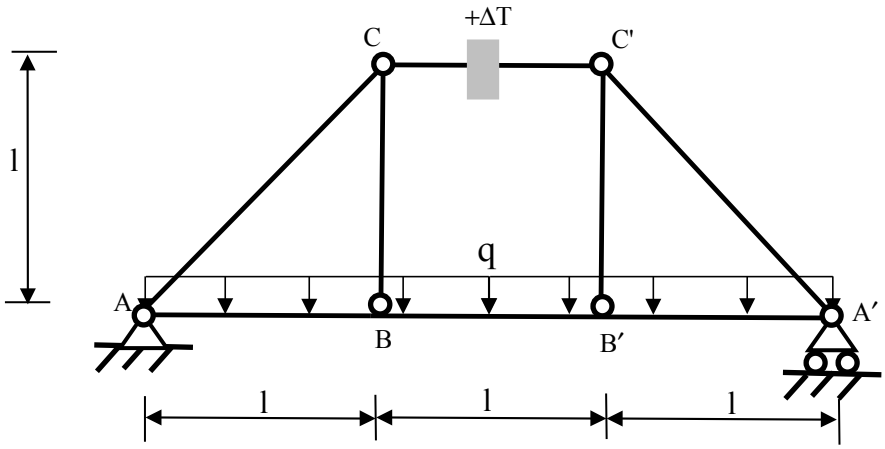
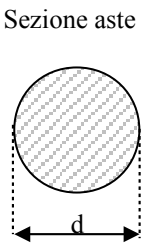
LAUREA IN INGEGNERIA MECCANICA
UNIVERSITÀ DEGLI STUDI DI FERRARA

PROVA SCRITTA DI STATICA

FERRARA, 07/09/2011





$l = 120$ cm, $q = 2$ t/m, $d = 4$ cm

$\sigma_{AMM} = 240$ MPa , $E = 210$ GPa

$\Delta T = +10$ °C, $\alpha = 10^{-5}$ °C^{-1}

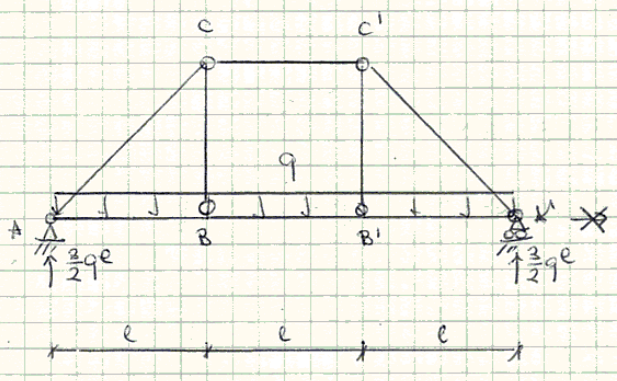
Si consideri la travatura iperstatica di figura, in cui le aste AC, A'C', BC, B'C' e CC' sono realizzate con ferri tondi aventi diametro pari a 4 cm.

1. Utilizzando il metodo delle forze risolvere la travatura in presenza del solo carico q. Disegnare i diagrammi delle caratteristiche di sollecitazione (N, T, M).
2. Dimensionare la trave ABB'A' con profilati IPE.
3. Calcolare la rotazione dei nodi B e B'.
4. Risolvere nuovamente la travatura considerando anche un riscaldamento uniforme dell'asta CC': disegnare i nuovi diagrammi delle caratteristiche di sollecitazione (N, T, M) comprensivi sia di q che di ΔT.

1)

Trovata 1 volta iperstatica individuata

Incognita iperstatica: $X_1 = N_{CC'}$



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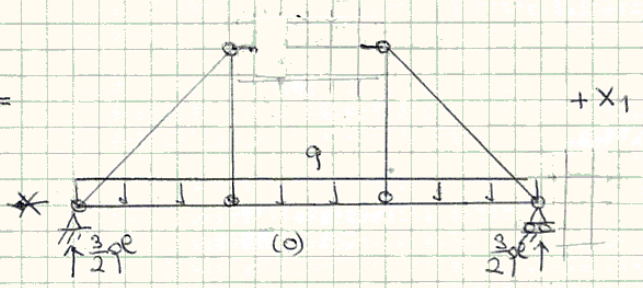
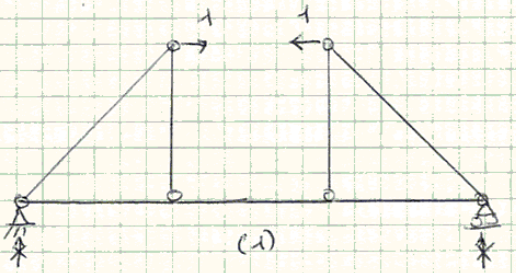
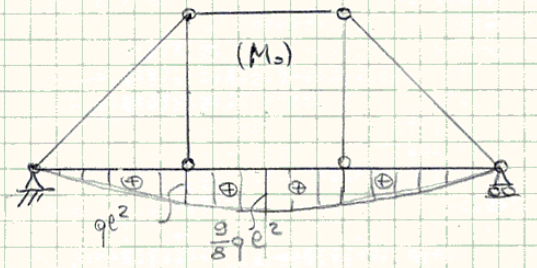
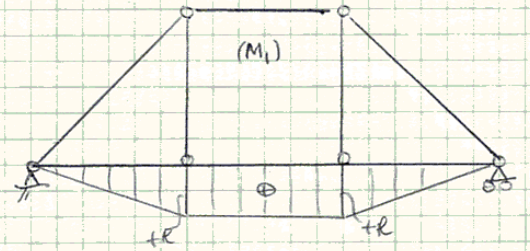
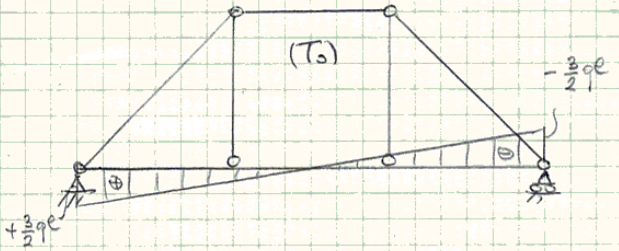


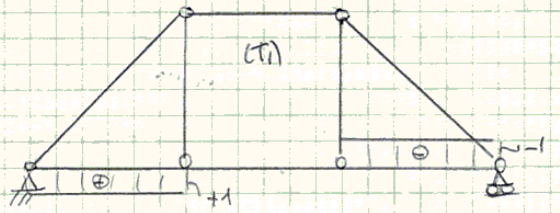
$+ X_1$

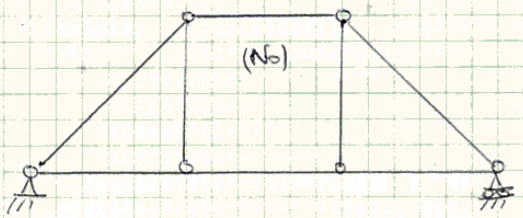


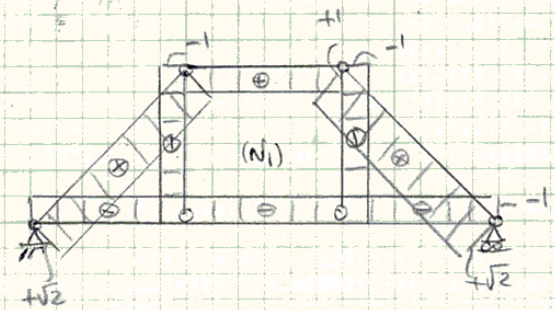












$$EI_1 y_{10} = 2\int_0^{\ell}\left(\frac{3}{2}q\ell x_3 - q\frac{x_3^2}{2}\right)x_3\,dx_3 + 2\int_{\ell}^{\frac{3}{2}\ell}\left(\frac{3}{2}q\ell x_3 - q\frac{x_3^2}{2}\right)\ell\,dx_3 = \frac{11}{6}q\ell^4$$

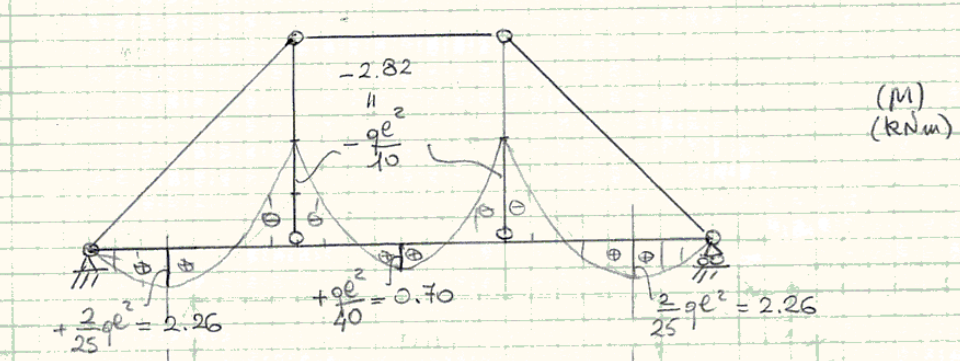
$$EI_1 y_{11} = 2\cdot\frac{1}{3}\ell\ell^2 + \ell\ell^2 = \frac{5}{3}\ell^3$$

$$X_1 = -\frac{y_{10}}{y_{11}} = -\frac{11}{6}q\ell^4\frac{3}{5\ell^3} = -\frac{11}{10}q\ell = -25.88\ \text{kN}$$

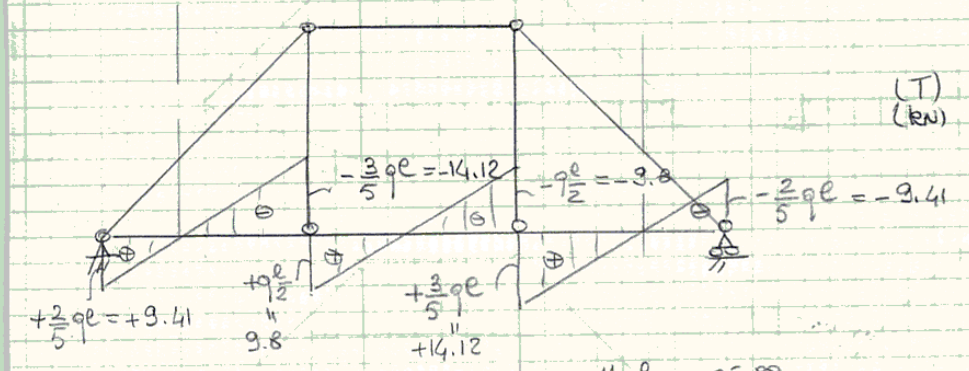
$q = 2\ t/m = 19.61\ \text{kN/m}$

$\ell = 1.2\ m$

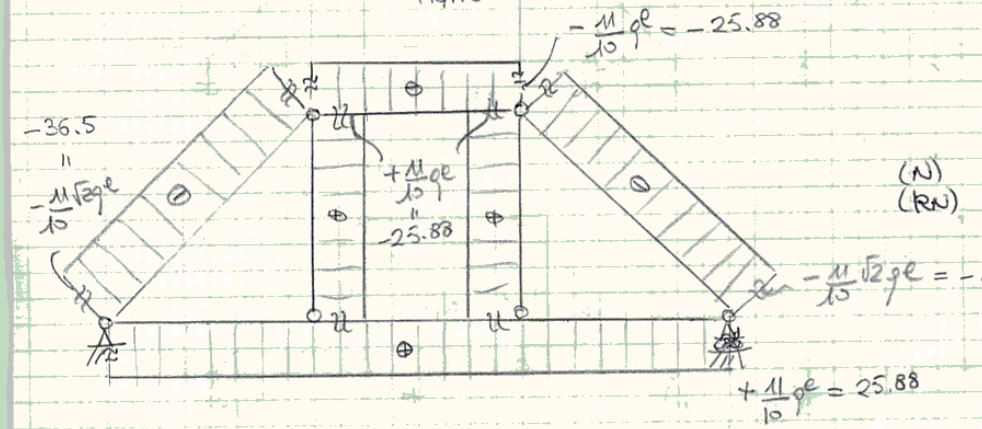
Diagramme:



(M)
(kNm)



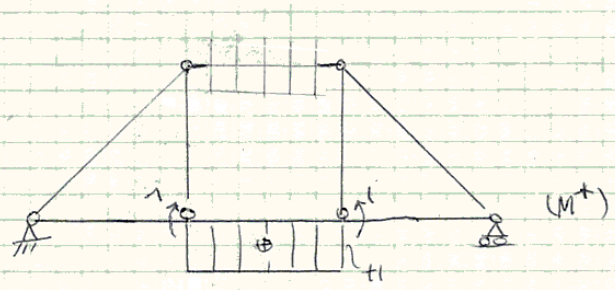
(T)
(kN)



(N)
(kN)

2) $W_1 \geq \frac{M_{max}}{\sigma_{AMM}} = \frac{(2,82)\cdot 10^3}{240 \cdot 10^6}\ m^3 = 117\ cm^3$ IPE 180 $\begin{cases} W_1 = 146.3\ cm^3 \\ I_1 = 1317\ cm^4 \\ A = 23.95\ cm^2 \end{cases}$

3)



$$2\cdot\varphi_B = \frac{2}{EI_1}\int_0^{\ell/2}\left(-\frac{q\ell^2}{10} + q\frac{\ell}{2}x_3 - q\frac{x_3^2}{2}\right)\cdot 1\,dx_3$$

$$= \frac{q\ell^3}{120EI_1} = \frac{19.61\ 10^{2}\ (1.2)^3}{120\cdot 210\cdot 10^{5}\cdot 1317\cdot 10^{-8}} = 0.102\cdot 10^{-3} = 0.0058°$$

4) $M_{1t} = 1\cdot\alpha\Delta T\cdot\ell$

$$X_1 = -\frac{11}{10}q\ell - \frac{32\Delta T E I_1}{5\ell^2} = (-25.88 - 0,118)\ kN$$

I diagrammi non si discostano in modo significativo da quelli ricavati al punto (1).