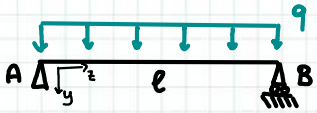
ES 1



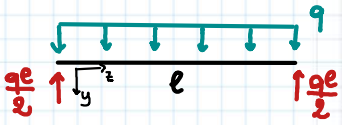
M, T, N continui su tutto ℓ

1° step: devo conoscere le REAZ. VINCOLARI

2° step: calcolo gli andamenti M, T, N.

METODO 1

$$\begin{cases} \frac{dN}{dz} = 0 \quad N = cost = 0 \\ N(z=0) = 0 \end{cases}$$



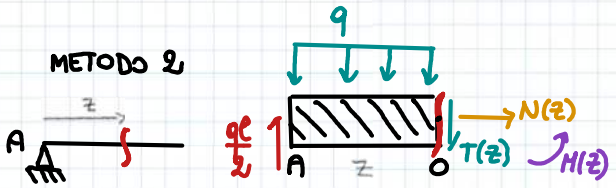
$$\begin{cases} \frac{dT}{dz} = -q \quad T = -qz + C \quad T = \frac{q\ell}{2} - qz \\ T(z=0) = \frac{q\ell}{2} \end{cases}$$

$\frac{q\ell}{2}$ $z=0$

$-\frac{q\ell}{2}$ $z=\ell$

$$\begin{cases} \frac{dM}{dz} = T(z) = -qz + \frac{q\ell}{2} \quad M = -q\frac{z^2}{2} + \frac{q\ell}{2}z + C \\ M(z=0) = 0 \quad C = 0 \end{cases} \qquad M(z) = -q\frac{z^2}{2} + \frac{q\ell z}{2}$$

METODO 2



sez. a distanza z da A

Eq assi z di AO $N(z) = 0$

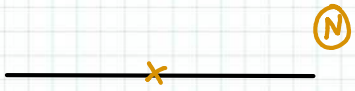
Eq verticale di AO $T(z) - \frac{q\ell}{2} + qz = 0$

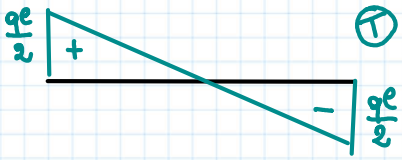
$$T(z) = \frac{q\ell}{2} - qz$$

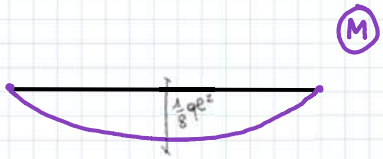
Eq. momento in O $M(0) = M(z) + q\frac{z^2}{2} - \frac{q\ell}{2}z = 0$

$$M(z) = \frac{q\ell z}{2} - \frac{qz^2}{2}$$

Rappresentazione grafica





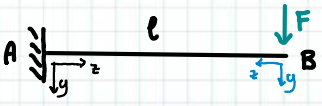


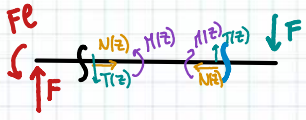
Massimo?

$$\frac{dM(z)}{dz} = 0 \qquad \frac{q\ell}{2} - qz = 0 \qquad z = \frac{\ell}{2}$$

$$M\left(\frac{\ell}{2}\right) = \frac{q\ell^2}{4} - \frac{q\ell^2}{8} = \frac{q\ell^2}{8}$$

ES 2





Metodo 1:

$$\begin{cases} \frac{dN}{dz} = 0 \quad N = cost = 0 \\ N(z=0) = 0 \end{cases}$$

$$\begin{cases} \frac{dT}{dz} = 0 \quad T = cost = F \\ T(z=0) = F \end{cases}$$

$$\begin{cases} \frac{dM}{dz} = T = F \quad M = Fz + C \quad M = -F\ell + Fz \\ M(z=0) = -F\ell \quad C = -F\ell \end{cases}$$

Metodo 2 (sist zy)

$N(z) = 0$

$T(z) - F = 0 \quad T(z) = F$

$M(0) = M(z) + F\ell - Fz = 0$

$M(z) = Fz - F\ell \rightarrow z=0 \quad M = -F\ell$

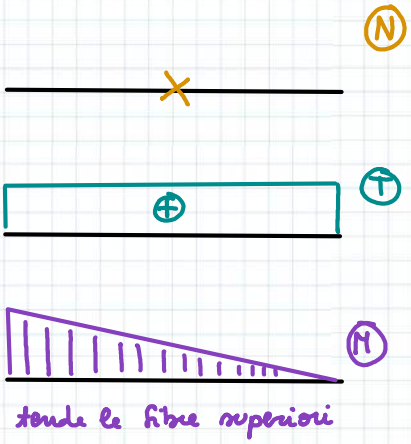
$\rightarrow z=\ell \quad M = 0$

sist. zy

$N(z) = 0$

$T(z) - F = 0 \quad T(z) = F$

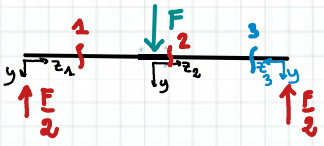
$M(0) = M(z) + Fz = 0 \quad M(z) = -Fz$ → $M(z=0) = 0$, $M(z=\ell) = -F\ell$



tende le fibre superiori

ES 3

NB Una F concentrata causa un SALTO nel diagramma di TAGLIO pari all'entità del modulo della forza.



③ $N(z_3)=0$

$T(z_3)+\frac{F}{2}=0 \quad T(z_3)=-\frac{F}{2}$

$M(z_3)=\frac{F}{2}z_3$

① $N(z_1)=0$

$T(z_1)=\frac{F}{2}$

$M(z_1)-\frac{F}{2}z_1=0 \quad M(z_1)=\frac{F}{2}z_1$

② $N(z_2)=0$

$T(z_2)+F-\frac{F}{2}=0 \quad T(z_2)=-\frac{F}{2}$

$M(z_2)+Fz_2-\frac{F}{2}\left(\frac{\ell}{2}+z_2\right)=0$

$M(z_2)=\frac{F\ell}{4}-\frac{F}{2}z_2$

Integrazione

① $N(z)=0$

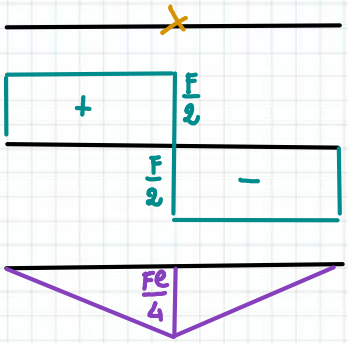
$\begin{cases}\frac{dT}{dz_1}=0 & T=\frac{F}{2}\\ T(z_1)=\frac{F}{2}\end{cases}$

$\begin{cases}\frac{dM}{dz_1}=T=\frac{F}{2} & M(z_1)=\frac{F}{2}z_1+C\\ M(z_1=0)=0 & M(z_1)=\frac{F}{2}z_1\end{cases}$

② $N(z_2)=0$

$\begin{cases}\frac{dT}{dz_2}=0 & T(z_2)=-\frac{F}{2}\\ T(z_2=0)=-F+\frac{F}{2}\end{cases}$

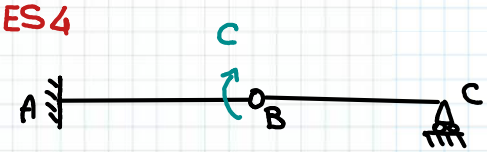
$\begin{cases}\frac{dM}{dz_2}=-\frac{F}{2} & M=-\frac{F}{2}z_2+\frac{F\ell}{4}\\ M(z_2=0)=\frac{F\ell}{4}\end{cases}$

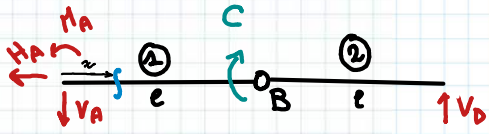


ATTENZIONE

Se integro in z_3, cambio $\frac{dM}{dz}=-T$ (da eq. del carico)

ES 4



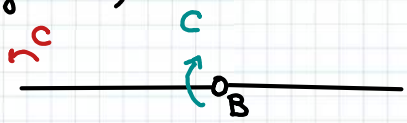


Eq^ne ausiliaria in B del corpo 2

$M(B)=V_D\cdot\ell=0 \quad V_D=0 \Rightarrow V_A=0$ (eq globale ↑)

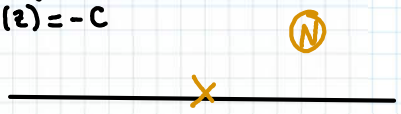
$H_A=0$ (eq globale →)

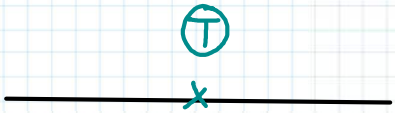
$M(A)=H_A-C=0 \quad H_A=C$



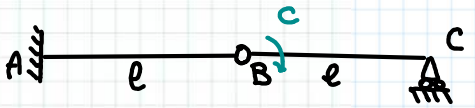
Diagrammi:

$M(z)=-C$





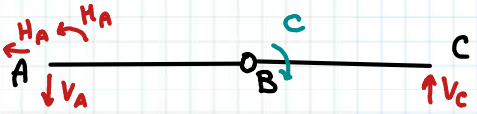
ES 5



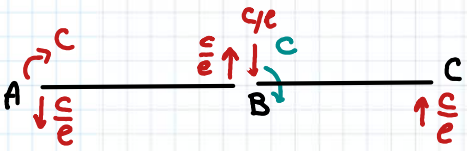
Eq.ne ausiliaria corpo 2

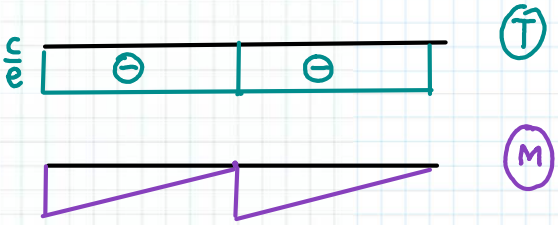
$\int M(B) = V_C \cdot \ell - C = 0 \quad V_C = \frac{C}{\ell} = V_A$ eq ↑ globale

$H_A = 0$ eq. orizz globale

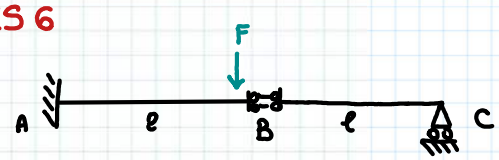


$\int M(A) = H_A - C + V_C \cdot 2\ell = 0 \quad H_A - C + 2C = 0 \quad H_A = -C$





ES 6

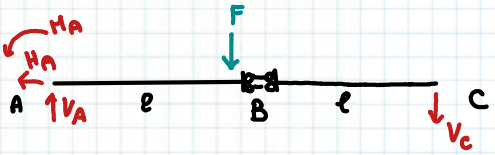


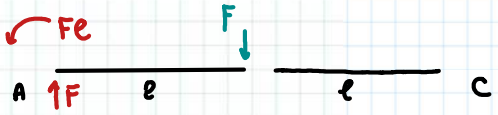
Eq.ne ausiliaria corpo 2 $\quad V_C = 0$

Eq. globale ↑ $\quad V_A = F$

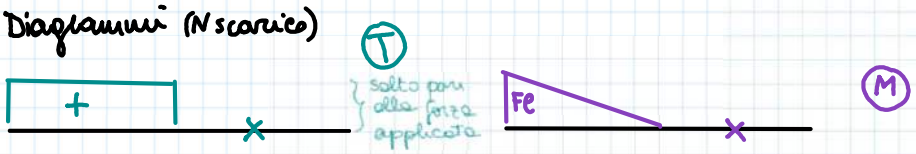
$H_A = 0$

$H_A = F\ell$

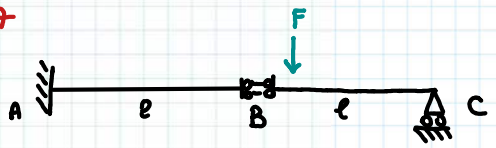




Diagrammi (N scarico)



ES 7



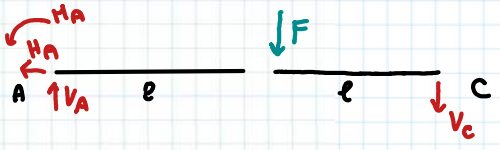
Eq.ne ausiliaria corpo 2 : $V_C = -F$

Eq. globale ↑ $V_A = 0$

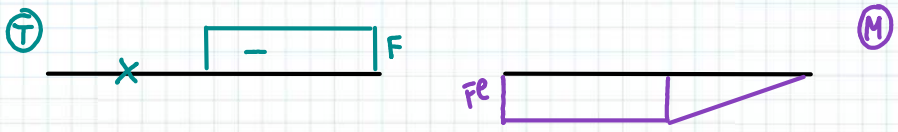
→ $H_A = 0$

$\int M(A) = H_A - F\ell - V_C 2\ell = 0$

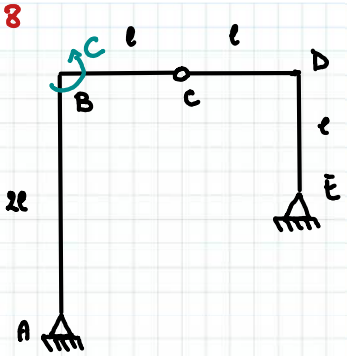
$H_A - F\ell + 2F\ell = 0 \quad H_A = -F\ell$

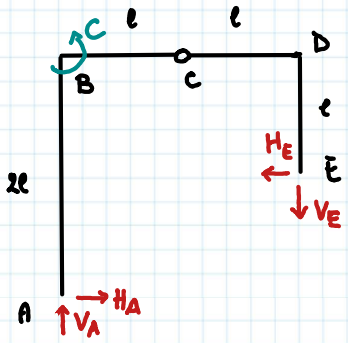


Diagrammi (N scarico)



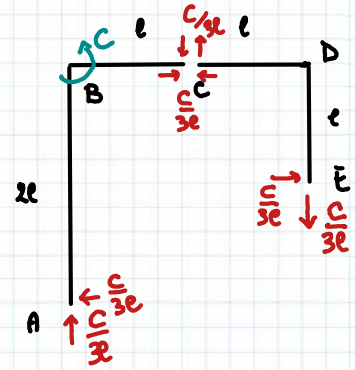
ES 8



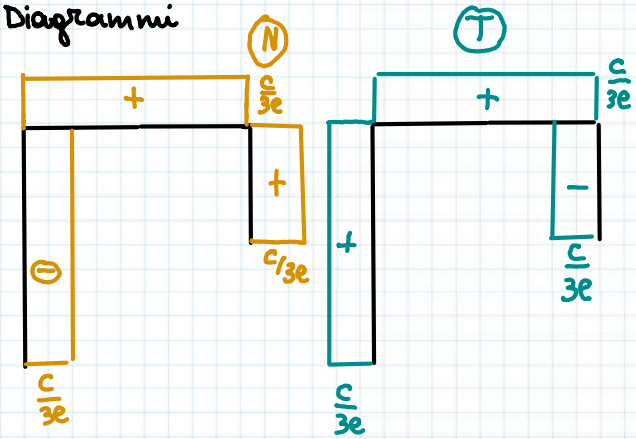


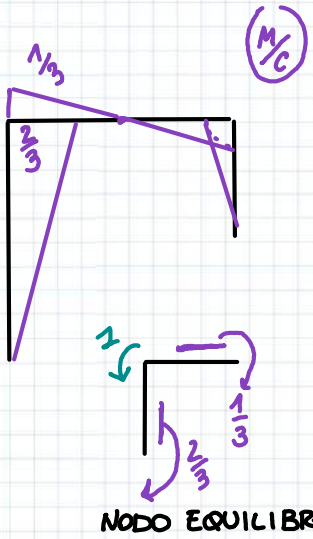
$$\begin{cases} H_A - H_E = 0 & H_A = -\frac{C}{3\ell} \\ V_A - V_E = 0 & V_A = \frac{C}{3\ell} \\ \sum M(A) = C + H_E\ell - V_E 2\ell = 0 & C - V_E\ell - 2V_E\ell = 0 \\ \sum M(C) = -H_E\ell - V_E\ell = 0 & H_E = -V_E \end{cases}$$

$$V_E = \frac{C}{3\ell} \qquad H_E = -\frac{C}{3\ell}$$



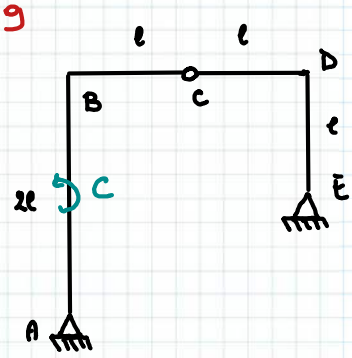
Diagrammi

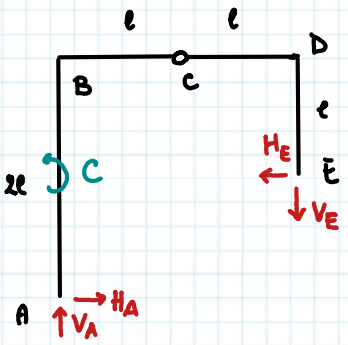




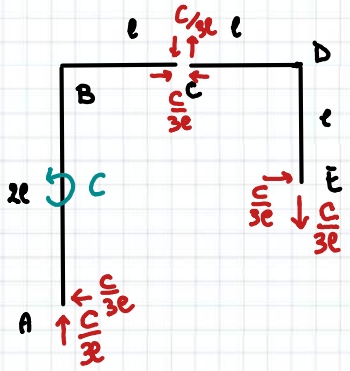
NODO EQUILIBRATO

ES 9

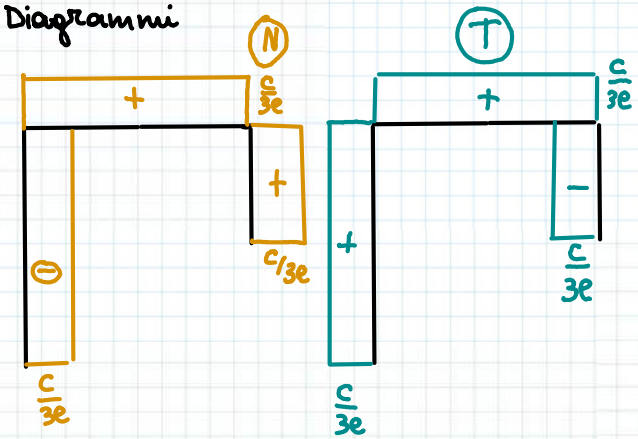


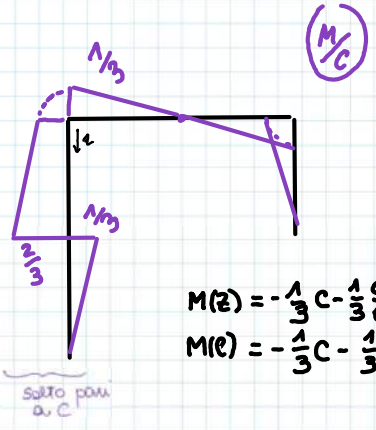


Stesse reazioni di prima (es 8)



Diagrammi



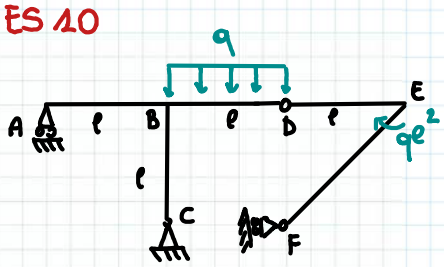


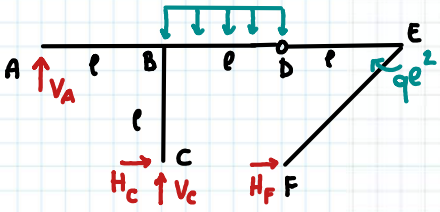
sotto pari a C

$$M(z) = -\frac{1}{3}C - \frac{1}{3}\frac{C}{\ell}\cdot z$$

$$M(\ell) = -\frac{1}{3}C - \frac{1}{3}C = -\frac{2}{3}C$$

ES 10





$H_C + H_F = 0 \qquad H_C = -qe$

$V_A + V_C - qe = 0 \qquad V_C = -V_A + qe = \frac{5}{2}qe$

$\sum M(C) = -V_A e - \frac{qe^2}{2} - qe^2 = 0 \qquad V_A = -\frac{3}{2}qe$

② $\sum M(D) = H_F \cdot e - qe^2 = 0 \qquad H_F = qe$