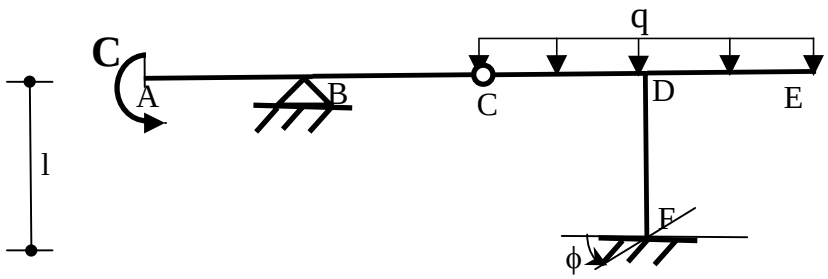
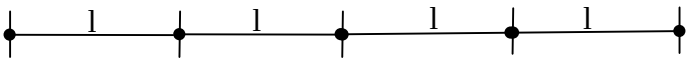
CORSO DI LAUREA IN INGEGNERIA MECCANICA
UNIVERSITÀ DEGLI STUDI DI FERRARA
PROVA SCRITTA DI STATICA
FERRARA, 07/12/2007

B



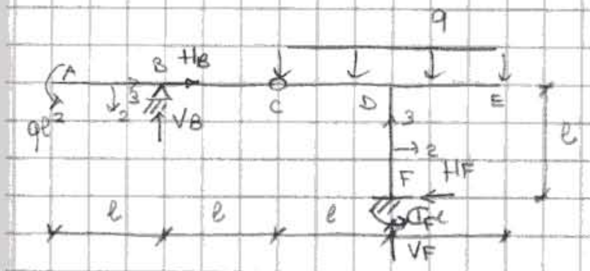


l =1 m, q = 1 t/m, C=ql^2, σ_{AMM} = 2400 kg/cm^2
E = 2.1 10^6 kg/cm^2, ϕ = 0.1°

La travatura iperstatica di figura è realizzata con profilati IPE.

1. Utilizzando il metodo delle forze risolvere la travatura in presenza dei carichi q e C e disegnare i diagrammi delle caratteristiche della sollecitazione (N, T, M). Trascurare le deformazioni assiali.
2. Progettare la travatura.
3. Calcolare la rotazione del nodo D.
4. Risolvere nuovamente la travatura considerando anche il cedimento δ del vincolo in F e disegnare i diagrammi delle caratteristiche della sollecitazione (N, T, M).

B.1)



Eq.ne ausiliaria:

$(C\circlearrowleft)_{ABC} \quad V_B l = q l^2$

Eq.ni cardinali:

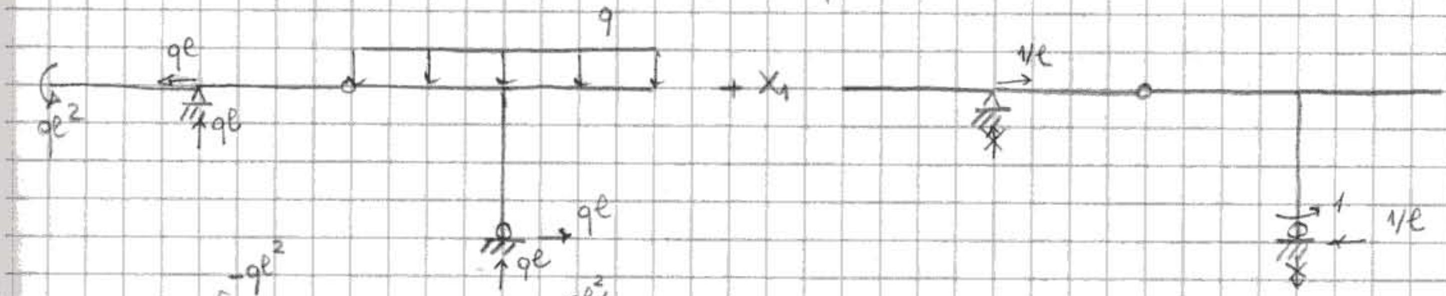
$(\uparrow) \quad V_F = 2ql - ql = ql$

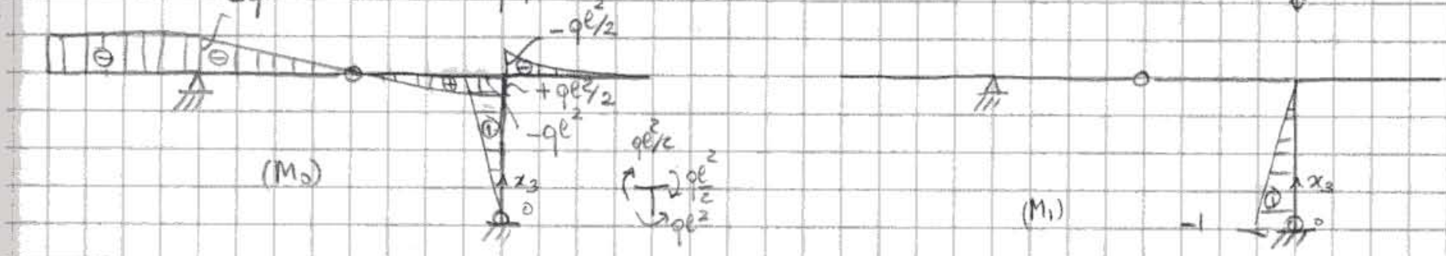
$(\rightarrow) \quad H_B = H_F$

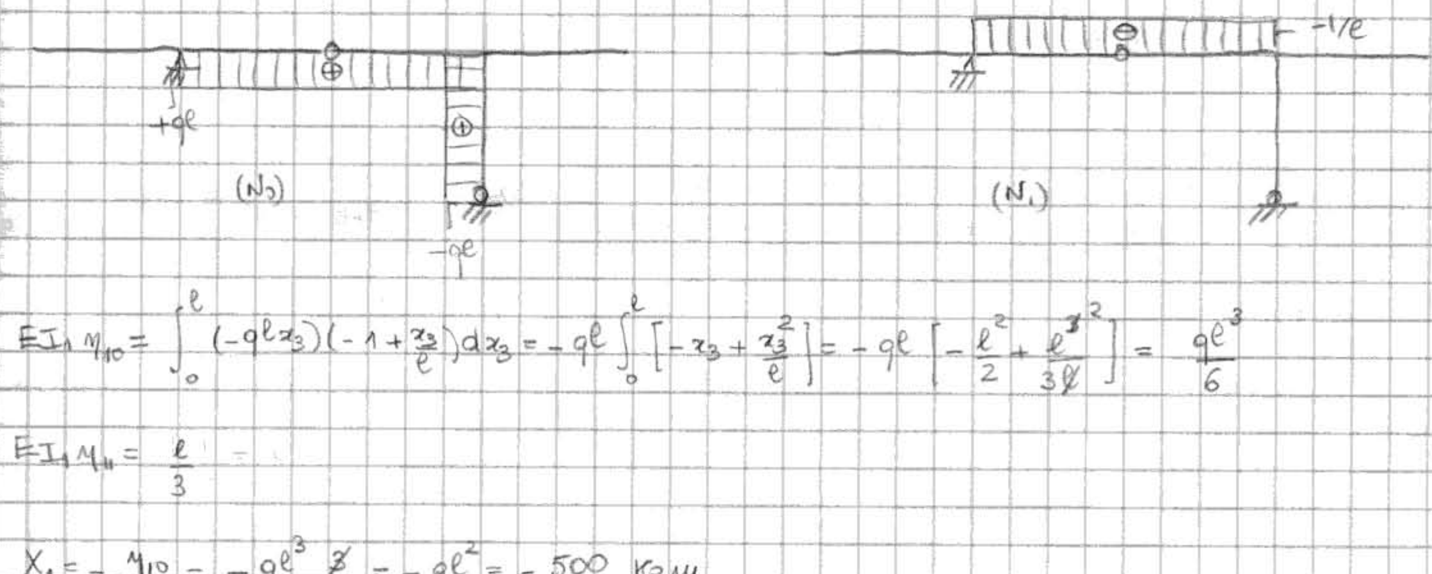
$(F\circlearrowleft) \quad C_F + ql^2 - 2ql^2 - H_B l = 0$

} tre incognite, due eq.ni.

Travatura una volta iperstatica. Incognita iperstatica: $X_1 = C_F$.







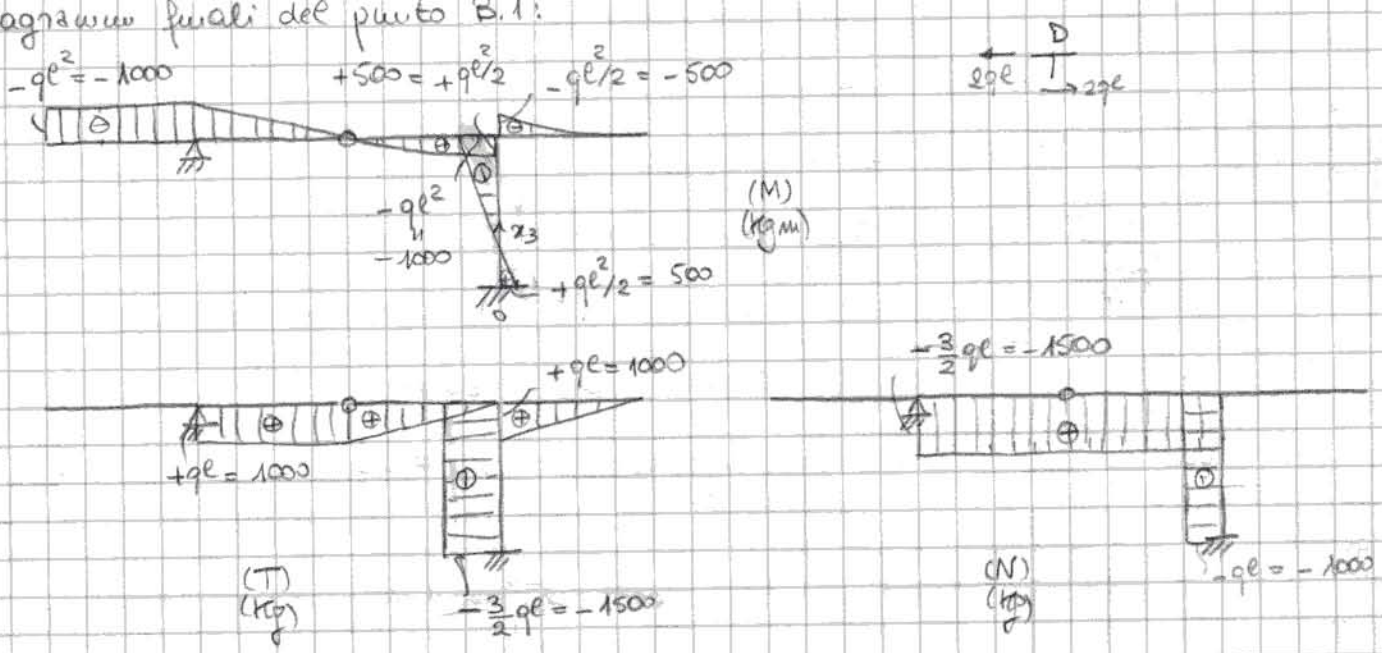
$$EI_1\,\eta_{10} = \int_0^l (-ql x_3)\left(-1 + \frac{x_3}{l}\right) dx_3 = -ql \int_0^l \left[-x_3 + \frac{x_3^2}{l}\right] = -ql\left[-\frac{l^2}{2} + \frac{l^3}{3l}\right] = \frac{ql^3}{6}$$

$$EI_1\,\eta_{11} = \frac{l}{3}$$

$$X_1 = -\frac{\eta_{10}}{\eta_{11}} = -\frac{ql^3}{6}\,\frac{3}{l} = -\frac{ql^2}{2} = -500 \text{ kgm}$$

$$T_F = -ql - \frac{ql}{2} = -\frac{3}{2}ql$$

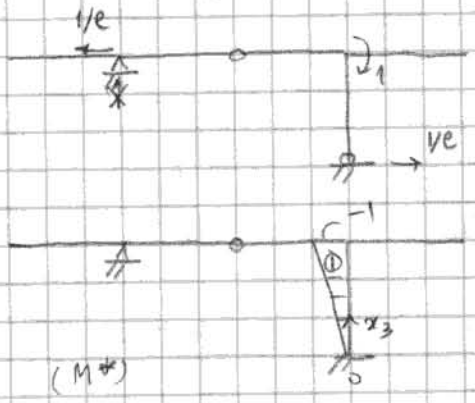
Diagrammi finali del punto B.1:



B2) Progetto

$$W_x \geq \frac{1000 \cdot 100}{2400} = 42\ cm^3 \Rightarrow IPE\ 120 \qquad \begin{cases} I_1 = 318\ cm^4 \\ A = 10,4\ cm^2 \end{cases}$$

B3) Rotazione in D



$$1 \cdot \varphi_D = \frac{1}{EI_1}\int_0^{\ell}\left(-\frac{x_3}{\ell}\right)\left(\frac{q\ell^2}{2} - \frac{3}{2}q\ell x_3\right)dx_3$$

$$= \frac{1}{EI_1}\int_0^{\ell}\left[\frac{3}{2}qx_3^2 - q\ell\frac{x_3}{2}\right]dx_3$$

$$= \frac{1}{EI_1}\left[\frac{q}{2}\ell^3 - q\frac{\ell^3}{4}\right] = \frac{q\ell^3}{4EI_1} = \frac{10 \cdot 100^3}{4 \cdot 2{,}1 \cdot 10^6 \cdot 318} = 0{,}9^\circ$$

B4) Cedimento in colore

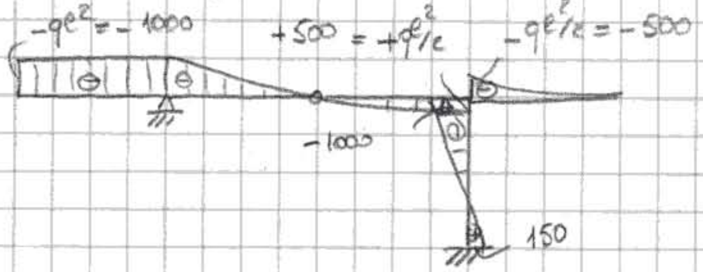
$$M_1 = 1 \cdot \varphi \qquad M_{11} = \frac{\ell}{3EI_1} + \frac{2\ell}{\ell^2 EA}$$

$$\frac{M_{11}^{\,I}}{M_{11}^{\,M}} = \frac{2}{\ell EA}\,\frac{3EI_1}{\ell} = \frac{6I_1}{A\ell^2} = 1{,}8\,\%$$ M_m^N è trascurabile

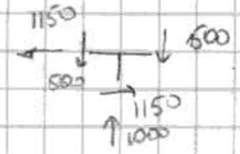
$$X_1 = -\frac{M_{10}}{M_{11}} + \frac{M_1}{M_{11}}$$

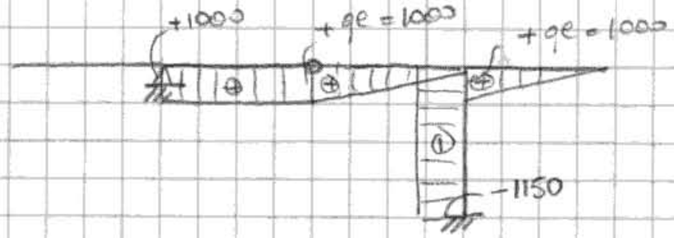
$$= -\frac{q\ell^2}{2} + \frac{3EI_1\varphi}{\ell} = -500 + \frac{3 \cdot 2{,}1 \cdot 10^6 \cdot 318 \cdot 0{,}1 \cdot \pi/180}{100} \cdot \frac{1}{100}\ kgm = -500 + 350\ kgm = -150\ kgm$$

Diagrammi finali punto B.4.

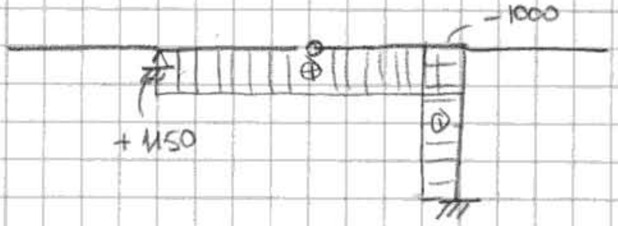


(M)
(tfm)





(T)
(tf)



(N)
(tf)