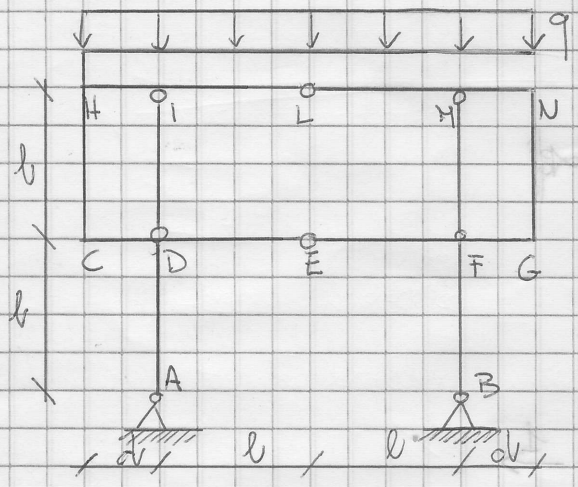
FILA A



$b = 3\ m$

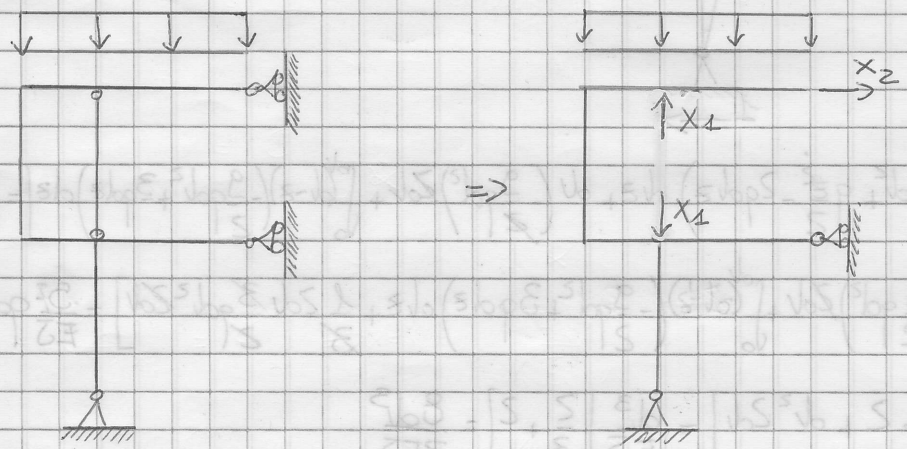
$d = 1,5\ m$

$q = 20\ kN/m$

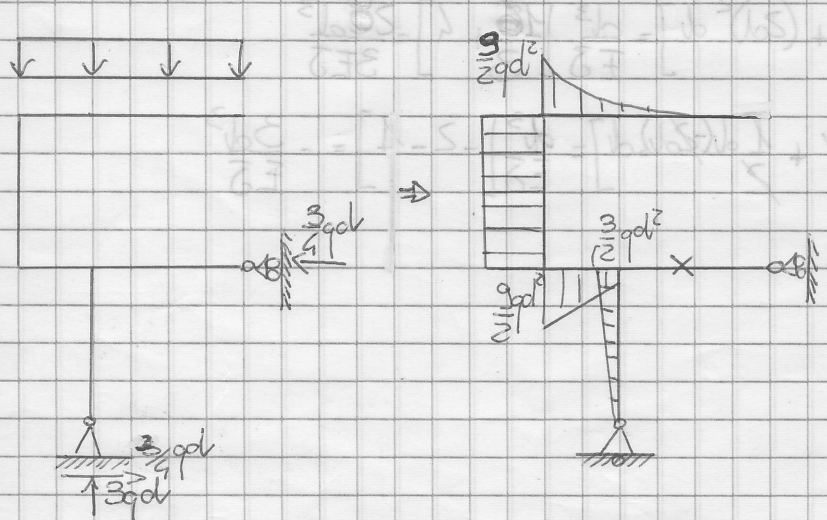
$E = 210\ GPa$

$\sigma_{amm} = 260\ MPa$

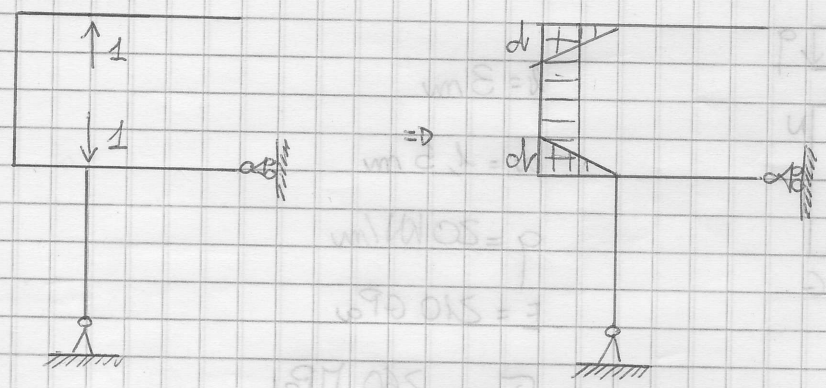
Data la simmetria della struttura, dei vincoli e dei carichi ne considero solo metà con gli opportuni vincoli



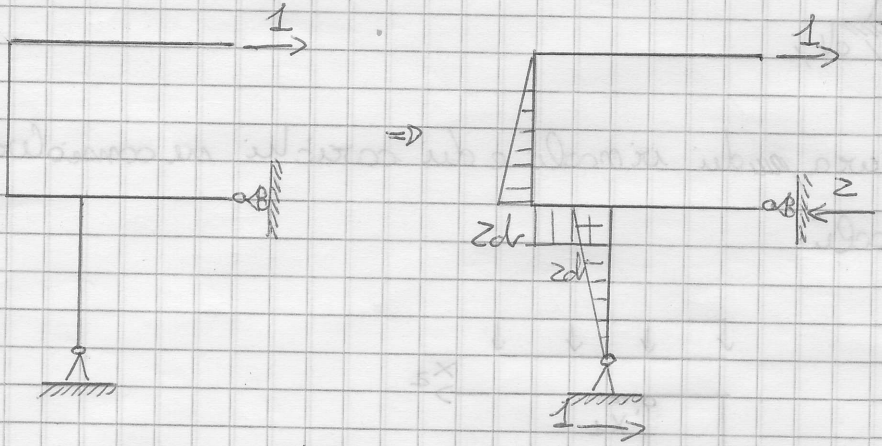
(a)



(1)



(2)



$$y_{10} = \int_{\Omega} \frac{M_1 M_0}{EJ}\,dz = \frac{1}{EJ}\left[\int_0^{dv} z\left(-2qdv^2 - q\frac{z^2}{2} - 2qdvz\right)dz + dv\left(-\frac{9}{2}qdv^2\right)2dv + \int_0^{dv}(dv-z)\left(-\frac{9}{2}qdv^2 + 3qdz\right)dz\right] = -\frac{301}{24}qdv^4$$

$$y_{20} = \int_{\Omega} \frac{M_2 M_0}{EJ}\,dz = \frac{1}{EJ}\left[\frac{1}{2}(-2dv)\left(-\frac{9}{2}qdv^2\right)2dv + \int_0^{dv}(-2dv)\left(-\frac{9}{2}qdv^2 + 3qdz\right)dz + \frac{1}{2}2dv\frac{3}{2}qdv^2 2dv\right] = \frac{17}{EJ}qdv^4$$

$$y_{11} = \int_{\Omega} \frac{M_1^2}{EJ}\,dz = \frac{1}{EJ}\left[\frac{1}{3}dv^2 dv \cdot 2 + dv^2 2dv\right] = \frac{dv^3}{EJ}\left[\frac{2}{3} + 2\right] = \frac{8dv^3}{3EJ}$$

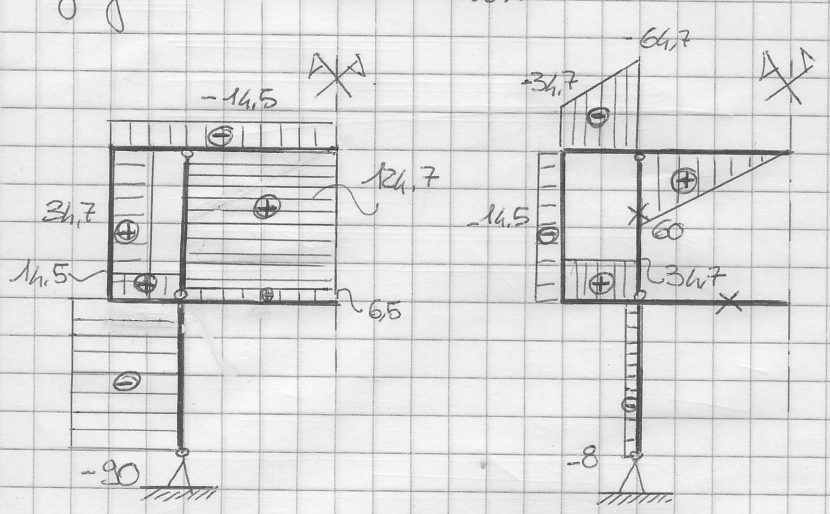
$$y_{22} = \int_{\Omega} \frac{M_2^2}{EJ}\,dz = \frac{1}{EJ}\left[\frac{1}{3}(2dv)^2 2dv \cdot 2 + (2dv)^2 dv\right] = \frac{dv^3}{EJ}\left[\frac{16}{3} + 4\right] = \frac{28dv^3}{3EJ}$$

$$y_{12} = \int_{\Omega} \frac{M_1 M_2}{EJ}\,dz = \frac{1}{EJ}\left[\frac{1}{2}dv(-2dv)2dv + \frac{1}{2}dv(-2dv)2dv\right] = \frac{dv^3}{EJ}\left[-2-1\right] = -\frac{3dv^3}{EJ}$$

$$\begin{bmatrix} \frac{8}{3} & -3 \\ -3 & \frac{28}{3} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} \frac{301}{24}qdv \\ -17qdv \end{bmatrix}$$

$X_1 = 12{,}47$ kN $\qquad X_2 = -1{,}45$ kN

Grafici delle sollecitazioni



Ⓝ [kN] Ⓣ [kN] Ⓜ [kN m]

Progetto della struttura

$$W_{min} = \frac{M_{max}}{\sigma_{am}} = \frac{90}{260 \cdot 10^6} \cdot 10^6 = 346{,}2\ cm^3 \Rightarrow HEB\,180$$

Si considera ora la deformabilità assiale delle aste ID e HF. L'unico termine non nullo è il seguente

$$\gamma_{11}^{a} = \int_0^{2d} \frac{N_1^2}{EA}\,dz = \frac{1 \cdot 2d}{EA}$$

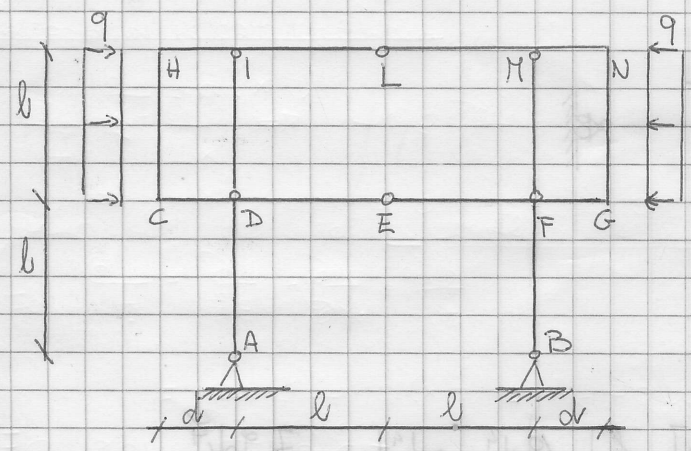
tramite il quale si ricavano i nuovi valori di X_1 e X_2

$$\begin{bmatrix} \frac{8}{3} + \frac{2J}{d^2A} & -3 \\ -3 & \frac{28}{3} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} \frac{301}{24} qd \\ -17qd \end{bmatrix}$$

$X_1 = 12{,}66\ kN$

$X_2 = -14{,}9\ kN$

FILA B



$l = 3\ m$

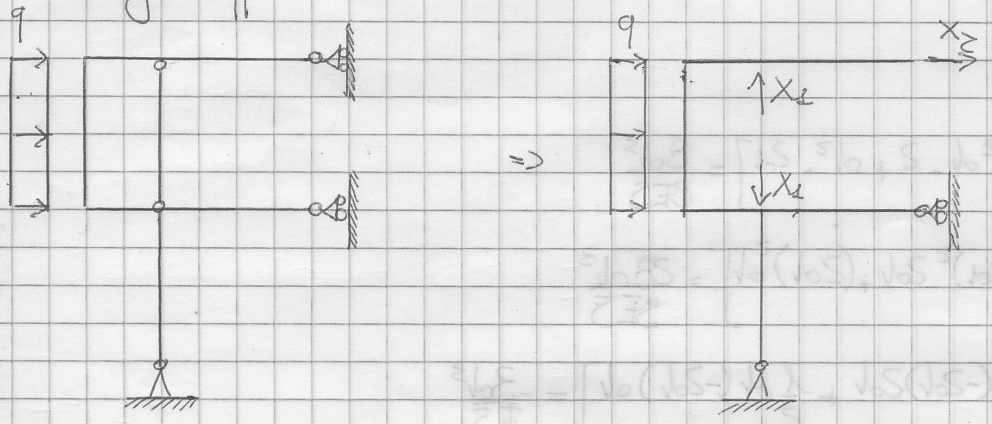
$d = 1{,}5\ m$

$q = 40\ kN/m$

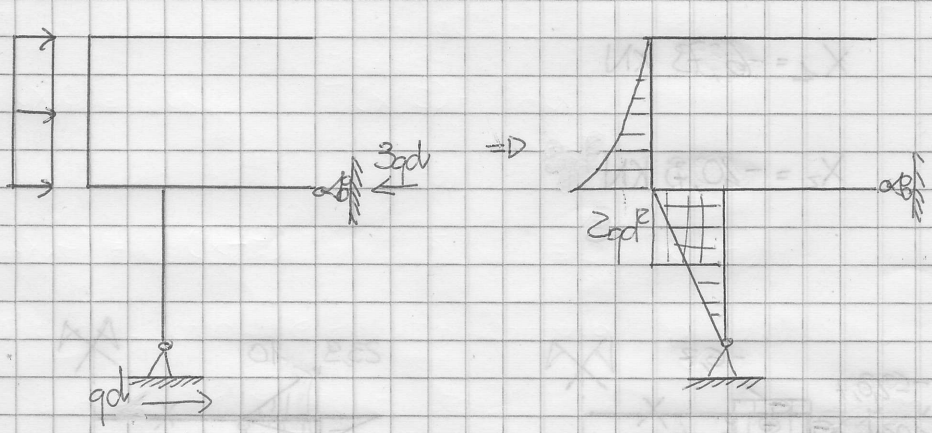
$E = 210\ GPa$

$\sigma_{amm} = 260\ MPa$

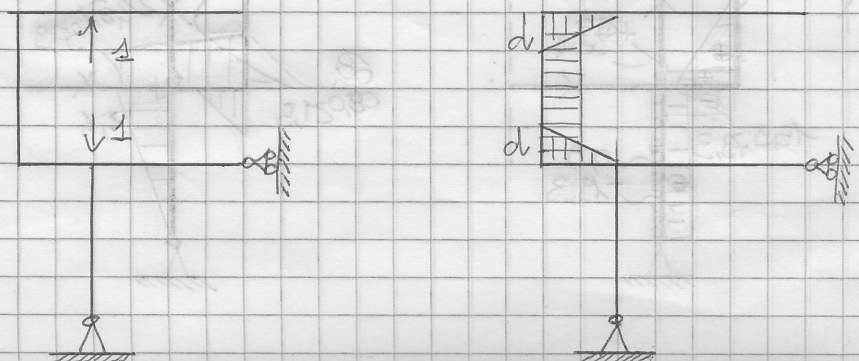
Data la simmetria della struttura, dei vincoli e dei carichi ne considero solo metà con gli opportuni vincoli.



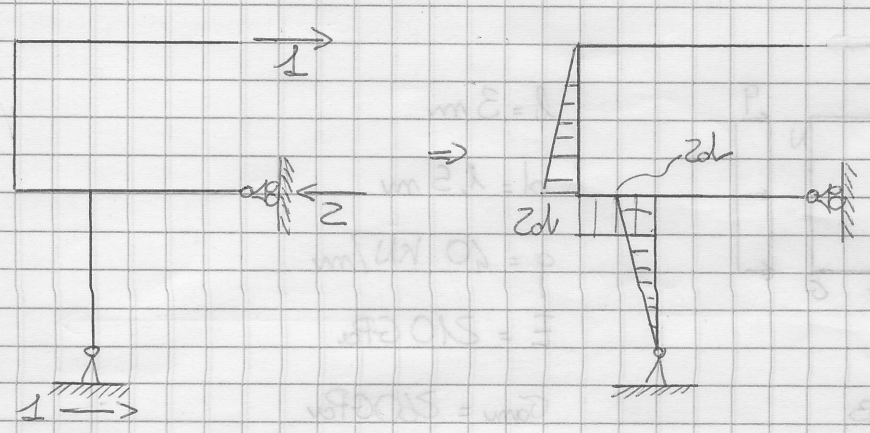
(0)



(1)



(z)



$$\eta_{10} = \int_\Omega \frac{M_1 M_0}{EJ}\,dz = \frac{1}{EJ}\left[\int_0^{2d} dv\left(-q\frac{z^2}{2}\right)dz - \frac{1}{2}\,dv\,2qd^2dv\right] = \frac{1}{EJ}\left[-\frac{4qd^4}{3} - qdv^4\right] = -\frac{7}{3}\frac{qdv^4}{EJ}$$

$$\eta_{20} = \int_\Omega \frac{M_2 M_0}{EJ}\,dz = \frac{1}{EJ}\left[\int_0^{2d}(-z)\left(-q\frac{z^2}{2}\right)dz + 2dv\,2qd^2dv + \frac{1}{3}\,2dv\,2qd^2\,2dv\right] = \frac{1}{EJ}\left[2qd^4 + 4qd^4 + \frac{8}{3}qdv^4\right]$$

$$= \frac{26}{3EJ}qdv^4$$

$$\eta_{11} = \int_\Omega \frac{M_1^2}{EJ}\,dz = \frac{1}{EJ}\left[\frac{1}{3}d^2dv\cdot 2 + d^2\cdot 2dv\right] = \frac{8dv^3}{3EJ}$$

$$\eta_{22} = \int_\Omega \frac{M_2^2}{EJ}\,dz = \frac{1}{EJ}\left[\frac{1}{3}(2d)^2\,2dv + (2dv)^2dv\right] = \frac{28dv^3}{3EJ}$$

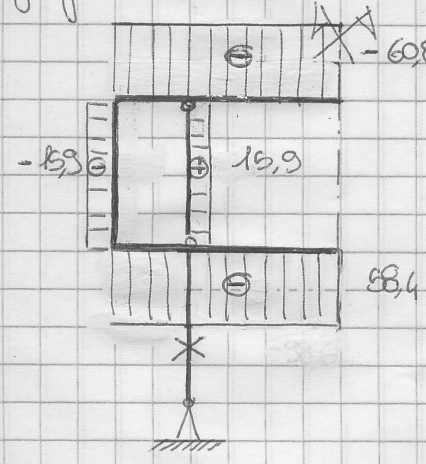
$$\eta_{12} = \int_\Omega \frac{M_1 M_2}{EJ}\,dz = \frac{1}{EJ}\left[\frac{1}{2}dv(-2dv)2dv + \frac{1}{2}dv(-2dv)dv\right] = -\frac{3dv^3}{EJ}$$

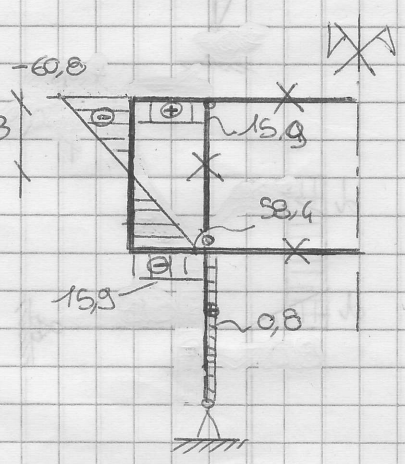
$$\begin{bmatrix} \frac{8}{3} & -3 \\ -3 & \frac{28}{3} \end{bmatrix}\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} \frac{7}{3}qdv \\ -\frac{26}{3}qdv \end{bmatrix}$$

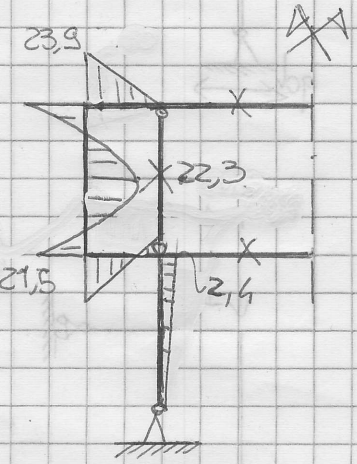
$X_1 = -15{,}9$ kN

$X_2 = -60{,}8$ kN

Grafici delle sollecitazioni







Pagetto della sezione

$$W_{min} = \frac{M_{max}}{\sigma_{am}} = \frac{23,9}{260 \cdot 10^3} 10^6 = 91,9\ cm^3 \Rightarrow IPE\ 160$$

Si considera ora la deformabilità assiale delle aste ID e HF. L'unica componente non nulla è la seguente

$$v_{11}^{a} = \int_0^{2d} \frac{N_1^2}{EA} dz = \frac{1 \cdot 2d}{EA}$$

tramite il quale si ricavano i nuovi valori di X_1 e X_2

$$\begin{bmatrix} \frac{8}{3} + \frac{2\delta}{d^2 A} & -3 \\ -3 & \frac{28}{3} \end{bmatrix} \begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} = \begin{bmatrix} \frac{7}{3} qd \\ -\frac{26}{3} qd \end{bmatrix}$$

$X_1 = -15,92\ kN$ $\qquad$ $X_2 = -60,83\ kN$