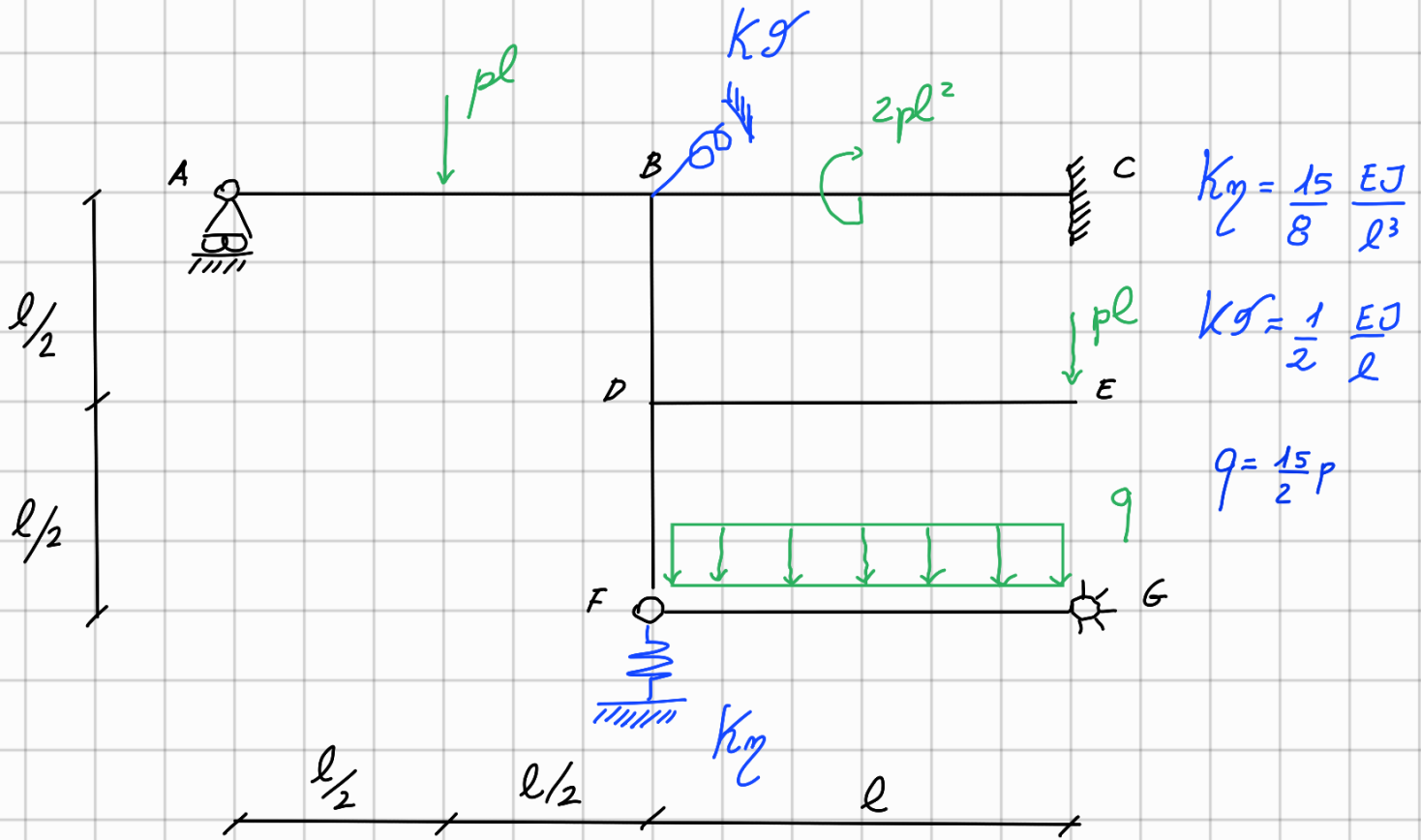
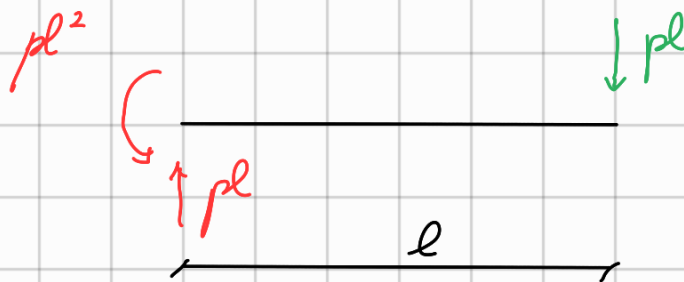
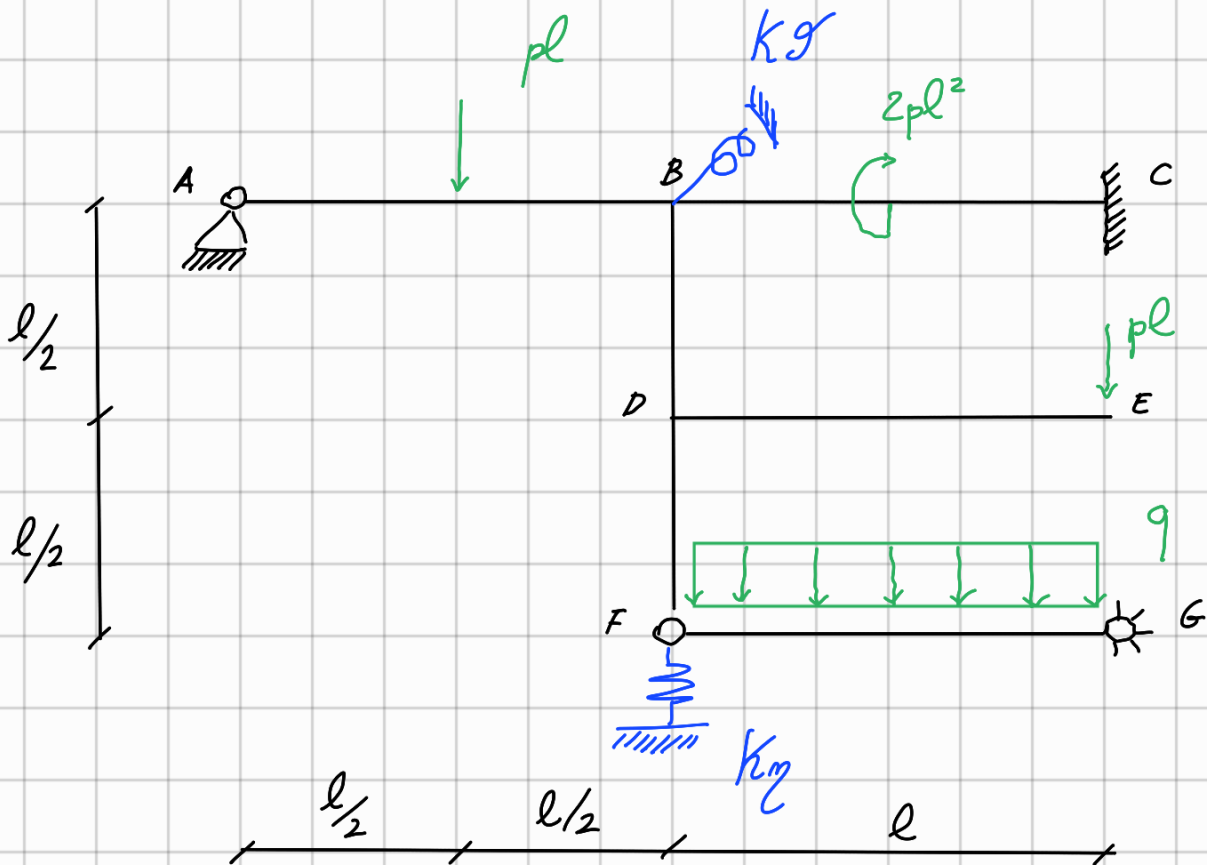


TEMA D'ESAME 29/08/2023

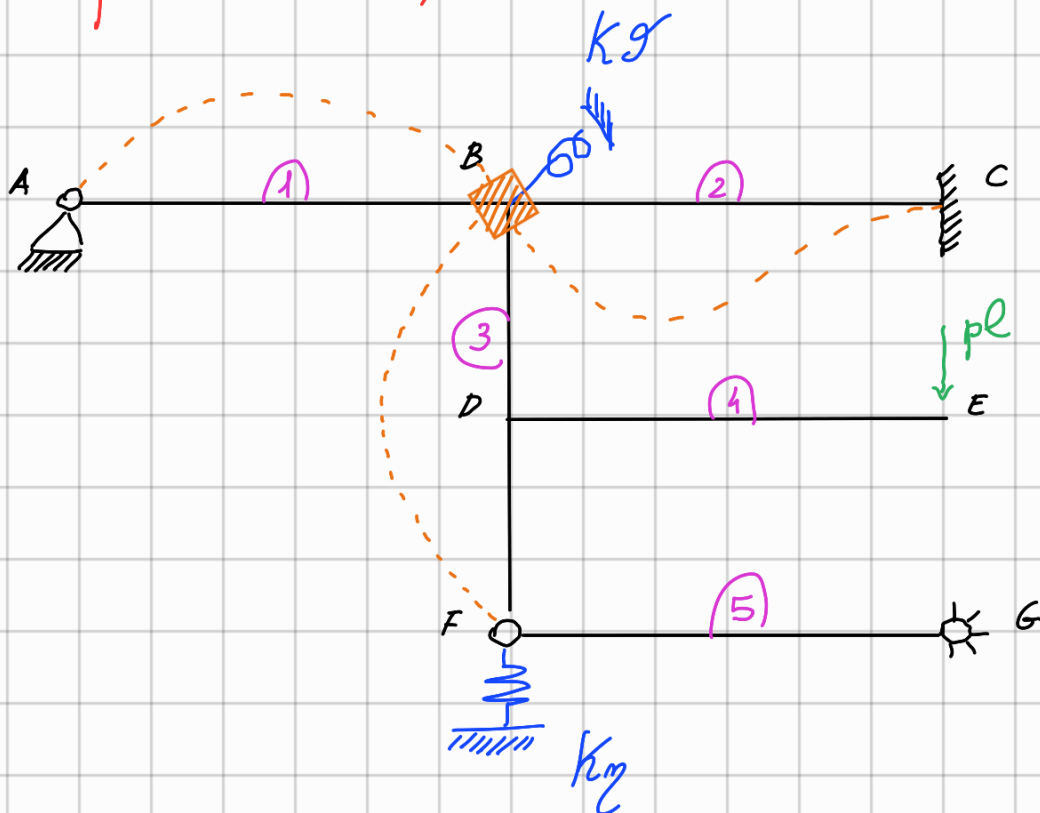


La struttura è a nodi spostabili in direzione verticale.  
Si riconosce la presenza di un'appendice indeformabile asta DE.





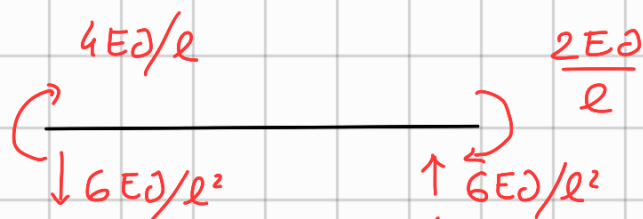
Imporog  $\phi=1$   $\Delta T=0$ ,  $P=0$



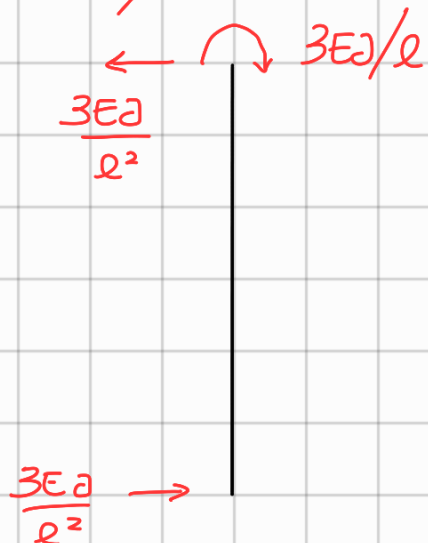
ASTA 1



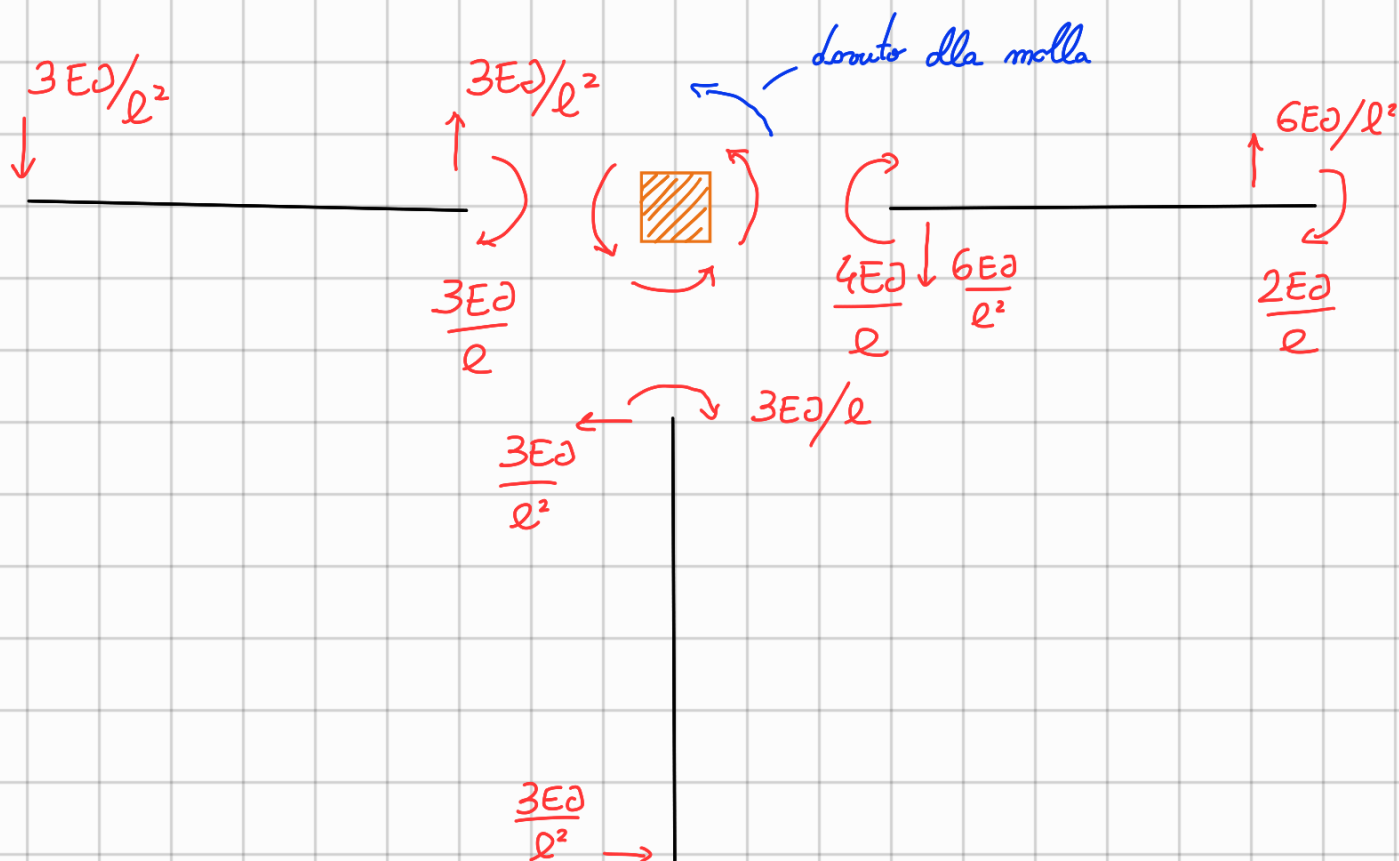
ASTA 2



ASTA 3



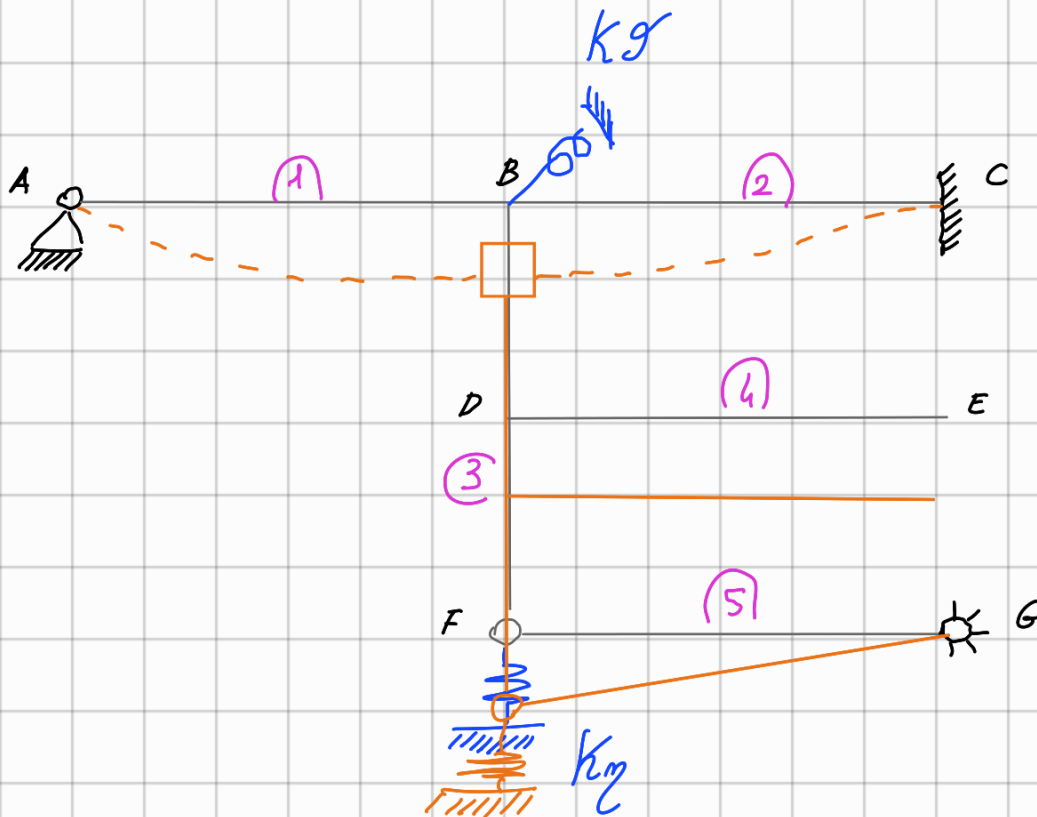
ASTA 4 E ASTA 5 INDEFORMATE



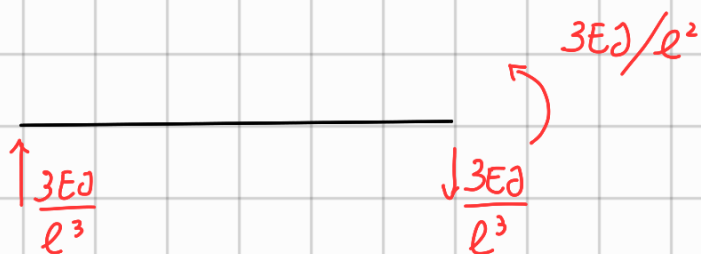
$$\phi_{B\theta} = \frac{3E\theta}{l} + \frac{3E\theta}{l} + \frac{4E\theta}{l} + \frac{1}{2} \frac{E\theta}{l} = \frac{6+6+8+1}{2} \frac{E\theta}{l} = \frac{21E\theta}{2l}$$

$$\psi_{B\theta} = \frac{6E\theta}{l^2} - \frac{3E\theta}{l^2} = \frac{3E\theta}{l^2}$$

Impungor  $\eta=1$



ASTA 1

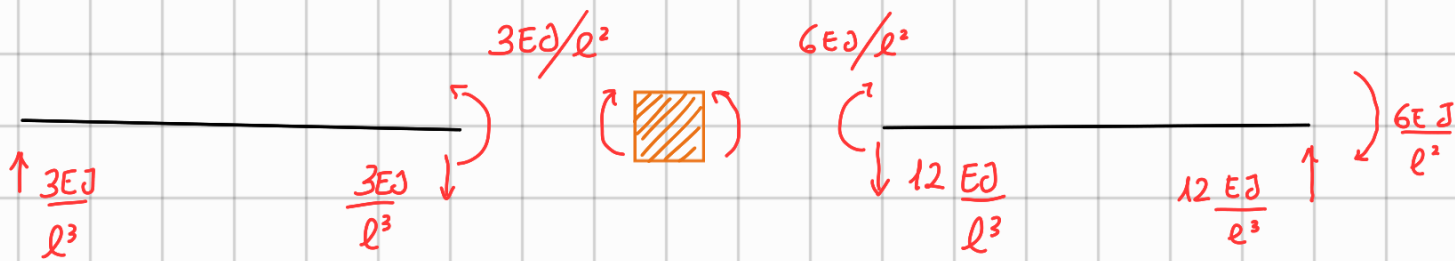


ASTA 2



ASTA 3 indeformata

ASTA 4 e 5 indeformate

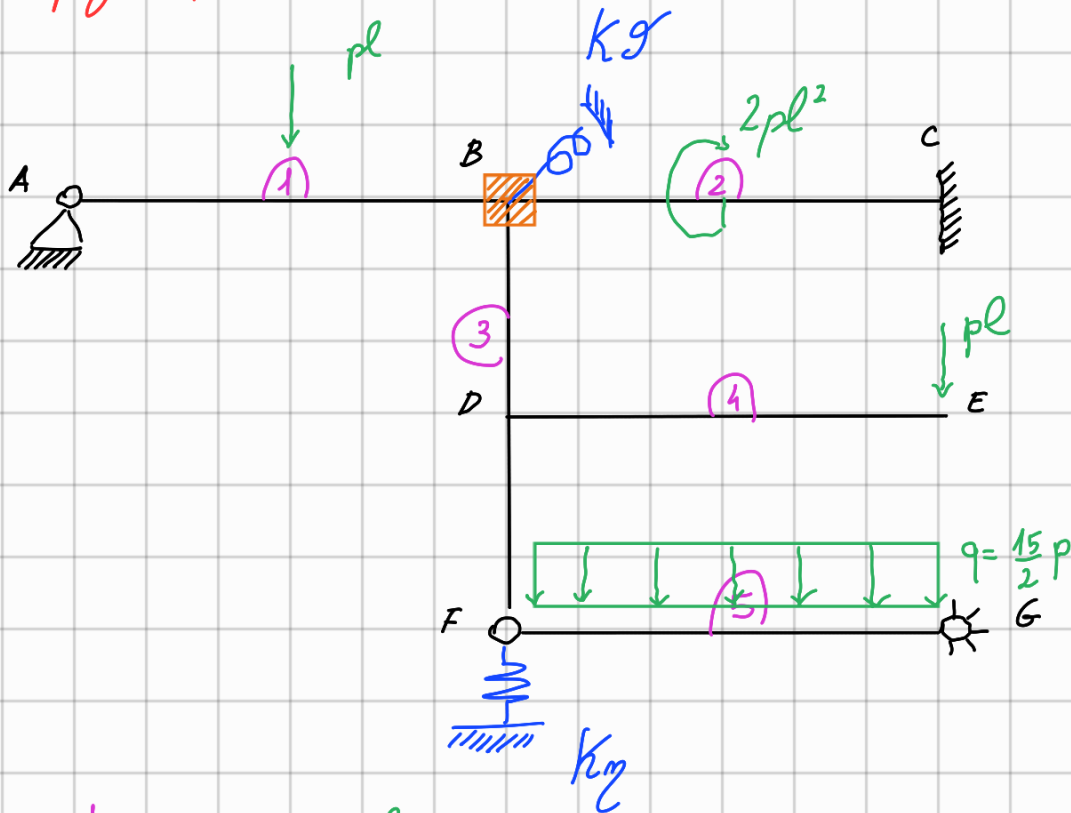


$$K = \frac{15EJ}{8l^3}$$

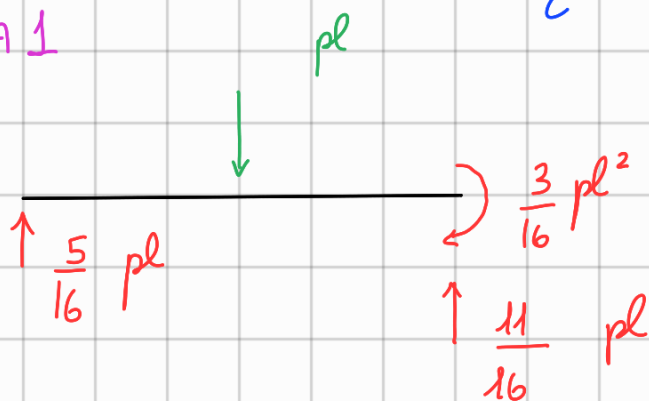
$$\varphi_B = \frac{6EJ}{l^2} - \frac{3EJ}{l^2} = \frac{3EJ}{l^2}$$

$$\eta_B = \frac{12EJ}{l^3} + \frac{3EJ}{l^3} + \frac{15}{8} \frac{EJ}{l^3} = \frac{96+24+15}{8} \frac{EJ}{l^3} = \frac{135}{8} \frac{EJ}{l^3}$$

Impostazione P/O

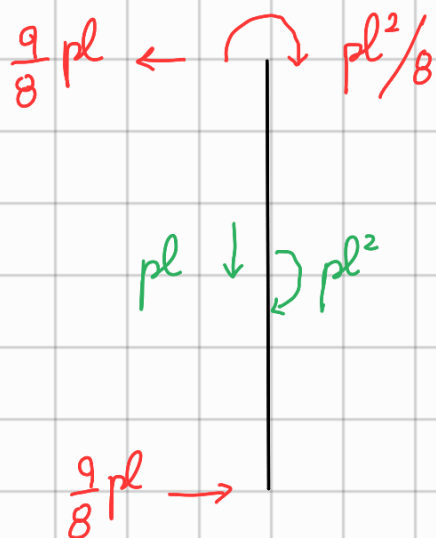


ASTA 1

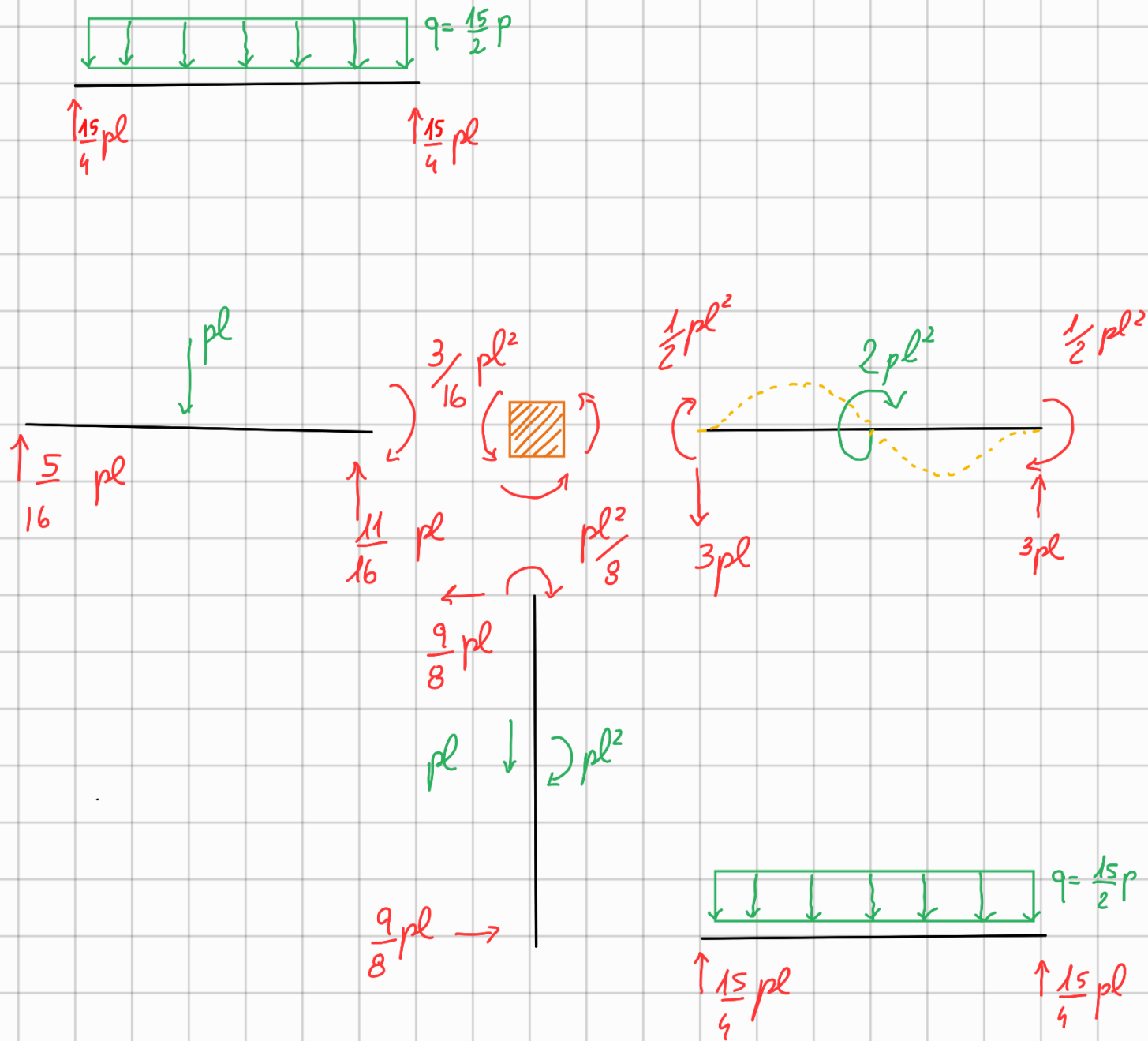


ASTA 2 è indeformata

ASTA 3 ricerca il contributo dell'asta 4



# ASTA 5



$$f_{B0} = \frac{11}{16} pl^2 + \frac{1}{8} pl^2 = \frac{11 + 2}{16} pl^2 = \frac{13}{16} pl^2$$

$$h_{B0} = -\frac{15}{4} pl - \frac{11}{16} pl + 3pl - pl = \frac{-60 - 11 + 48 - 16}{16} pl = -\frac{39}{16} pl$$

## EQ RISOLVENTE

$$\begin{cases} \textcircled{1} \quad \frac{21}{2} \frac{EJ}{l} \varphi_B + \frac{3EJ}{l^2} \eta_B + \frac{13}{16} pl = 0 \\ \textcircled{2} \quad \frac{3EJ}{l^2} \varphi_B + \frac{135}{8} \frac{EJ}{l^3} \eta_B - \frac{39}{16} pl = 0 \end{cases}$$

Dalla 2

$$\begin{aligned} \varphi_B &= \left( -\frac{135}{8} \frac{EJ}{l^3} \eta_B + \frac{39}{16} pl \right) \frac{l^2}{3EJ} \\ &= -\frac{45}{8} \frac{1}{l} \eta_B + \frac{13}{16} pl^3 \end{aligned}$$

$$\frac{21}{2} \frac{EJ}{l} \left( -\frac{45}{8} \frac{1}{l} \eta_B + \frac{13}{16} pl^3 \right) + \frac{3EJ}{l^2} \eta_B + \frac{13}{16} pl^2 = 0$$

$$-\frac{945}{16} \frac{EJ}{l^2} \eta_B + \frac{273}{32} EJ pl^2 + \frac{3EJ}{l^2} \eta_B + \frac{13}{16} pl^2 = 0$$

$$-\frac{945+48}{16} \frac{EJ}{l^2} \eta_B + \frac{273+26}{32} pl^2 = 0$$

$$-\frac{897}{16} \frac{EJ}{l^2} \eta_B + \frac{299}{32} pl^2 = 0$$

$$\eta_B = \frac{\cancel{299} \cdot \cancel{16}}{\cancel{32} \cdot \cancel{897}} \frac{pl^2}{EJ} = \frac{1}{6} \frac{pl^2}{EJ}$$

$$\varphi_B = -\frac{135}{8} \frac{EJ}{l^3} \cdot \frac{1}{6} \frac{pl^2}{EJ} \cdot \frac{l^2}{3EJ} + \frac{39}{16} pl \cdot \frac{l^2}{3EJ}$$

$$-\frac{135}{144} \frac{pl^3}{EJ} + \frac{39}{48} \frac{pl^3}{EJ}$$



$$\frac{-135 + 117}{144} \frac{pl^3}{EI} = -\frac{18}{144} \frac{pl^3}{EI} = -\frac{1}{8} \frac{pl^3}{EI}$$

$$\eta_B = \frac{1}{6} \frac{pl^4}{EI}$$

$$\phi_B = -\frac{1}{8} \frac{pl^3}{EI}$$

Trovare le azioni:

ASTE

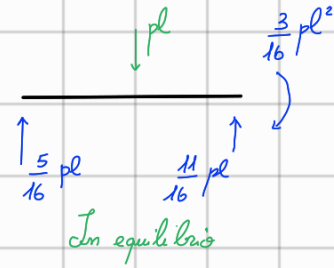
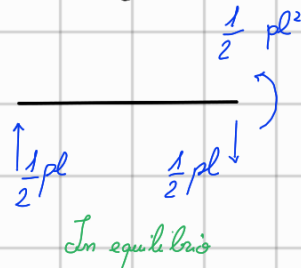
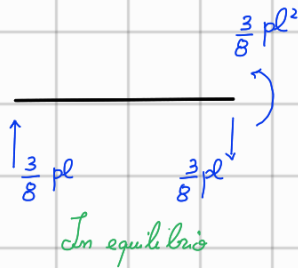
$\phi_B$

$\eta_B$

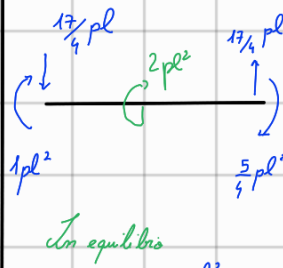
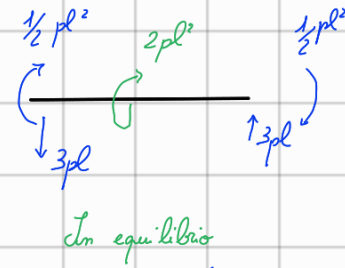
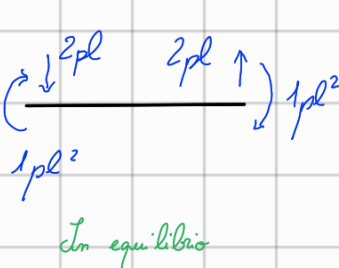
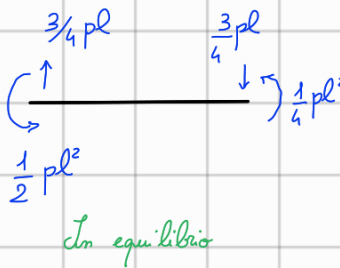
P

Risultante

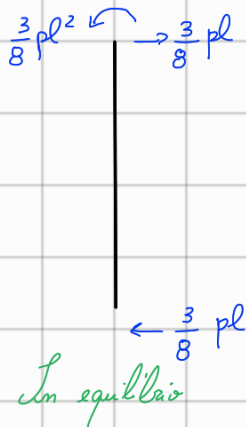
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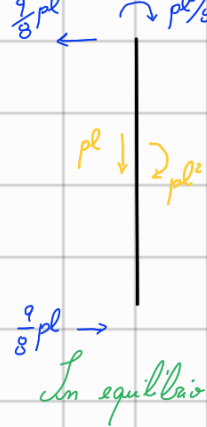
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3



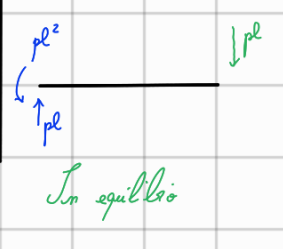
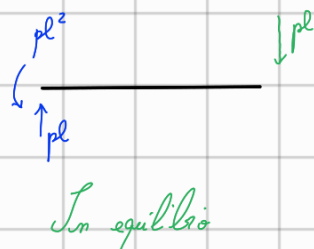
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4

//

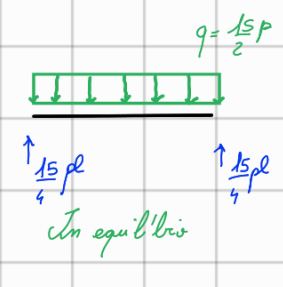
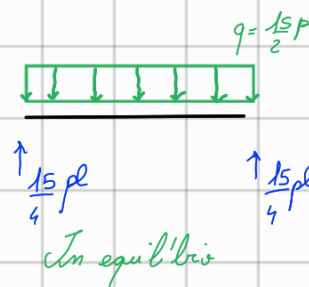
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5

//

//

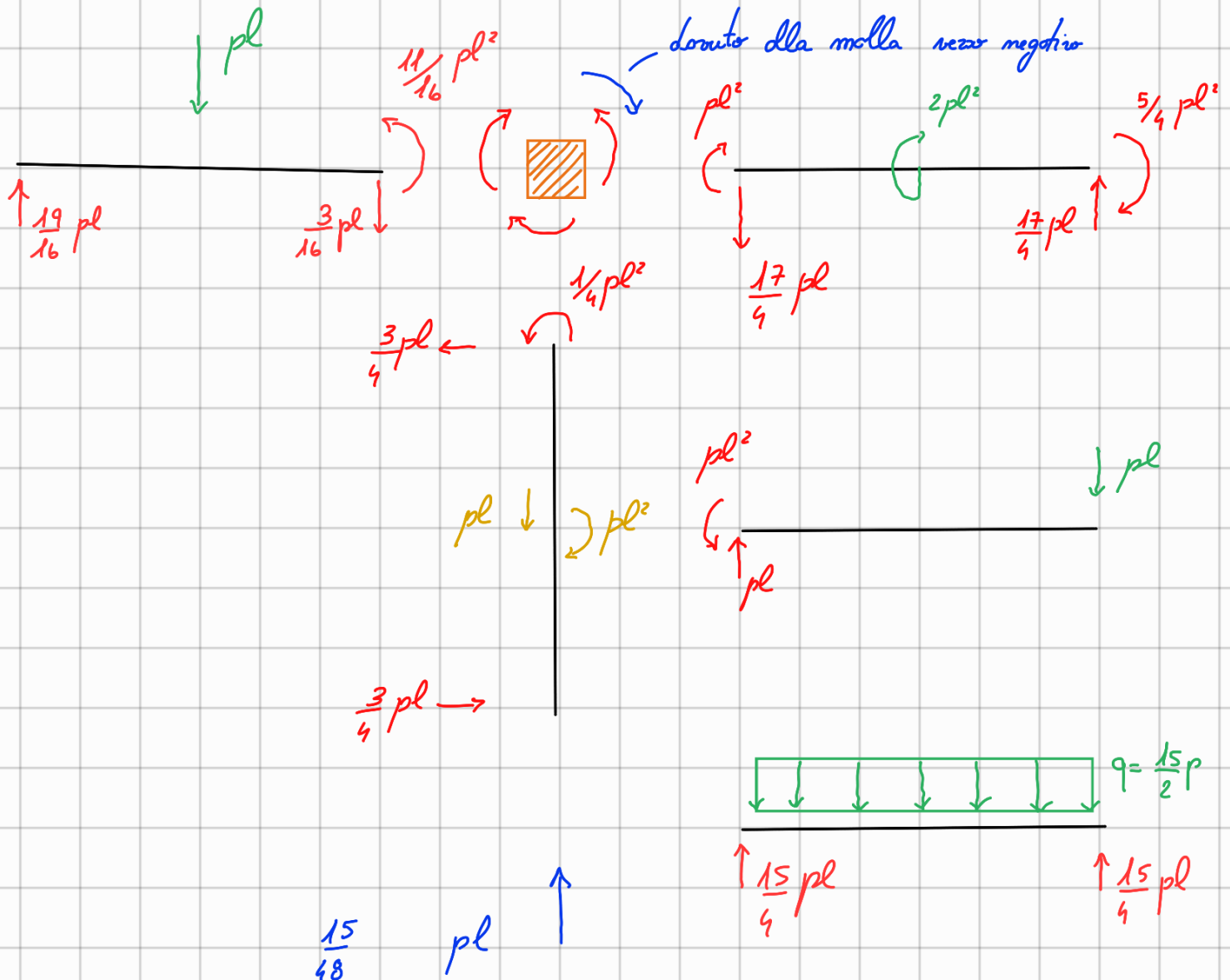


N.B.

Si ha una rotazione negativa  
per cui la molla resiste ad  
un momento pari  $kg \cdot l$

Si ha una trazione positiva  
che comprime la molla in "F"  
la quale restituisce un'azione pari  
a  $kg \cdot \gamma$

$$\frac{1}{8} \cdot \frac{1}{2} pl^2 = \frac{1}{16} pl^2$$

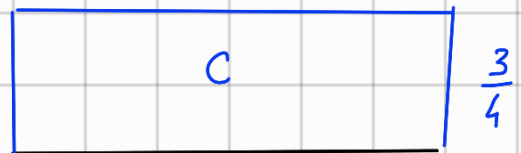
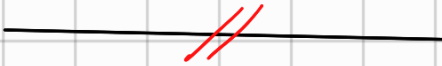


Verifico il nodo in "B"

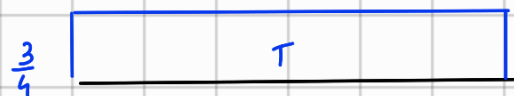
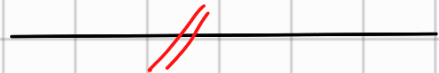
$$-\frac{11}{16}pl^2 - \frac{1}{4}pl^2 + pl^2 - \frac{1}{16}pl^2 = \frac{-11 - 4 + 16 - 1}{16} = 0 \text{ Verificato}$$

GRAFICI

$\checkmark \rightarrow \boxed{+} \leftarrow$

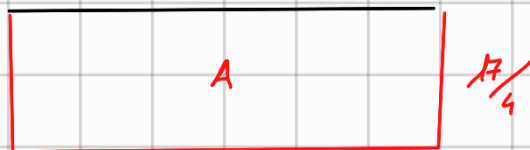
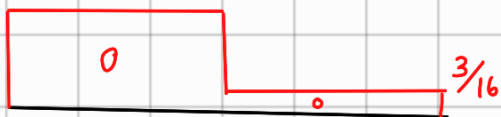


$\frac{55}{16}$

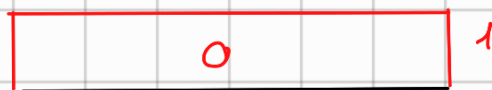


$19/16$

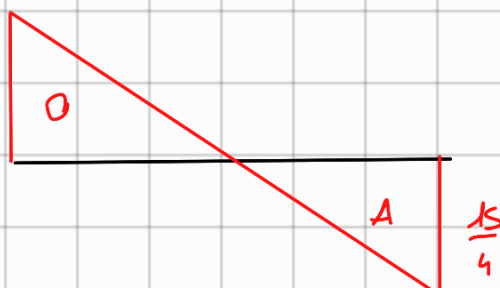
$\times$



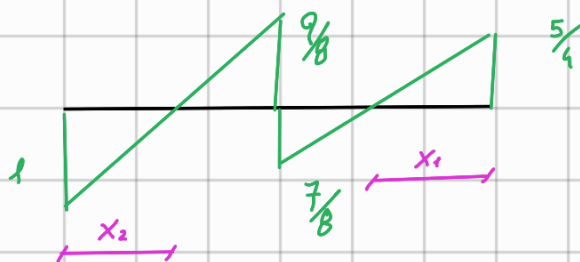
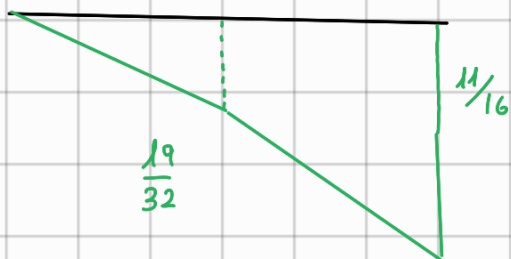
$3/4$



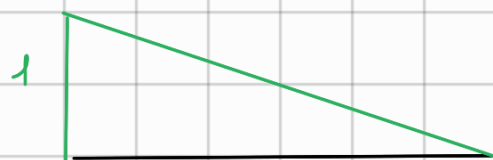
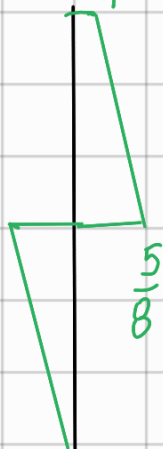
$15/4$



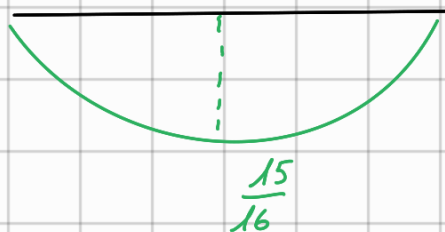
$M$



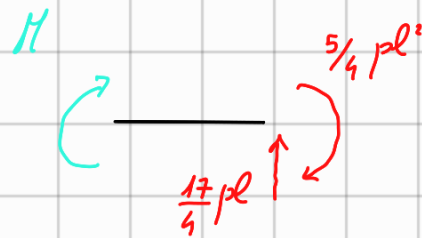
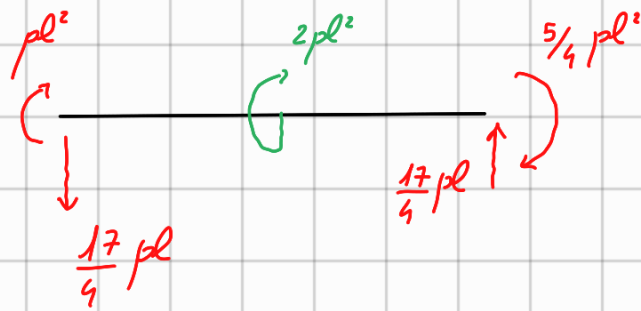
$1/4$



$3/8$

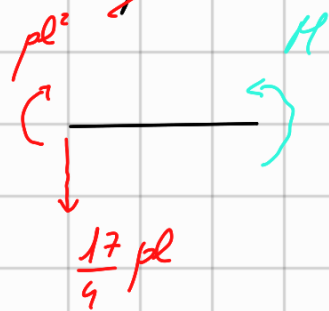


## CALCOLO PUNTI DI FLESSO ASTA 2



$$-\frac{5}{4}pl^2 + \frac{17}{4}pl \cdot x = 0$$

$$x_1 = \frac{\cancel{5}pl^2}{\cancel{4}pl} \cdot \frac{\cancel{4}}{17} = \frac{5}{17}l$$



$$+pl^2 - \frac{17}{4}plx = 0$$

$$x_2 = \frac{\cancel{pl^2}}{\cancel{pl}} \cdot \frac{4}{17} = \frac{4}{17}l$$

# DEFORMATA

