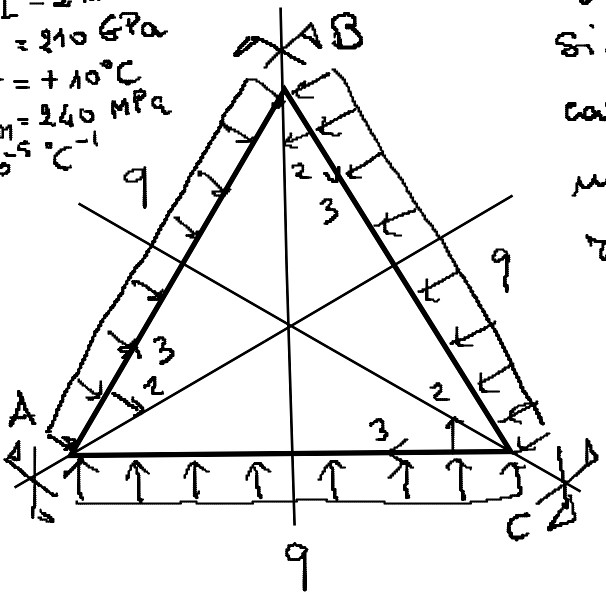
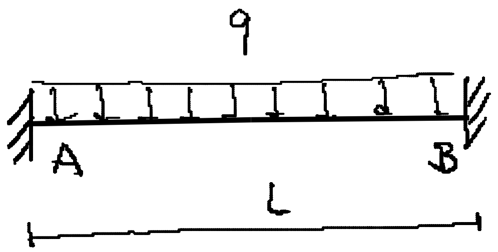
$q = 10$ kN/m
$L = 2$ m
$E = 210$ GPa
$\Delta T = +10\,°C$
$\sigma_{AMM} = 240$ MPa
$\alpha = 10^{-5}\,°C^{-1}$

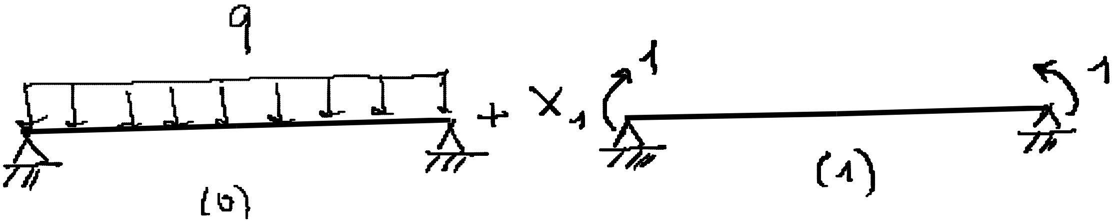


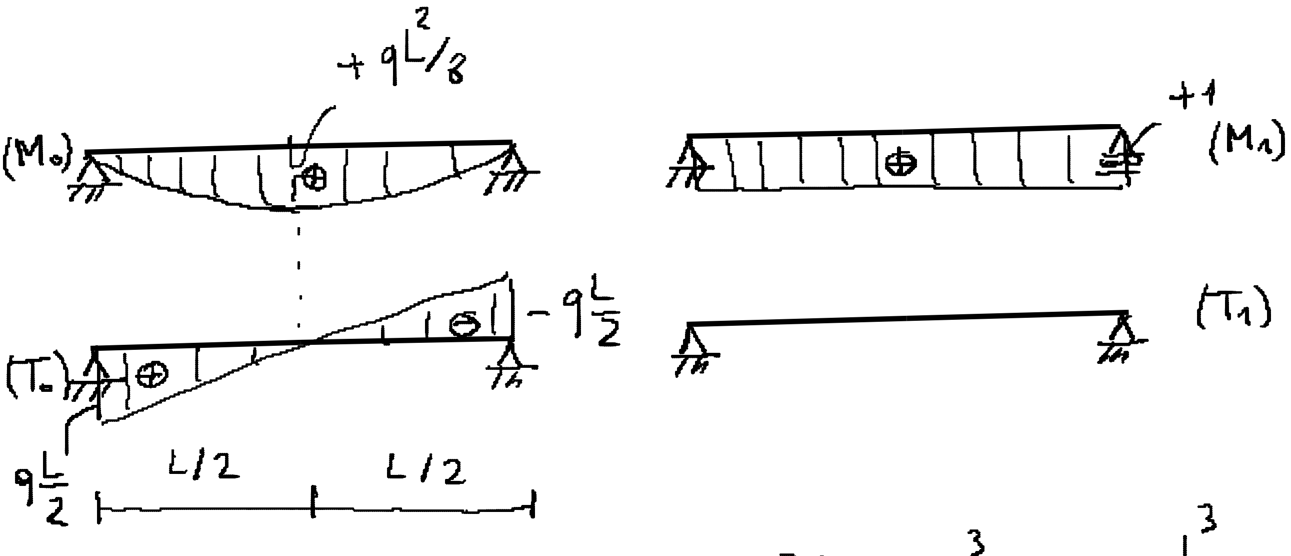
La struttura presenta 3 assi di simmetria. Data la condizione di carico, i nodi sugli assi di simmetria non ruotano ed è quindi possibile ricondursi allo studio della struttura:



che è una volta iperstatica.

Come incognita iperstatica si assume il momento in A (e in B).



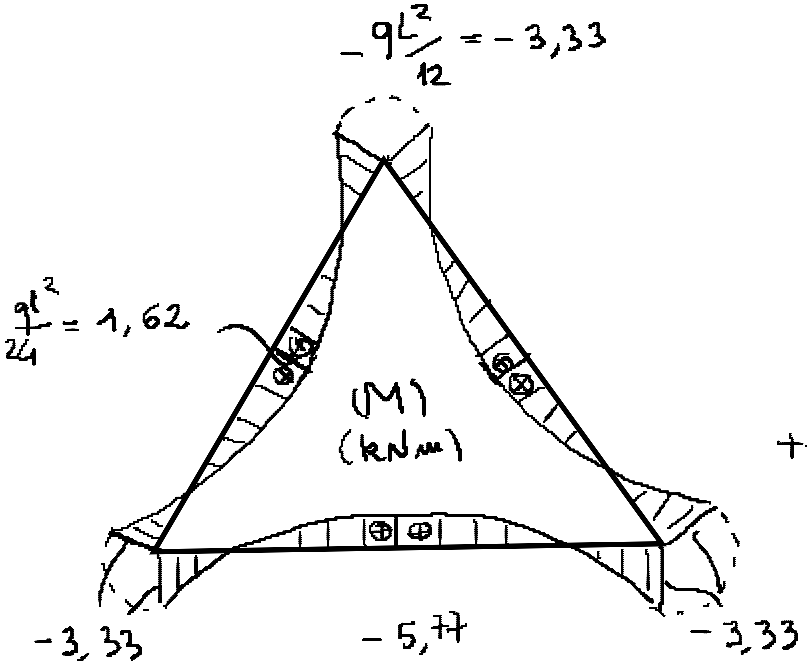


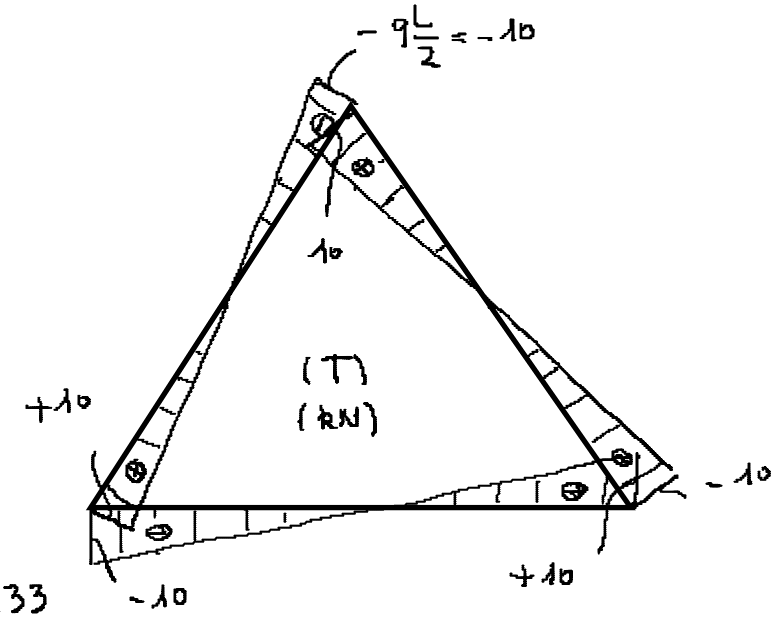
$$EI_1\eta_{10} = 1\left(q\frac{L^2}{8}\cdot L - \cancel{2}\,\frac{1}{3}\,\frac{L}{\cancel{2}}\,q\frac{L^2}{8}\right) = q\frac{L^3}{8}\,\frac{2}{3} = q\frac{L^3}{12}$$

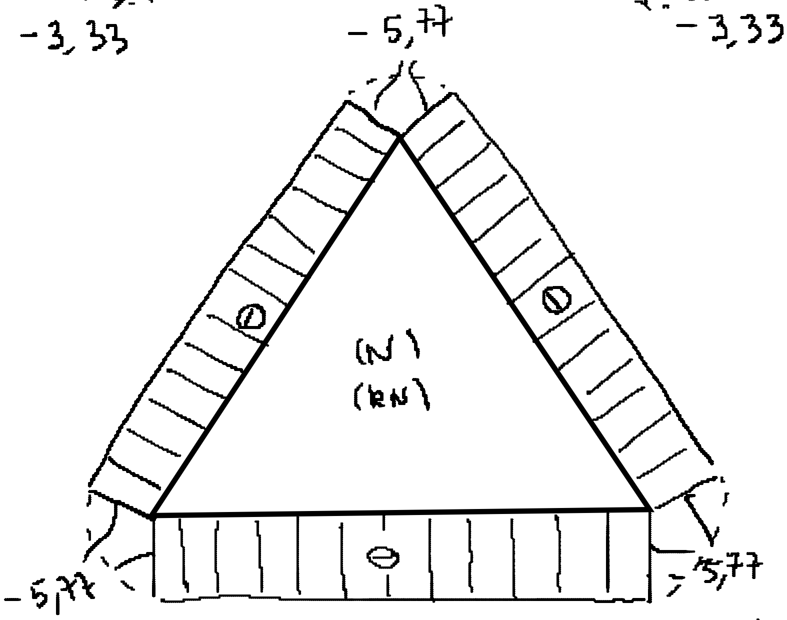
$$EI_1\eta_{11} = L$$

$$X_1 = -\frac{\eta_{10}}{\eta_{11}} = -\,q\frac{L^2}{12} = -\,10\cdot\frac{4}{12}\ \text{kNm} = -3{,}33\ \text{kNm}$$

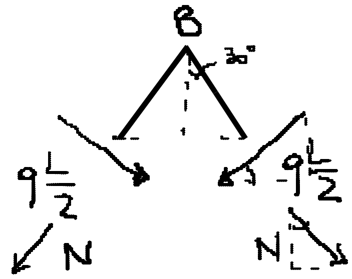
Diagrammi delle caratteristiche della sollecitazione (solo q):

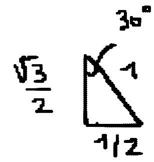






Per calcolare N, è stato considerato l'equilibrio dei nodi ai vertici (es. 8):





$\sin 30° = \frac{1}{2}$

$\cos 30° = \frac{\sqrt{3}}{2}$

$(\rightarrow)\ N\frac{1}{2} - N\frac{1}{2} - q\frac{L}{2}\frac{\sqrt{3}}{2} + q\frac{L}{2}\frac{\sqrt{3}}{2} = 0$ ✓

$(\downarrow)\ 2N\frac{\sqrt{3}}{2} + 2q\frac{L}{2}\frac{1}{2} = 0 \rightarrow N = -qL\frac{\sqrt{3}}{6}$

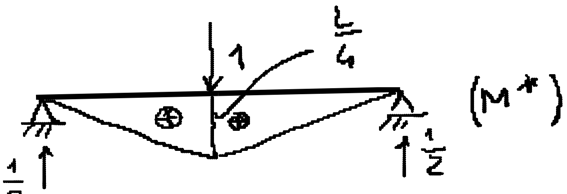
$= -5{,}77$ kN

Dimensionamento:

$W_1 \geq \frac{M_{max}}{\sigma_{AMM}} = \frac{qL^2}{12\,\sigma_{AMM}} = \frac{3{,}33 \cdot 10^{2}}{24 \cdot 10^{6}} \cdot 10^{6}\ cm^3 = \frac{333}{24}\ cm^3 = 13{,}87\ cm^3$

IPE 80
$\begin{cases} W_1 = 20{,}03\ cm^3 \\ I_1 = 80{,}14\ cm^4 \\ H = 80\ mm \end{cases}$

Spostamento trasversale:



$1 \cdot \delta = \frac{2}{EI_1}\int_0^{L/2}\left(\frac{x}{2}\right)\left(-q\frac{L^2}{12} + q\frac{L}{2}x - q\frac{x^2}{2}\right)dx$

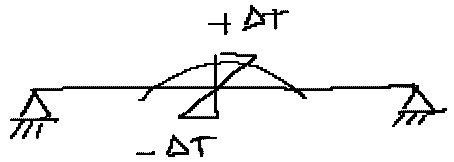
$= \frac{q}{EI_1}\left\{-\frac{L^2}{12}\cdot\frac{1}{2}\frac{L^2}{4} + \frac{L}{2}\frac{1}{3}\frac{L^3}{8} - \frac{1}{2}\frac{1}{4}\frac{L^4}{16}\right\}$

$= \frac{qL^4}{16EI_1}\left(-\frac{1}{6} + \frac{1}{3} - \frac{1}{8}\right) = \frac{qL^4}{384\,EI_1} =$

$$= \frac{10\cdot 10^3 \cdot 16 \cdot 10^8}{384 \cdot 210 \cdot 10^5 \cdot 80,14} \cdot 10^2 \text{ cm}$$

$$= \frac{10\,000}{24 \cdot 21 \cdot 80,14} = 0,25 \text{ cm}$$

Carico termico



$$\eta_{1t} = +\int_0^L M_1 \chi_t \, dx = -L\,\frac{2\alpha\Delta T}{H}$$

$$X_1 = -\frac{\eta_{10}}{\eta_{11}} - \frac{\eta_{1t}}{\eta_{11}} = -\frac{qL^2}{12} + \frac{2\alpha\Delta T L}{H}\,\frac{EI_1}{L}$$

$$= \left(-3,33 + \frac{2\cdot 10^{-5}\cdot 10 \cdot 210 \cdot 10^{9}\cdot 80,14 \cdot 10^{-8} \cdot 10^{-3}}{400 \cdot 10^{-3}}\right) \text{kNm}$$

$$= \left(-3,33 + \frac{21\cdot 80,14}{4000}\right) \text{kNm}$$

$$= \left(-3,33 + 0,42\right) \text{kNm} = -2,90 \text{ kNm}$$

Diagrammi delle c.s. complessivi sia di q che di ΔT: