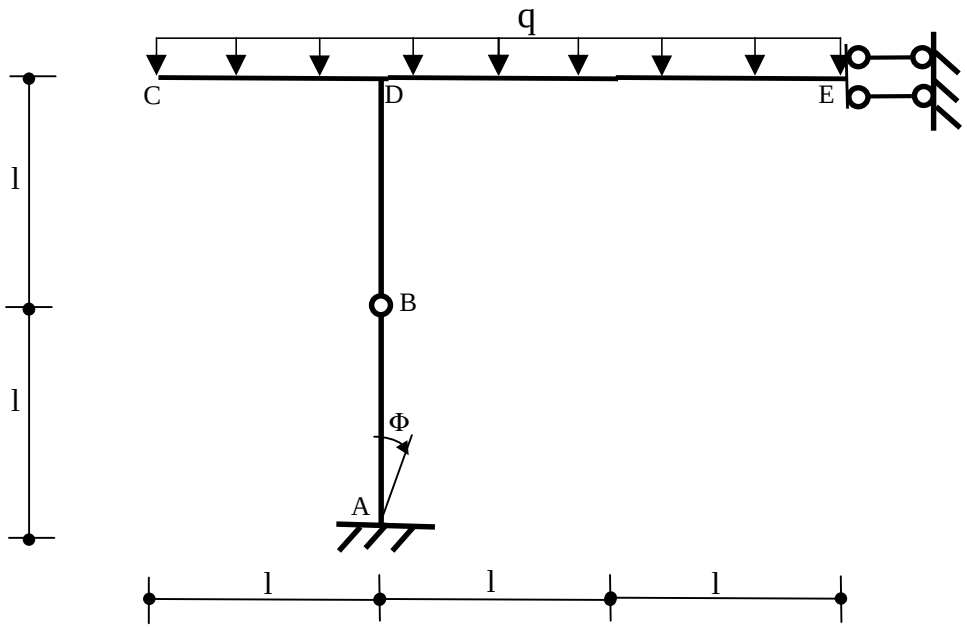
LAUREA IN INGEGNERIA MECCANICA
UNIVERSITÀ DEGLI STUDI DI FERRARA

PROVA SCRITTA DI STATICA

FERRARA, 9/7/2009



$l = 1$ m, $q = 2$ t/m

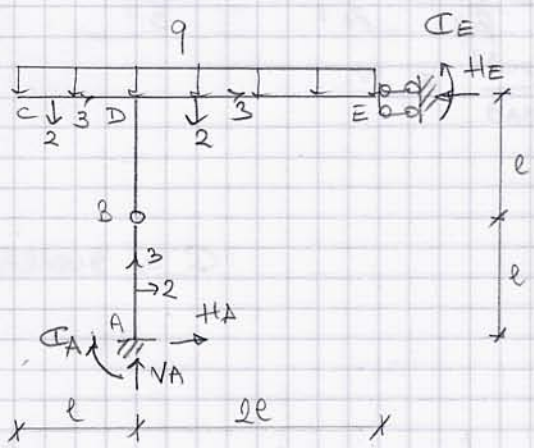
$\sigma_{AMM} = 2400$ kg/cm^2, $E = 2.1\ 10^6$ kg/cm^2

$\Phi = 0.2°$

La travatura iperstatica di figura è realizzata con profilati IPE.

1. Utilizzando il metodo delle forze risolvere la travatura in presenza del solo carico q e disegnare i diagrammi delle caratteristiche di sollecitazione (N, T, M). Considerare trascurabili le deformazioni assiali.
2. Progettare la travatura.
3. Calcolare la rotazione del nodo D.
4. Risolvere nuovamente la travatura considerando anche un cedimento angolare Φ dell'incastro in A. Disegnare i nuovi diagrammi delle caratteristiche di sollecitazione (N, T, M) comprensivi sia di q che di Φ.

1)



Eq.ni cardinali della Statica:

$(\rightarrow)$ $H_A = H_E$ (1)

$(\uparrow)$ $V_A = 3q\ell$

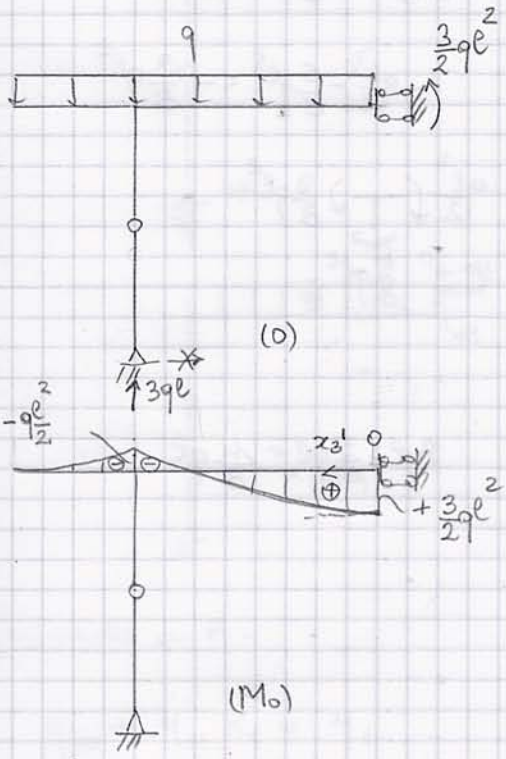
$(A\uparrow)$ $H_E 2\ell + \mathcal{C}_E - 3q\ell\frac{\ell}{2} = 0$ (2)

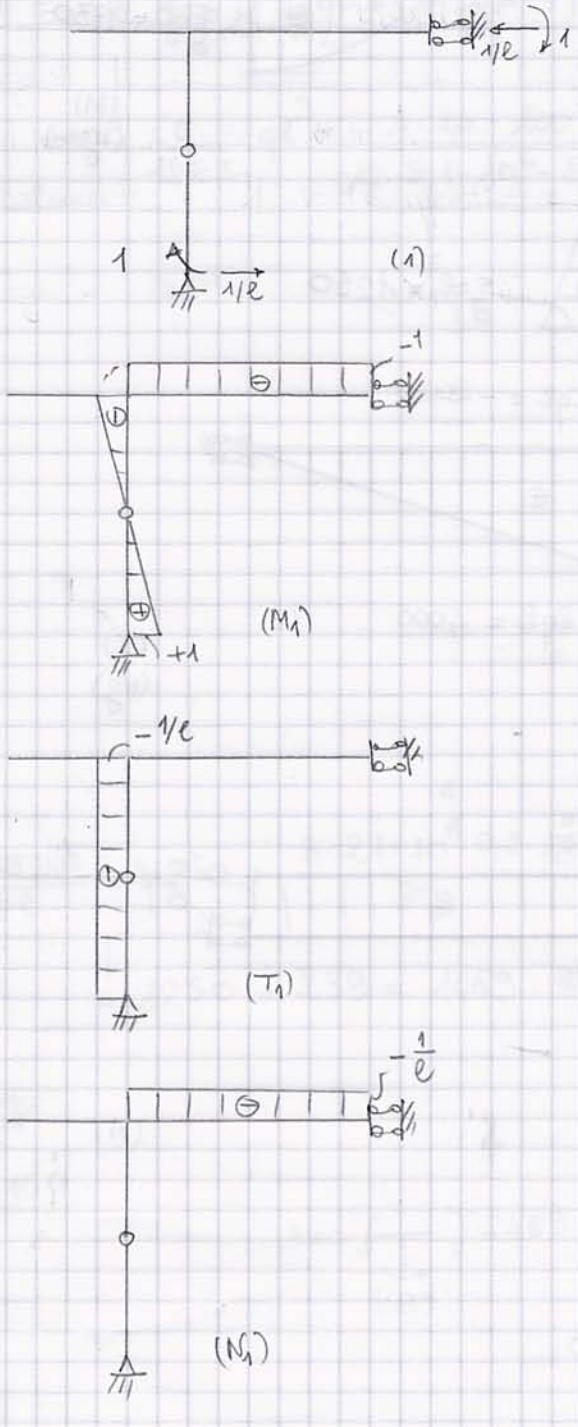
Eq.ne della ocoiversione in B:

$(B\uparrow)_{AB}$ $\mathcal{C}_A = H_A\ell$ (3)

Incognite: $H_A, H_E, \mathcal{C}_E, \mathcal{C}_A$ } Trovato una volta iperstatica

Eqni: (1), (2), (3)

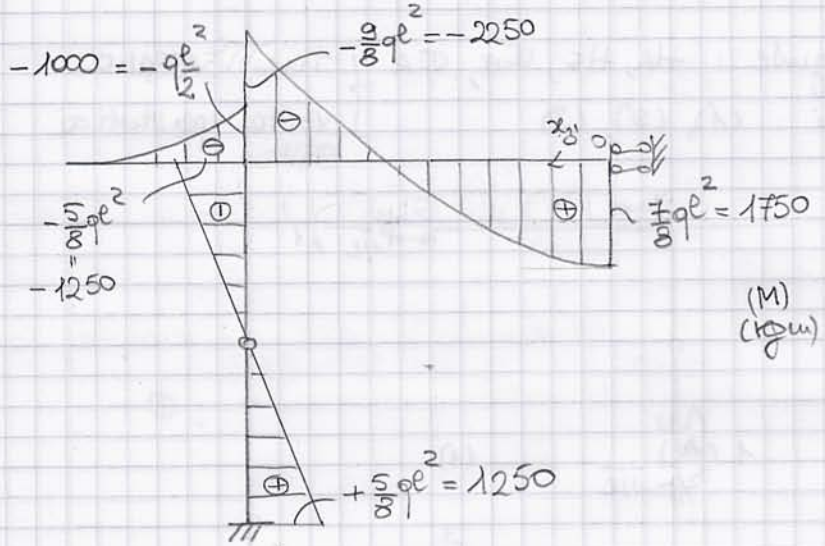




$$EI_1 \Delta_{10} = \int_0^{2\ell} (-1)\left(\frac{3}{2}q\ell^2 - q\frac{x_3'^2}{2}\right) dx_3' = \left[\frac{q}{2}\frac{x_3'^3}{3} - \frac{3}{2}q\ell^2 x_3'\right]_0^{\ell} = \frac{q}{6}\ell^3 - \frac{3}{2}q\ell^3 = -\frac{5}{3}q\ell^3$$

$$EI_1 \delta_{11} = 2\ell + \frac{2}{3}\ell = \frac{8}{3}\ell$$

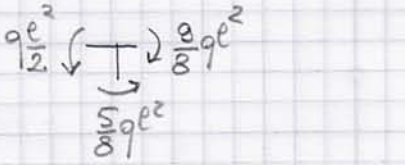
$$X_1 = -\frac{\Delta_{10}}{\delta_{11}} = \frac{5}{8}q\ell^3 \frac{3}{8\ell} = \frac{5}{8}q\ell^2 = 1250 \text{ kgm}$$



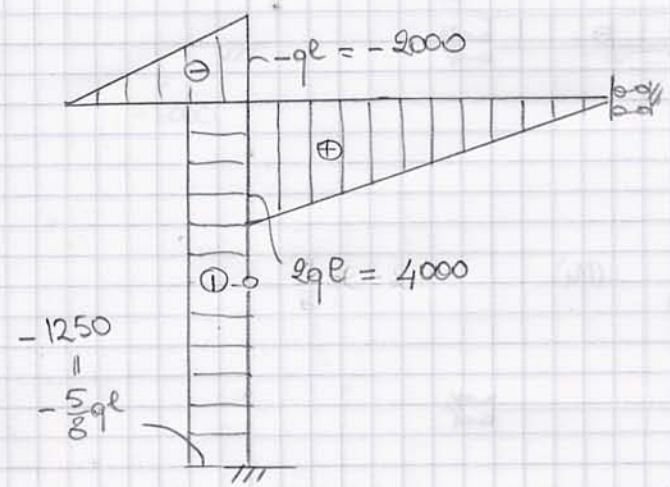
(M)
(kgm)

$$4\cdot\frac{3}{2}q\ell^2 - \frac{5}{8}q\ell^2 = \frac{7}{8}q\ell^2$$

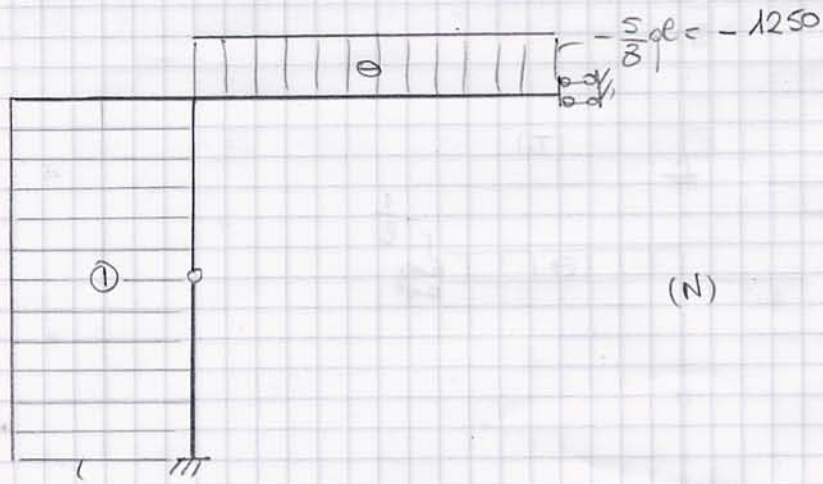
$$-q\frac{\ell^2}{2} - \frac{5}{8}q\ell^2 = -\frac{9}{8}q\ell^2$$



$$2q\ell - \frac{5}{8}q\ell = \frac{11}{8}q\ell$$



(T)
(kg)

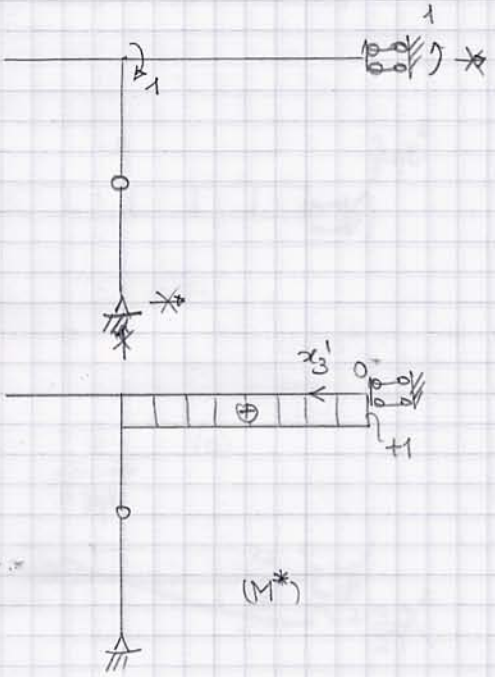


(N)

Dimensionamento:

$$W_1 \geq \frac{M_{max}}{\sigma_{AMM}} = \frac{2250 \cdot 100}{2400} = 93{,}75 \ cm^3 \qquad \text{IPE 160} \begin{cases} J_1 = 869 \ cm^4 \\ A = 20 \ cm^2 \end{cases}$$

Rotazione in D:



$$1 \cdot \varphi_D = \frac{1}{EI_1} \int_0^{2\ell} \left[\frac{7}{8} q\ell^2 - q\frac{x_3'^2}{2} \right] dx_3'$$

$$= \frac{1}{EI_1} \left[\frac{7}{8} q\ell^2 \cdot 2\ell - \frac{q}{6} 8\ell^3 \right]$$

$$= \frac{5}{12 EI_1} q\ell^3 = \frac{5 \cdot 20 \cdot 100^3}{12 \cdot 2{,}1 \cdot 10^6 \cdot 869} = 0{,}26°$$

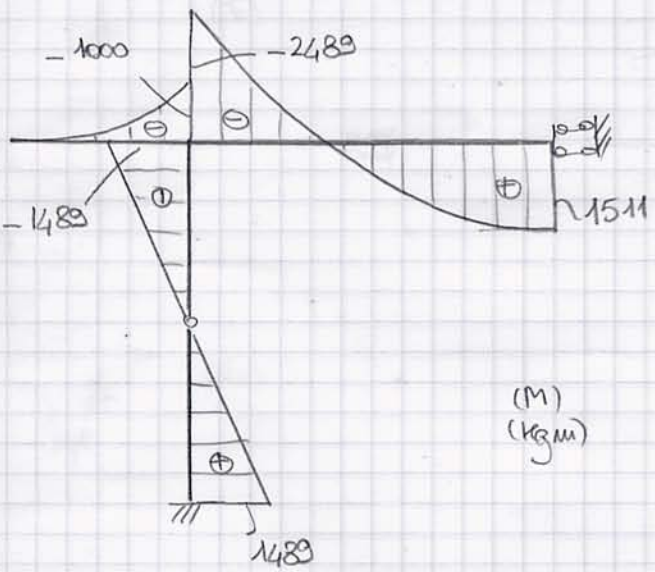
Cedimento in A:

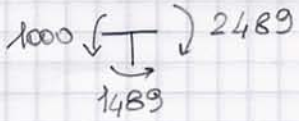
$$M_{10} + M_{11} X_1 = M_1$$

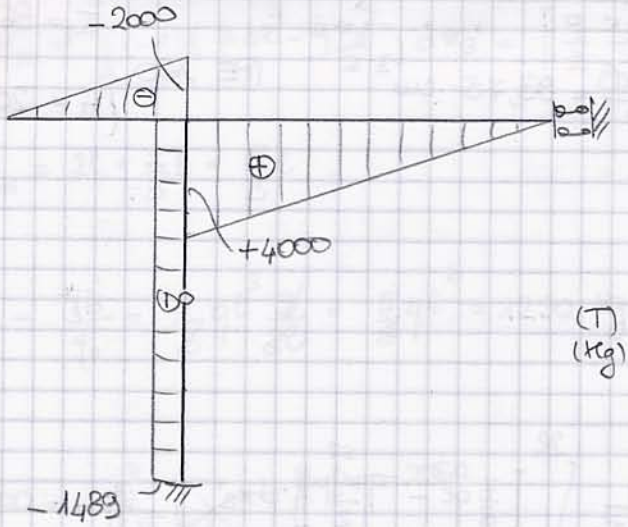
$$M_1 = 1 \cdot \Phi$$

$$X_1 = -\frac{M_{10}}{M_{11}} + \frac{M_1}{M_{11}} = \frac{5}{8} q\ell^2 + \frac{3 E I_1 \Phi}{8\ell} = 1250 + \frac{3 \cdot 2{,}1 \cdot 10^6 \cdot 0{,}2 \cdot \frac{\pi}{180}}{800} \cdot 10^{-2} \cdot 869$$

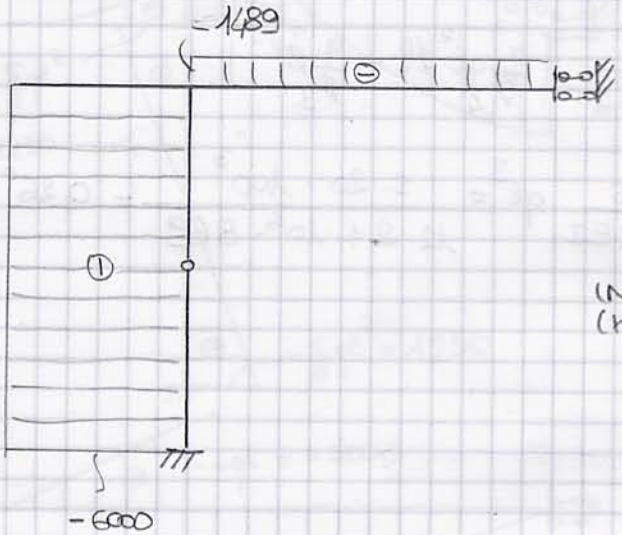
$$= 1250 + 239 = 1489 \ kgm$$







(T)
(kg)



(N)
(kg)