac{3}{16} : x = 1 : l \rightarrow x = \frac{3}{16} l$$

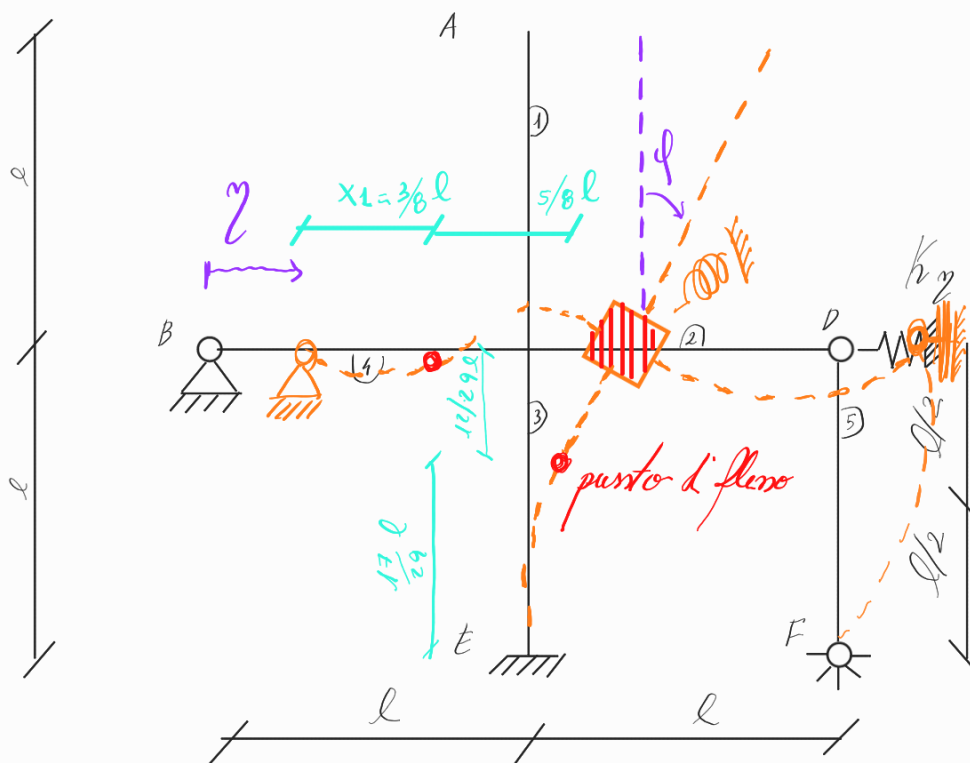


$$\frac{3}{16} q l \cdot \frac{3}{16} l - q \left(\frac{3}{16} l \right)^2 \cdot \frac{1}{2} = M$$

$$\frac{9}{256} q l^2 - \frac{9}{256} q l^2 \cdot \frac{1}{2} = M$$

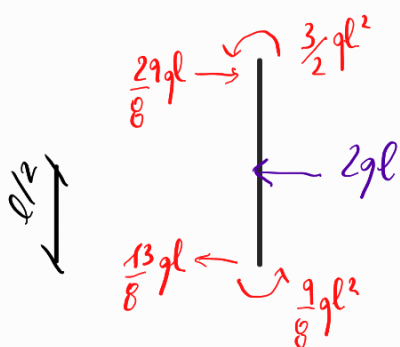
$$\frac{9}{256} q l^2 - \frac{9}{512} q l^2 = M \rightarrow M = \frac{9}{512} q l^2$$

Deformata qualitativa

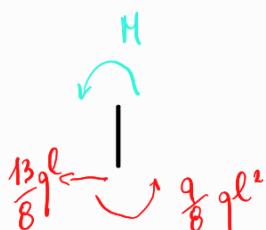


Calcolo i punti di flesso

ASTA 3



controllo su una distanza minore di $l/2$

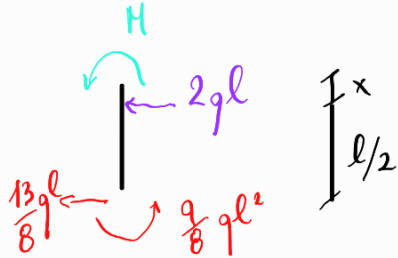


$$\frac{13}{8} q l x - \frac{2}{8} q l^2 = M$$

date M lo impongo $= 0$

$$x = \frac{\cancel{2} q l^2 \cdot \cancel{8}}{\cancel{13} q l} = \frac{2}{13} l \sim 0,15 l > l/2$$

Ricordo considerando una lunghezza maggiore di $l/2$



$$\frac{13}{8} q l (x + l/2) - \frac{2}{8} q l^2 + 2 q l x = 0$$

$$\frac{13}{8} q l x + \frac{13}{16} q l^2 - \frac{2}{8} q l^2 + 2 q l x = 0$$

$$\frac{13+16}{8} q l x + \frac{13-10}{16} q l^2 = 0$$

$$\frac{29}{8} q l x - \frac{3}{16} q l^2 = 0$$

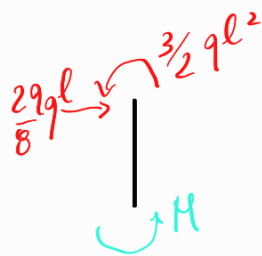
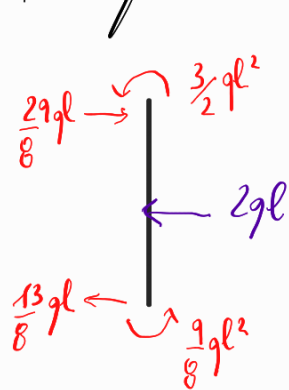
$$x = \frac{\cancel{3} q l^2}{\cancel{29} q l} \cdot \frac{\cancel{8}}{\cancel{16}}$$

$$x = \frac{5}{58} l$$

N.B

$$\begin{aligned} x_2 &= \frac{l}{2} + \frac{5}{58} l \\ &= \frac{29+5}{58} l \\ &= \frac{\cancel{34}}{\cancel{58}} l \\ &= \frac{17}{29} l \end{aligned}$$

Per verifica posso controllare il risultato nel seguente modo



$$\frac{29}{8} ql \cdot x - \frac{3}{2} ql^2 = M$$

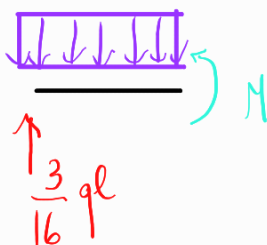
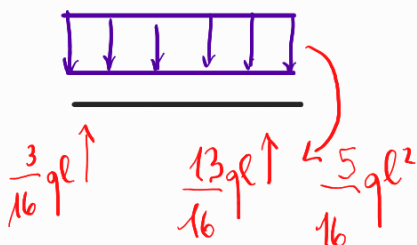
dove M lo prendo $= 0$

$$x = \frac{\frac{3}{2} ql^2 \cdot \frac{8}{29} ql}{ql}$$

$$x_3 = \frac{12}{29} l$$

Per congruenza $x_3 + x_2 = l \rightarrow \frac{12}{29} l + \frac{17}{29} l = \frac{29}{29} l$ Verificato

ASTA 4



$$\frac{3}{16} ql \cdot x - q \cdot x \cdot \frac{x}{2} = M$$

dove M lo impongo $= 0$
quindi:

$$\frac{3}{16} q l x - q \frac{x^2}{2} = 0$$

$$x \left(\frac{3}{16} q l - q \frac{x}{2} \right) = 0 \quad \text{da cui:}$$

$$x = 0$$

$$\frac{3}{16} q l - q \frac{x}{2} = 0 \rightarrow x_1 = \frac{\cancel{3}}{\cancel{16}_8} l \cdot \frac{\cancel{2}}{\cancel{q}}$$

$$x_1 = \frac{3}{8} l$$