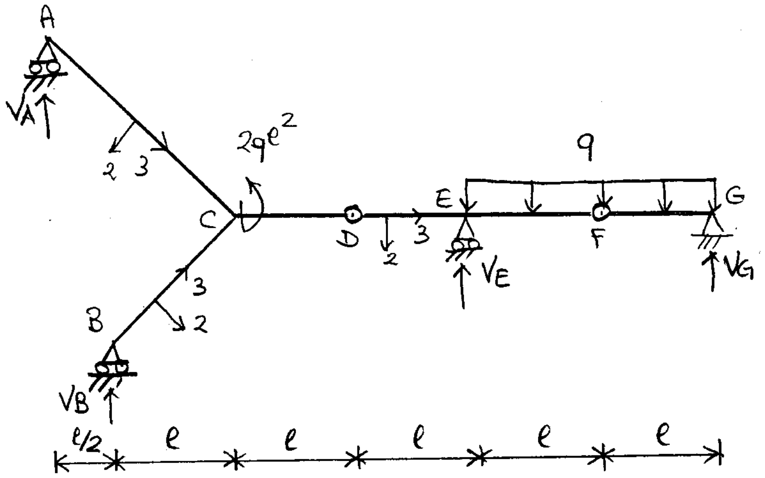
Soluzione Es. 1



$$F\circlearrowleft \quad V_G\ell - q\frac{\ell^2}{2} = 0 \rightarrow \boxed{V_G = q\frac{\ell}{2} = 250\ \text{kg}}$$

$$D\circlearrowleft \quad V_E\cdot\cancel{\ell} + V_G\cdot 3\cancel{\ell} - 2q\ell\cdot 2\cancel{\ell} = 0$$

$$\hookrightarrow \boxed{V_E} = 4q\ell - 3V_G = \boxed{\frac{5}{2}q\ell = 1250\ \text{kg}}$$

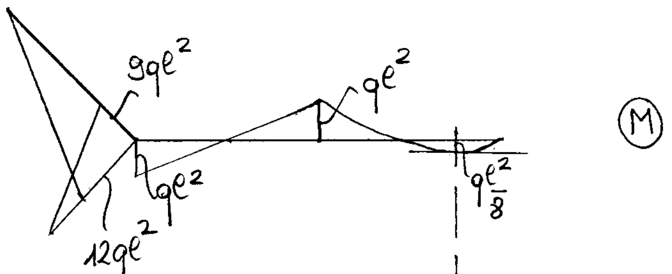
$$B\circlearrowleft \quad -V_A\frac{\ell}{2} + 2q\ell^2 + \frac{5}{2}q\ell\,3\ell + q\frac{\ell}{2}\,5\ell - 8q\ell^2 = 0$$

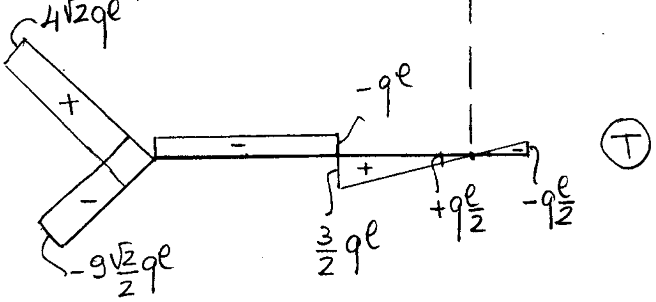
$$\hookrightarrow \frac{V_A}{2} = q\ell\left[2 + \frac{15}{2} + \frac{5}{2} - 8\right] = 4q\ell$$

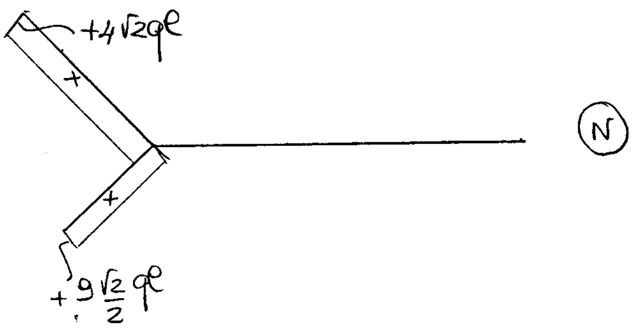
$$\hookrightarrow \boxed{V_A = 8q\ell = 4000\ \text{kg}}$$

$$V_B = 2q\ell - 8q\ell - \frac{5}{2}q\ell - q\frac{\ell}{2} \overset{!}{=} -9q\ell = -4500\ \text{kg}$$

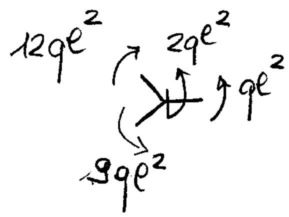
Diagrammi



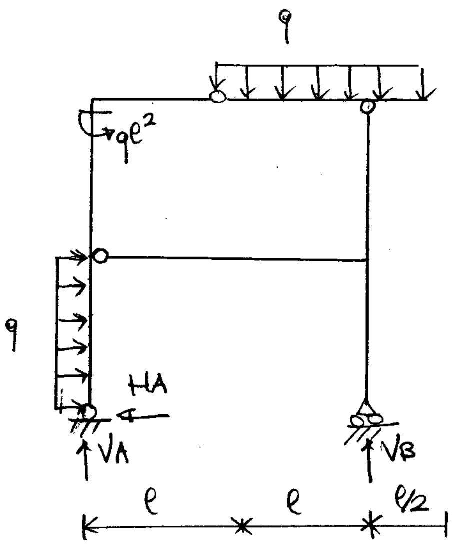




Equilibrio alla rotazione del nodo C:



Soluzione Es. 2



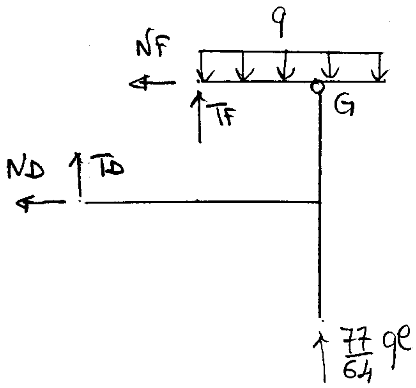
$H_A = \frac{5}{4} q\ell = 2500$ kg

A↺ $V_B \cdot 2\cancel{\ell} - \frac{3}{2} q\cancel{\ell}\left(\ell + \frac{3}{4}\ell\right) + q\ell^{\cancel{2}} - \frac{5}{4} q\ell \frac{5}{8}\cancel{\ell} = 0$

$\hookrightarrow 2V_B = q\ell\left[\frac{25}{32} - 1 + \frac{21}{8}\right] = \frac{77}{32} q\ell$

$\hookrightarrow \boxed{V_B = \frac{77}{64} q\ell = 2406 \text{ kg}}$

$\boxed{V_A} = \frac{3}{2}q\ell - V_B = \frac{19}{64}q\ell = \boxed{594 \text{ kg}}$



G↺ $-T_F \cdot \cancel{\ell} + q\ell \frac{\cancel{\ell}}{2} - q\frac{\ell}{2}\frac{\cancel{\ell}}{4} = 0 \rightarrow \boxed{T_F = \frac{3}{8}q\ell}$

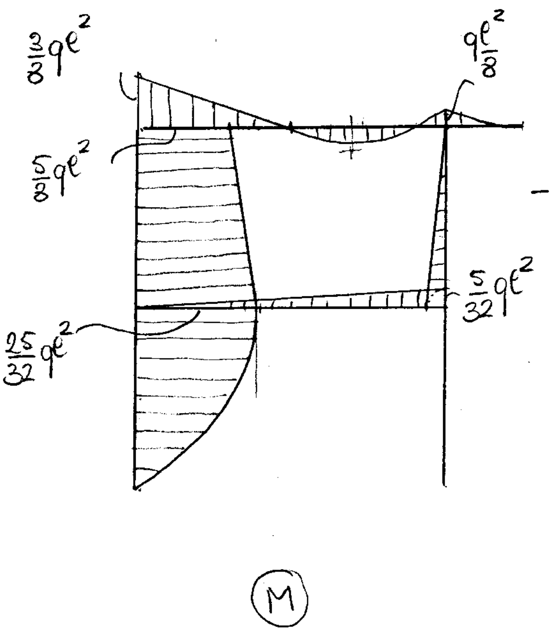
$\boxed{T_D} = \frac{3}{2}q\ell - \frac{3}{8}q\ell = \boxed{-\frac{5}{64}q\ell}$

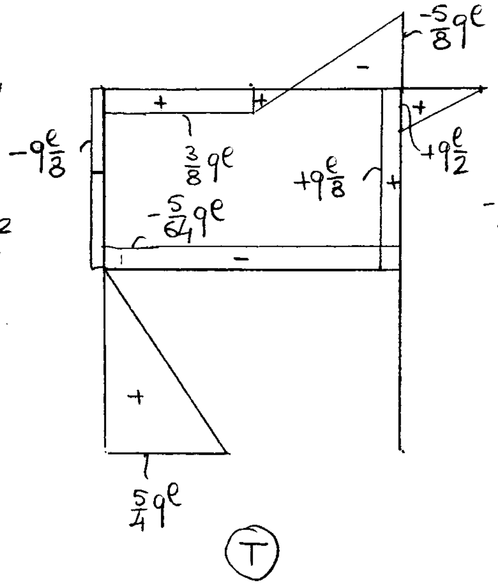
G↺ $-N_D \cdot \frac{5}{4}\cancel{\ell} - T_D \cdot 2\cancel{\ell} = 0$

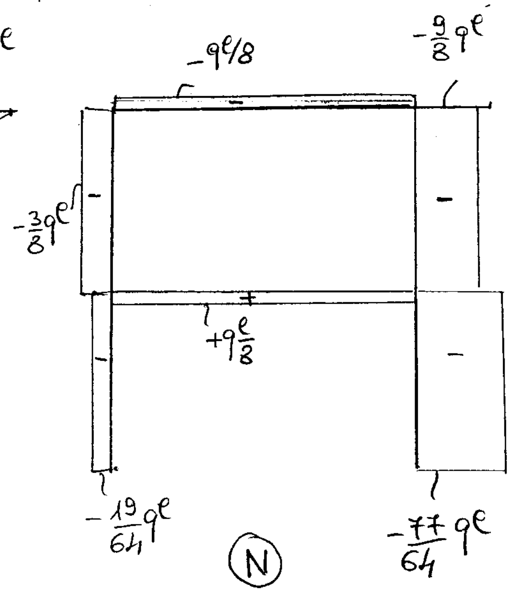
$\hookrightarrow \boxed{N_D} = -\frac{8}{5}T_D = \boxed{q\frac{\ell}{8}}$

$\boxed{N_F} = -N_D = \boxed{-q\frac{\ell}{8}}$

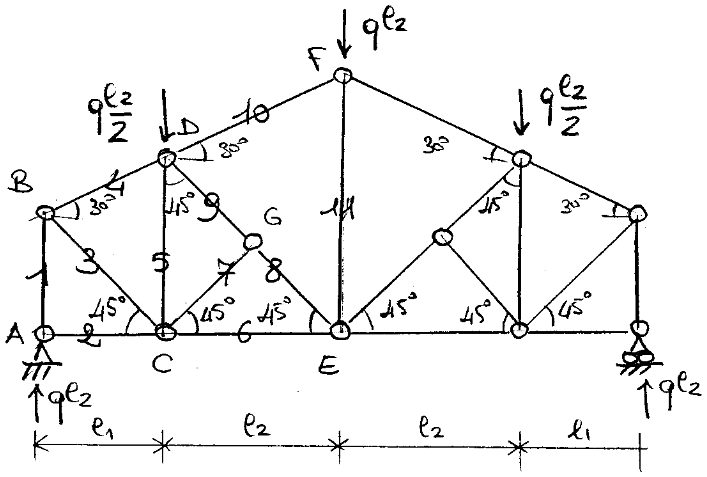
Diagrammi







Soluzione Es. 3



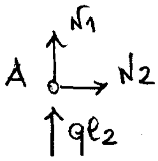
Le reazioni vincolari negli appoggi sono uguali per simmetria e pari alla metà del carico.

Inoltre,

$$\ell_2 = \ell_1\left(1+\mathrm{tg}\frac{\pi}{6}\right) = \frac{\ell_1}{\sqrt3}(1+\sqrt3)$$

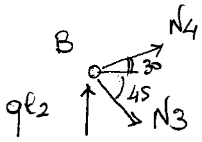
$$\mathrm{sen}\,\pi/6 = 1/2; \quad \cos\frac{\pi}{6} = \frac{\sqrt3}{2}$$

Equilibri ai nodi:

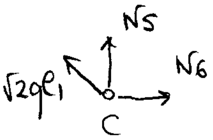


$$N_2 = 0$$

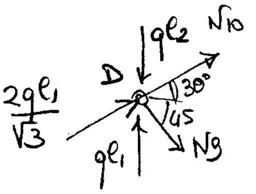
$$N_1 = -q\ell_2 = -q\ell_1\left(1+\frac{\sqrt3}{3}\right)$$



$$\begin{cases} N_4\frac{\sqrt3}{2} + N_3\frac{\sqrt2}{2} = 0 \\ \frac{N_4}{2} - N_3\frac{\sqrt2}{2} + q\ell_2 = 0 \end{cases} \longrightarrow \begin{cases} N_4 = -\frac{2q\ell_1}{\sqrt3} \\ N_3 = \sqrt2 q\ell_1 \end{cases}$$

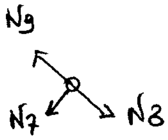


$$\begin{cases} N_6 = \sqrt2 q\ell_1\frac{\sqrt2}{2} = q\ell_1 \\ N_5 = -\sqrt2 q\ell_1\frac{\sqrt2}{2} = -q\ell_1 \end{cases}$$

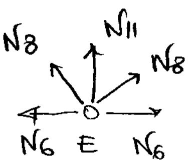


$$\begin{cases} N_{10}\frac{\sqrt3}{2} + N_9\frac{\sqrt2}{2} + 2q\frac{\ell_1}{\sqrt3}\frac{\sqrt3}{2} = 0 \\ N_{10}\frac{1}{2} - N_9\frac{\sqrt2}{2} + 2q\frac{\ell_1}{\sqrt3}\frac{1}{2} + q\ell_1 - q\ell_2 = 0 \end{cases}$$

$$\hookrightarrow \begin{cases} N_9 = \frac{q\ell_1}{\sqrt2}\frac{(\sqrt3-1)}{(\sqrt3+1)} \\ N_{10} = -q\ell_1\frac{(1+3\sqrt3)}{(3+\sqrt3)} \end{cases}$$



$$\begin{cases} N_8 = N_9 \\ N_7 = 0 \end{cases}$$

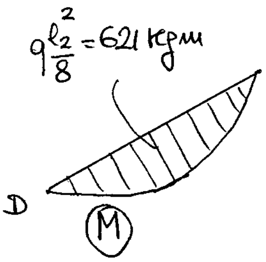


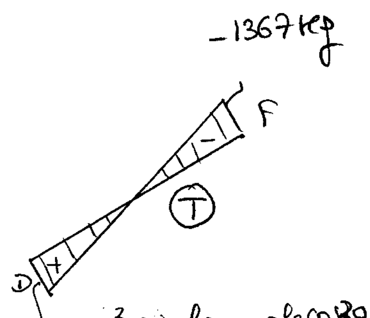
$$N_{11} = -2N_8\frac{\sqrt2}{2} = -q\ell_1\frac{(\sqrt3-1)}{(\sqrt3+1)}$$

Tabella dello stato "primario"

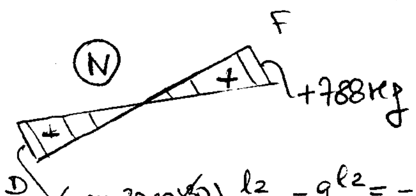
ASTA	N	N (kg)
1	$-q\ell_1(1+\frac{\sqrt3}{3})$	-3154
2	0	0
3	$\sqrt2 q\ell_1$	+2828
4	$-\frac{2q\ell_1}{\sqrt3}$	-2309
5	$-q\ell_1$	-2000
6	$+q\ell_1$	+2000
7	0	0
8	$q\frac{\ell_1}{\sqrt2}\frac{(\sqrt3-1)}{(\sqrt3+1)}$	+378
9	$\frac{q\ell_1}{\sqrt2}\frac{(\sqrt3-1)}{(\sqrt3+1)}$	+378
10	$-q\ell_1\frac{(1+3\sqrt3)}{(3+\sqrt3)}$	-2618
11	$-q\ell_1\frac{(\sqrt3-1)}{(\sqrt3+1)}$	-536

Stato "secondario"



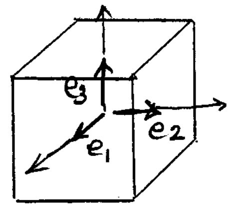


$$\left(\frac{q\cos^2 30}{2}\right)\frac{\ell_2}{\cos 30} = \frac{q\ell_2\cos 30}{2} = 1367\,\mathrm{kg}$$



$$-\left(\frac{q\,\mathrm{sen}\,30\cos 30}{2}\right)\frac{\ell_2}{\cos 30} = q\frac{\ell_2}{4} = -788\,\mathrm{kg}$$

Soluzione Es. 4



$$\underset{\sim}{T} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & -30X_2 & 30X_3 \\ 0 & 30X_3 & 10 \end{bmatrix} \qquad (\text{kg/cm}^2)$$

$\underset{\sim}{n} = \pm \underset{\sim}{e}_1$ $\quad \underset{\sim}{T}\,\underset{\sim}{n} = \underset{\sim}{0}$;

$X_1 = \pm \frac{l}{2}$

$\underset{\sim}{n} = +\underset{\sim}{e}_2$, $X_2 = +\frac{l}{2}$ $\quad \underset{\sim}{T}\,\underset{\sim}{n} = \begin{bmatrix} 0 \\ -150 \\ 30X_3 \end{bmatrix}$; $\quad \underset{\sim}{n} = -\underset{\sim}{e}_2$, $X_2 = -\frac{l}{2}$ $\quad \underset{\sim}{T}\,\underset{\sim}{n} = -\begin{bmatrix} 0 \\ +150 \\ 30X_3 \end{bmatrix} = \begin{bmatrix} 0 \\ -150 \\ -30X_3 \end{bmatrix}$

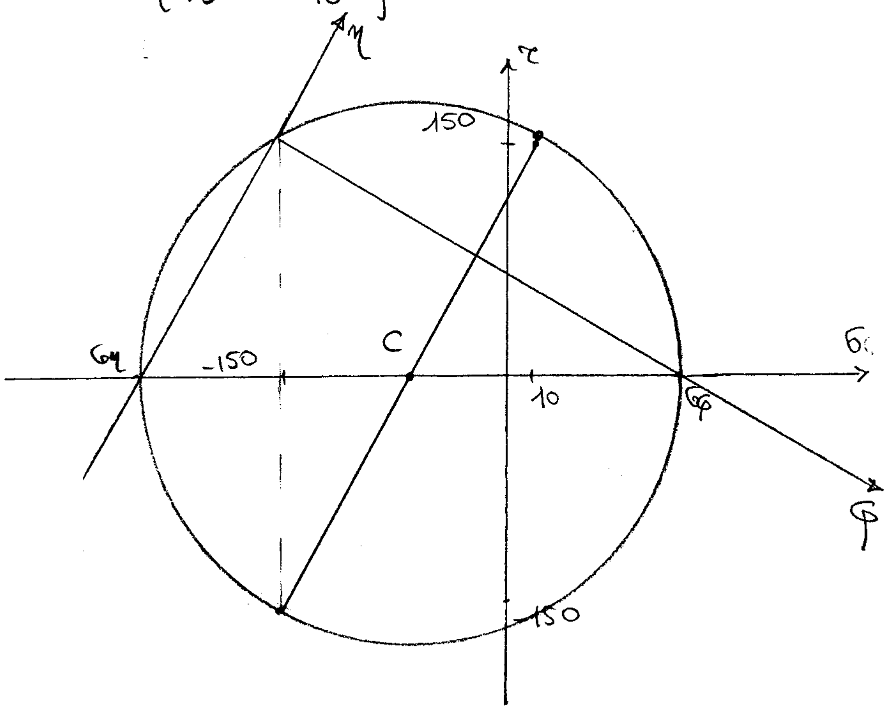
$\underset{\sim}{n} = +\underset{\sim}{e}_3$, $X_3 = +\frac{l}{2}$ $\quad \underset{\sim}{T}\,\underset{\sim}{n} = \begin{bmatrix} 0 \\ 150 \\ 10 \end{bmatrix}$; $\quad \underset{\sim}{n} = -\underset{\sim}{e}_3$, $X_3 = -\frac{l}{2}$ $\quad \underset{\sim}{T}\,\underset{\sim}{n} = -\begin{bmatrix} 0 \\ -150 \\ 10 \end{bmatrix} = \begin{bmatrix} 0 \\ 150 \\ -10 \end{bmatrix}$

Equazioni di equilibrio di Cauchy:

$$\operatorname{div} \underset{\sim}{T} = 0 \quad \rightarrow \quad \begin{cases} 0 = 0 \\ -30 + 30 = 0 \\ 0 + 0 = 0 \end{cases}$$

Cerchio di Mohr in $P = (+5, +5, +5)$:

$$\hat{\underset{\sim}{T}} = \begin{bmatrix} -150 & 150 \\ 150 & 10 \end{bmatrix}$$



$$\left.\begin{matrix} \sigma_\xi \\ \sigma_\eta \end{matrix}\right\} = -\frac{150+10}{2} \pm \sqrt{\left(\frac{160}{2}\right)^2 + 150^2} = \begin{cases} 100 \ \text{kg/cm}^2 \\ -240 \ \text{kg/cm}^2 \end{cases}$$

$$\alpha = \frac{1}{2}\,\text{arctg}\left(-\frac{2 \cdot 150}{160}\right) = -0{,}54 \,\hat{=}\, -31^\circ$$