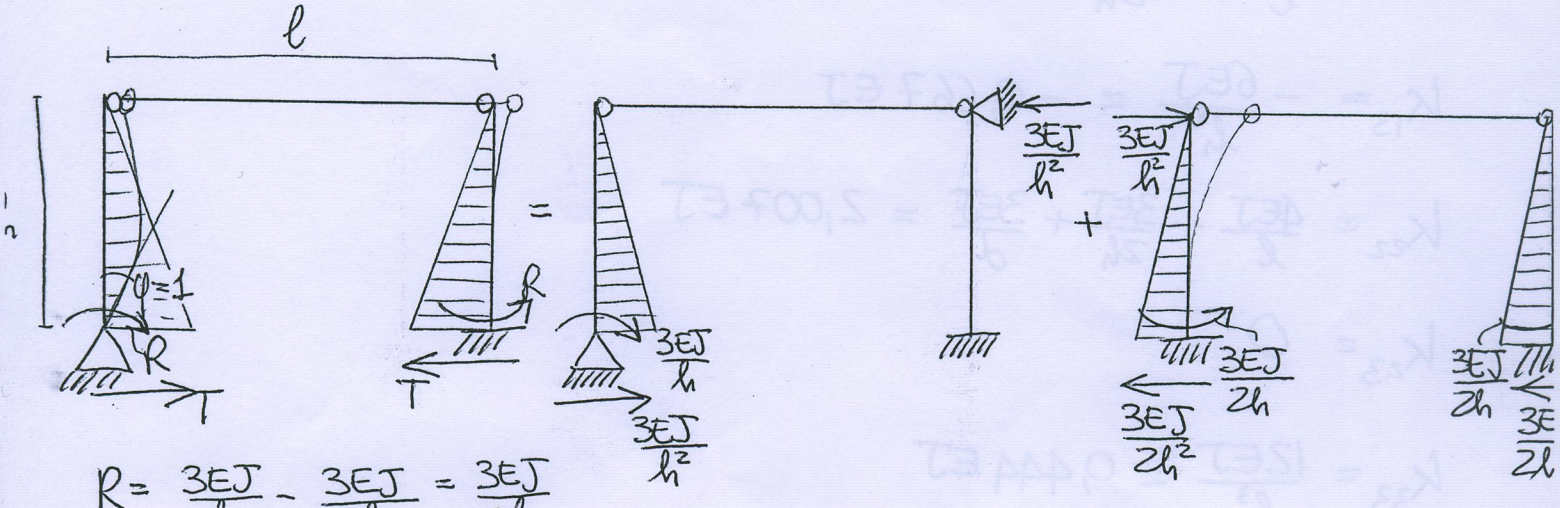
METODO SPOSTAMENTI

P = 20kN
q = 30 kN/m
l = 5m
h = 3m

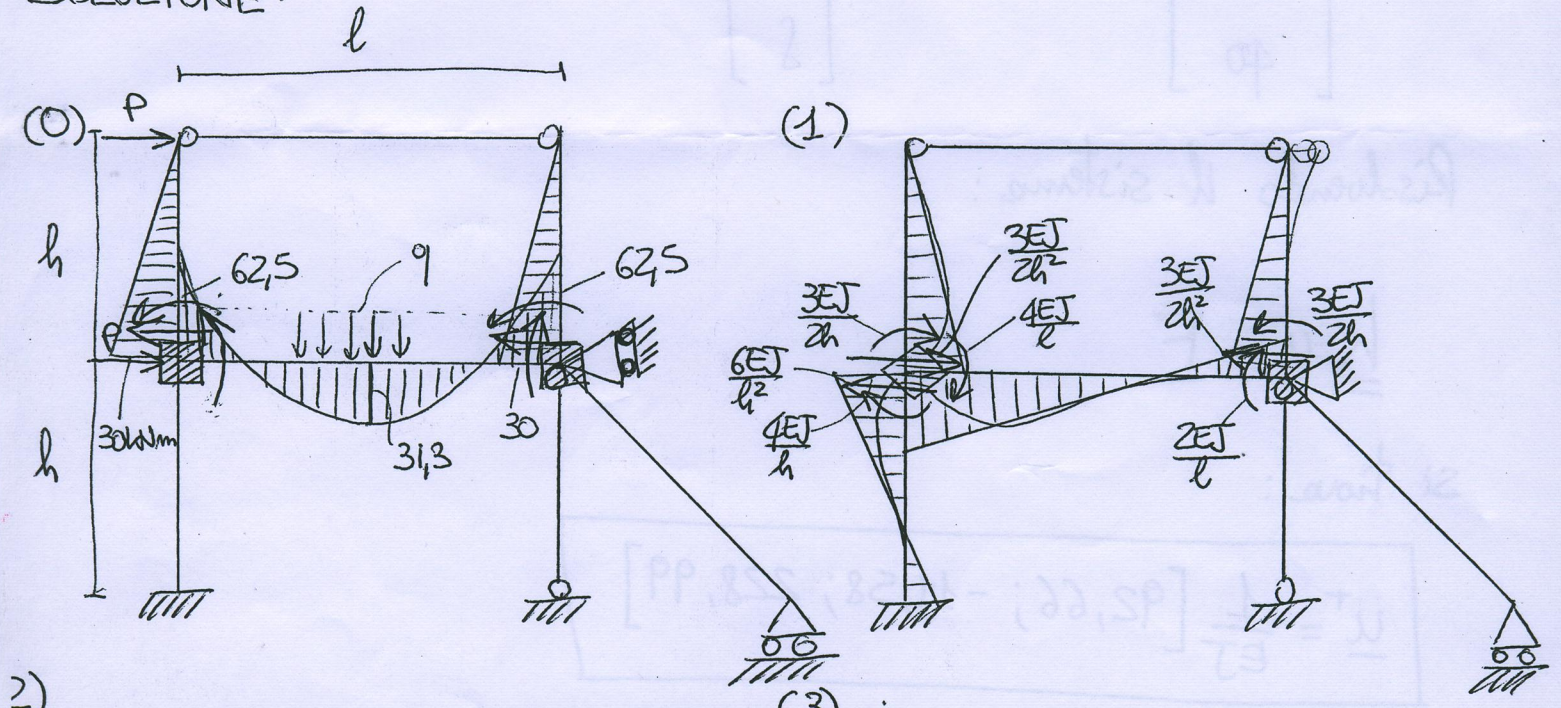
PREMESSA:

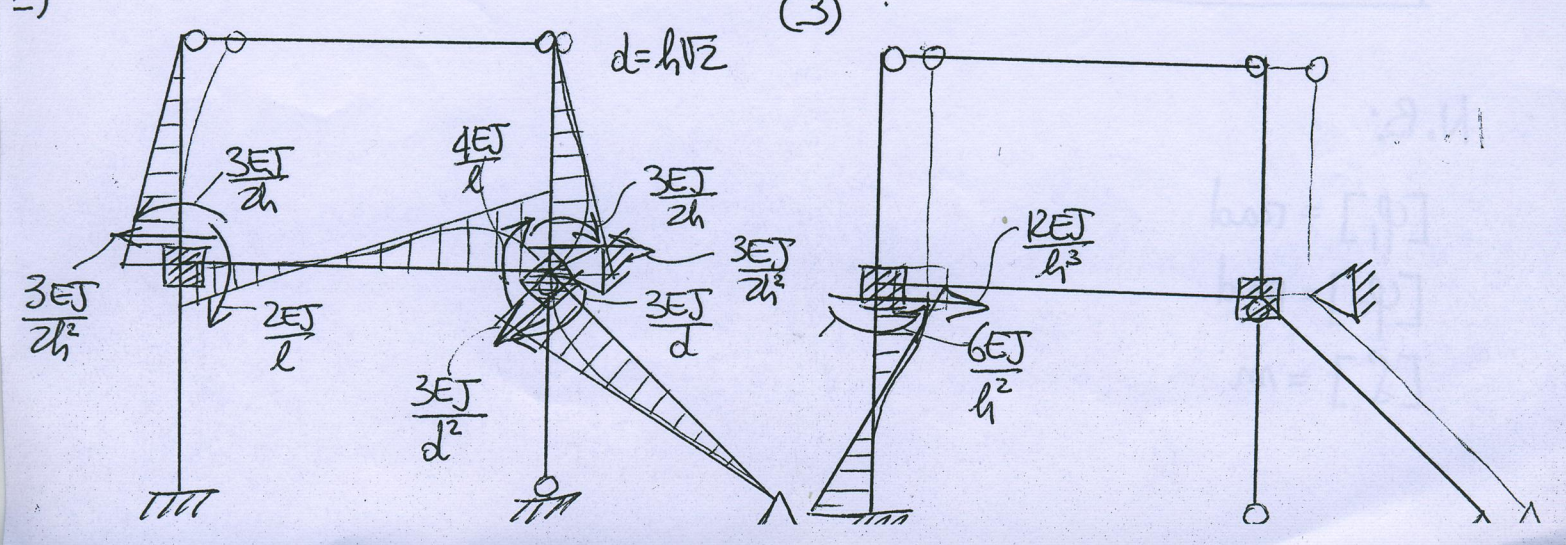


$$R = \frac{3EJ}{h} - \frac{3EJ}{2h} = \frac{3EJ}{2h}$$

$$T = \frac{3EJ}{h^2} - \frac{3EJ}{2h^2} = \frac{3EJ}{2h^2}$$

SOLUZIONE:





$$k_{12} = \frac{2EJ}{l} - \frac{3EJ}{2h} = -0{,}1\,EJ$$

$$k_{13} = -\frac{6EJ}{h^2} = -0{,}667\,EJ$$

$$k_{22} = \frac{4EJ}{l} + \frac{3EJ}{2h} + \frac{3EJ}{d} = 2{,}007\,EJ$$

$$k_{23} = 0$$

$$k_{33} = \frac{12EJ}{h^3} = 0{,}444\,EJ$$

$$\underline{F} = \begin{bmatrix} 92{,}5 \\ -325 \\ 40 \end{bmatrix} \qquad \underline{u} = \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \delta \end{bmatrix}$$

Risolvendo il sistema:

$$\underline{\underline{K}}\,\underline{u} = \underline{F}$$

si trova:

$$\boxed{\underline{u}^T = \frac{1}{EJ}\left[92{,}66;\ -11{,}58;\ 228{,}99\right]}$$

N.B.:

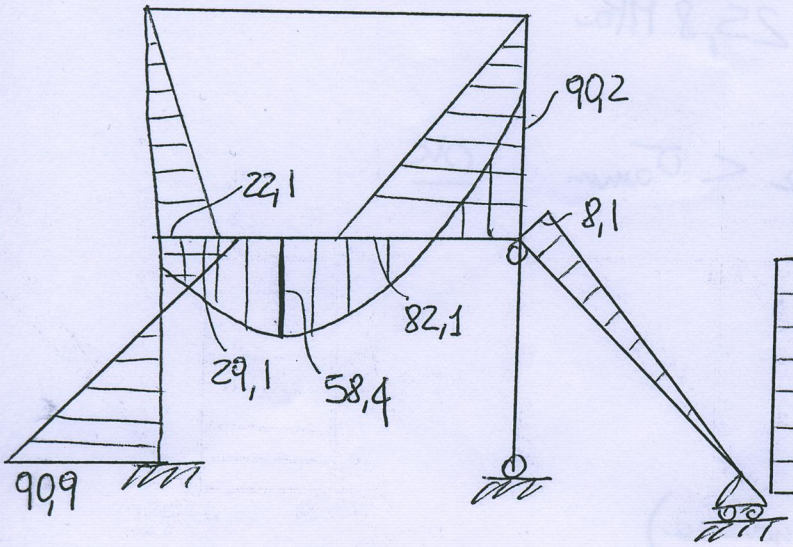
$[\varphi_1] = \text{rad}$

$[\varphi_2] = \text{rad}$

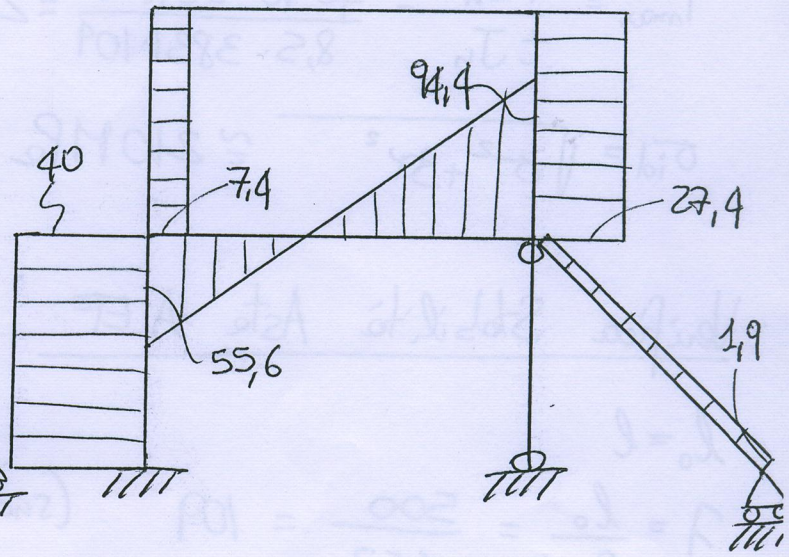
$[\delta] = m$

Diagrammi:

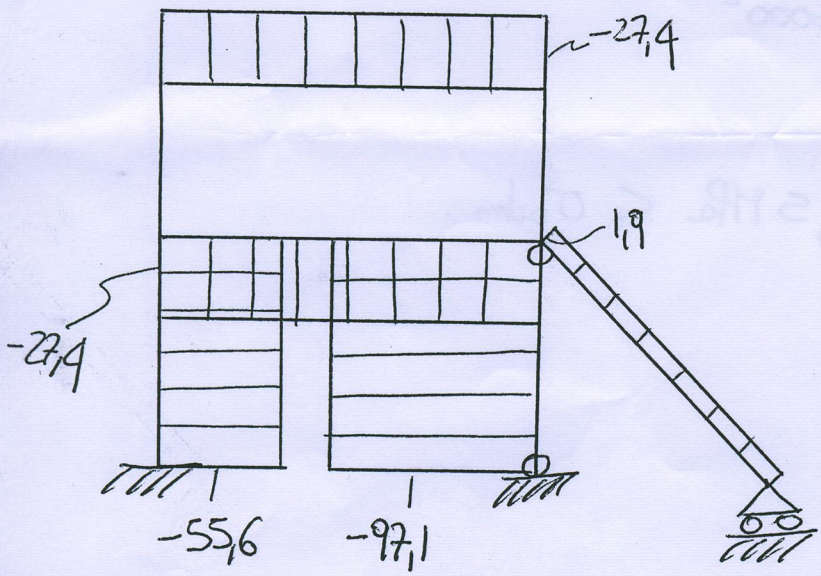
(M) (kNm)



(T) (kN)



(N) (kN)



Progetto:

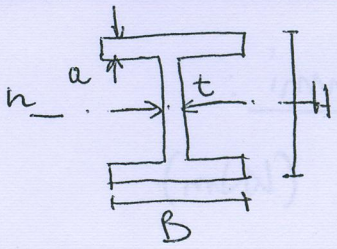
$M_{max} = 90,9\ kNm \Rightarrow W_{min} = \frac{M_{max}}{\sigma_{amm}} = \frac{90,9 \cdot 10^6}{260} = 349615\ mm^3$

Si sceglie HEB 180. ($A = 6530\ mm^2$; $W = 426000\ mm^3$)

Verifica nella sezione A

$\sigma_{comp} = \frac{N}{A} - \frac{M}{W} = \frac{-55,6 \cdot 10^3}{6530} - \frac{90,9 \cdot 10^6}{426000} = -204,9\ MPa$

④



$$S_n = aB\frac{(H-a)}{2} + \frac{t}{2}(H-2a) = 209806\ mm^3$$

$$\tau_{max} = \frac{TS_n}{tJ_n} = \frac{40\cdot10^3\cdot209806}{8,5\cdot3831\cdot10^4} = 25,8\ MPa$$

$$\sigma_{id} = \sqrt{\sigma^2+3\tau^2} \cong 210\ MPa < \sigma_{amm} \quad \underline{ok}$$

Verifica Stabilità Asta AEF:

$$l_0 = l$$

$$\lambda = \frac{l_0}{\rho_{min}} = \frac{500}{4,57} = 109 \quad (snellezza)$$

$$P_{cr} = \frac{\pi^2\cdot E\cdot J_{min}}{l_0^2} = \frac{\pi^2\cdot210000\cdot1363\cdot10^4}{5000^2} = 1130\ kN < N = -27,4\ kN$$

Metodo ω:

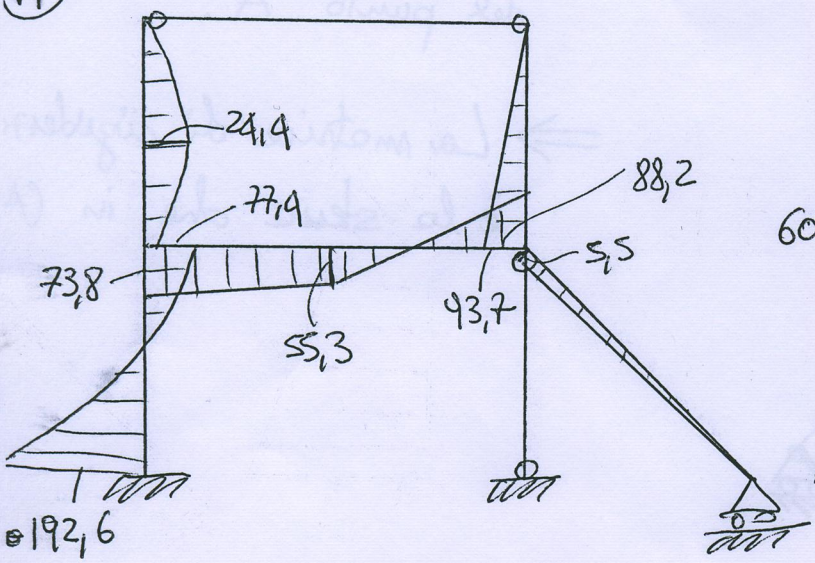
$$\sigma_{max} = \frac{-27,4\cdot10^3}{6530}\cdot\underbrace{2,02}_{\omega} \cong 8,5\ MPa < \sigma_{adm}.$$

Spostamento Punto B:

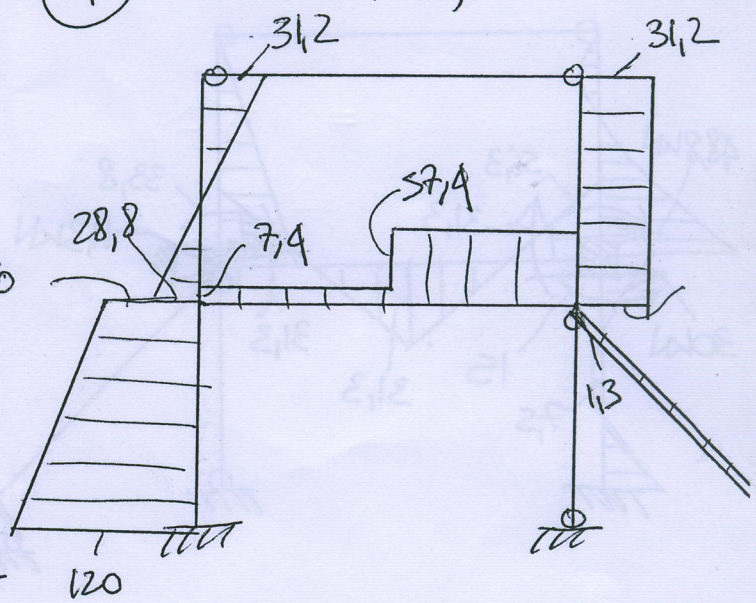
$$u_B = 28\ mm$$

Il punto B si svolge allo stesso modo. Riporto di seguito i risultati:

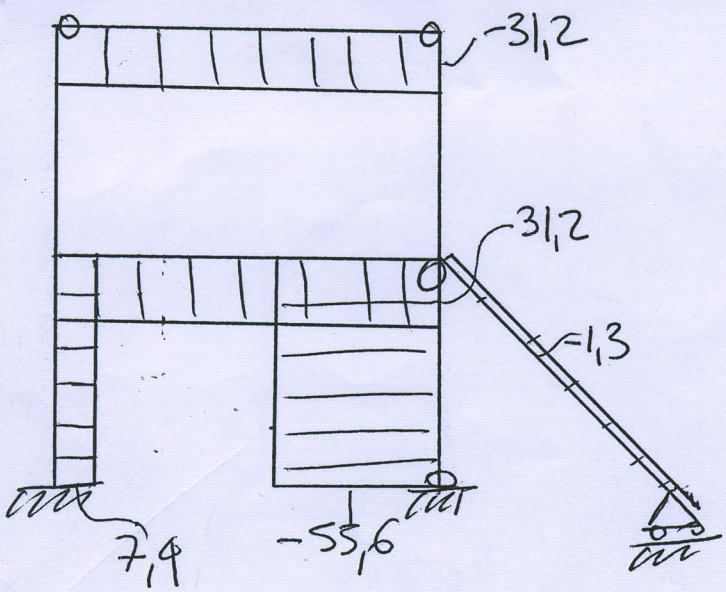
(M) (kN,m)



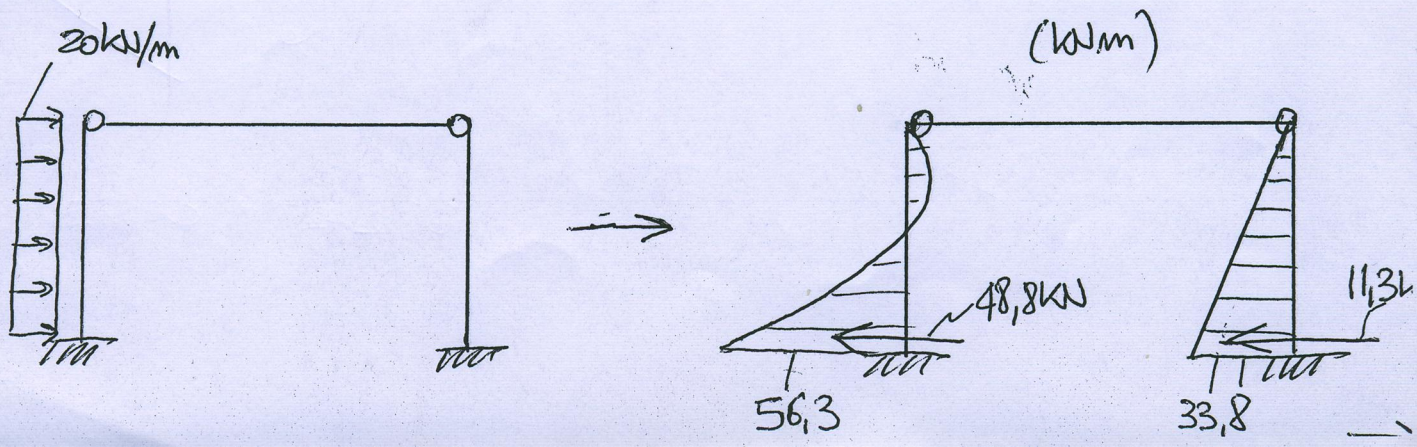
(T) (kN)



(N) (kN)

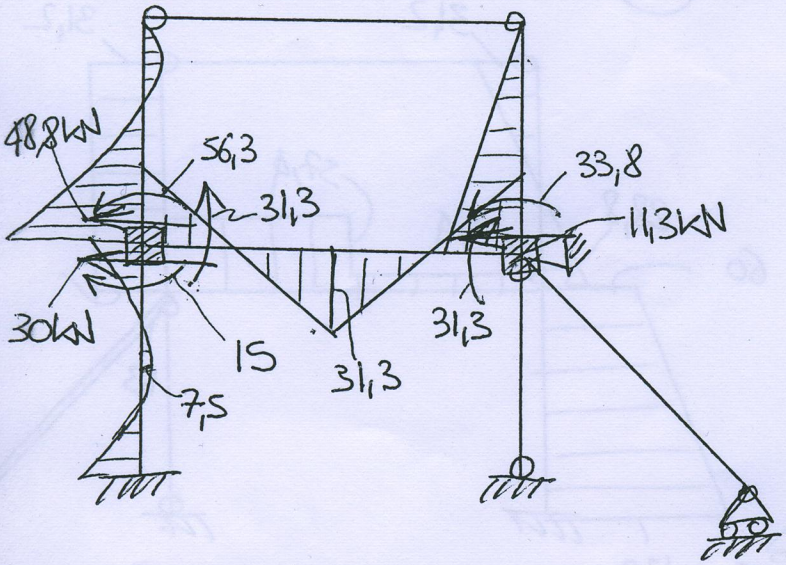


Dss//



(0)

(kN.m)



I sistemi (1), (2) e (3) sono uguali a quelli del punto A.

$\Rightarrow$ La matrice di rigidezza è la stessa che in (A

Cambia il vettore F che vale adesso:

$$F = \begin{bmatrix} 72,6 \\ 2,5 \\ 90,1 \end{bmatrix}$$

Risolvendo il sistema:

$$\underline{\underline{K}}\,\underline{u} = \underline{F}$$

si trova:

$$\underline{u}^T =$$