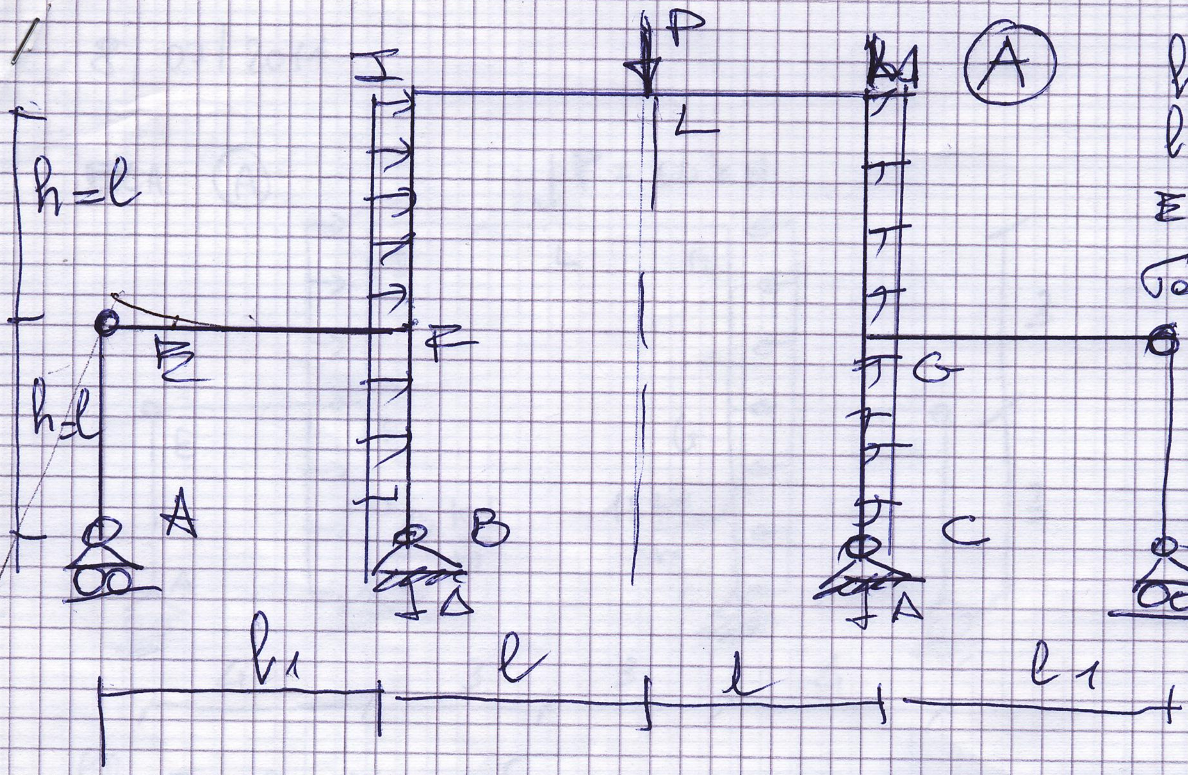


$h = l = 3\,m$

$l_1 = 4\,m$

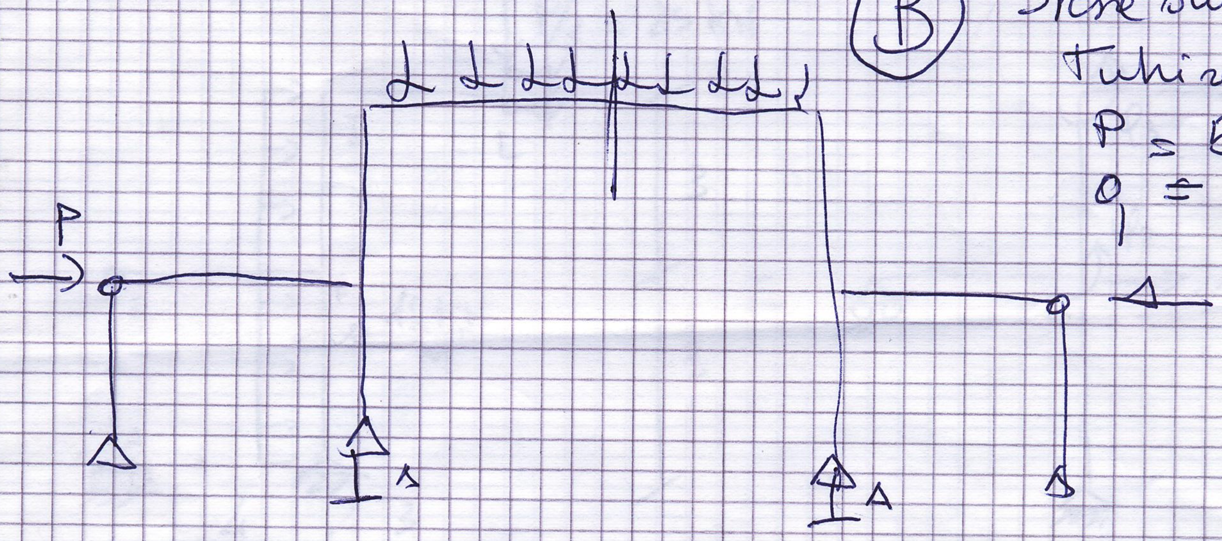
$E = 210'000\ N/mm^2$

$\sigma_{am} = 260\ N/mm^2$

(Tubi quadri)

$P = 50\ KN$

$q = 15\ KN/m$



Stere alluminio

Tubi rettangolari

$P = 60\ KN$

$q = 25\ KN/m$

A) Risolvere il telaio simmetrico e caricato simmetricamente in figura (se questo fosse e eventualmente trascurare la deformabilità assiale delle aste)

B) Disegna i diagrammi dell'equilibrio

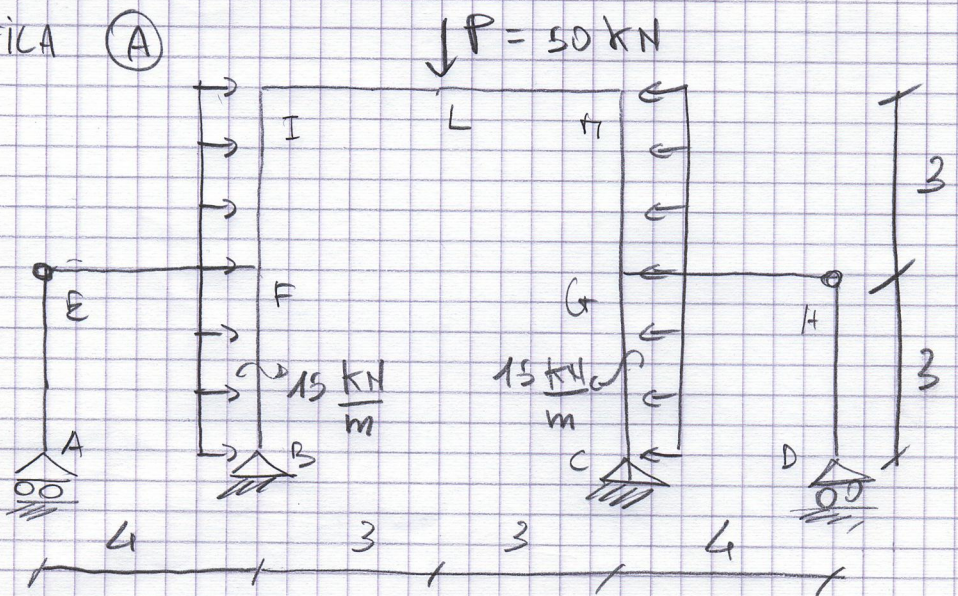
C) progettare con il profilato indicato e verificare l'ammissibilità dello stato tensionale

D) Considerare l'effetto di un cedimento verticale $\Delta = 2\,cm$

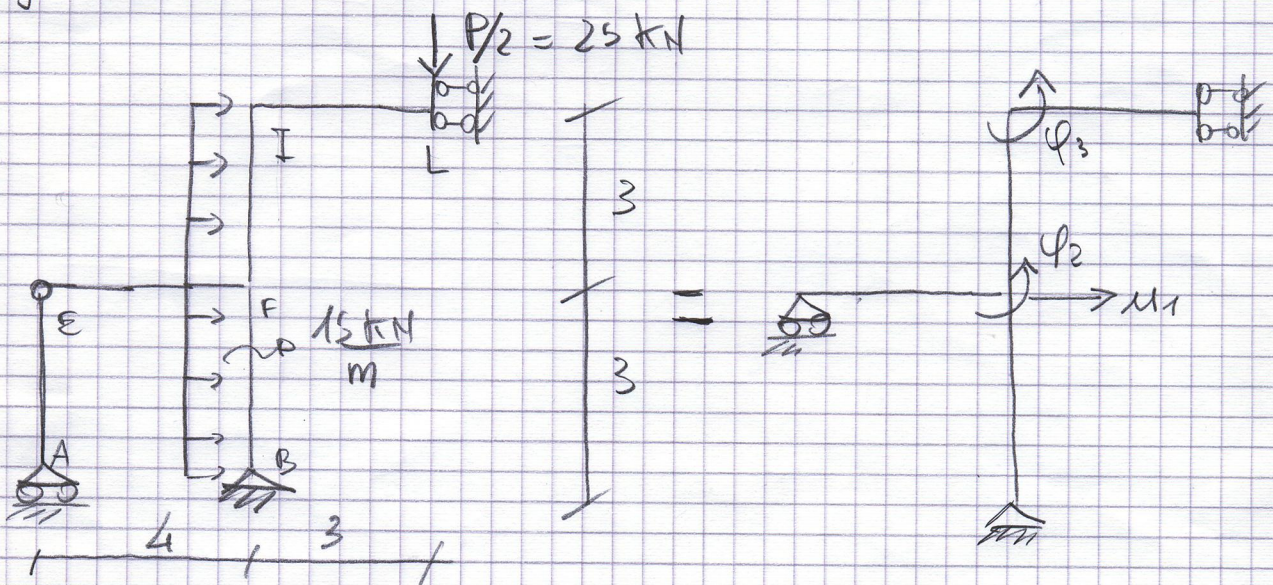
E) Calcolare lo spostamento verticale del punto A

8/07/2011

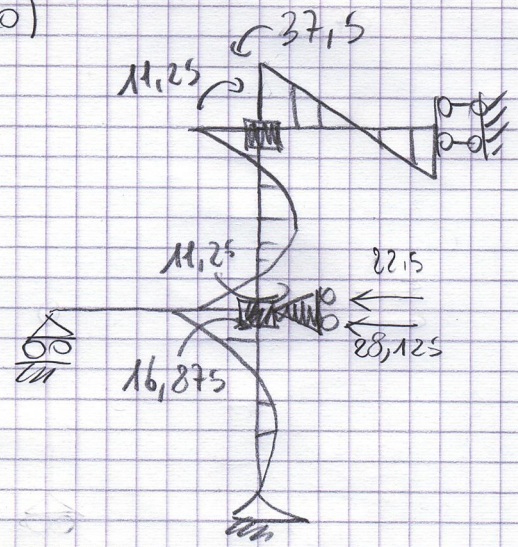
FILA (A)



Sfrutto la simmetria



(0)

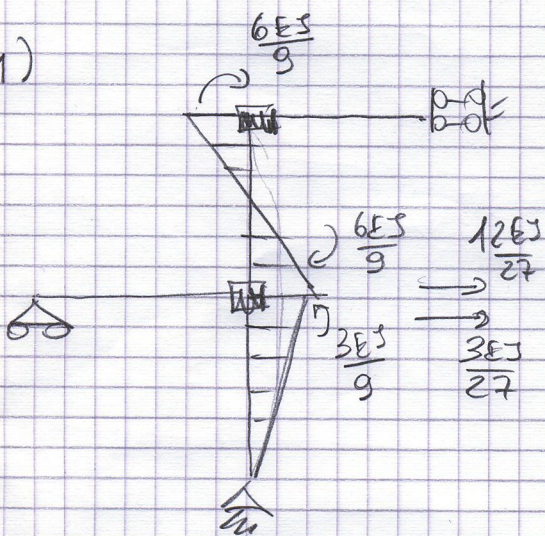


$$K_{10} = -50,625$$

$$K_{20} = -5,625$$

$$K_{30} = 26,25$$

(1)

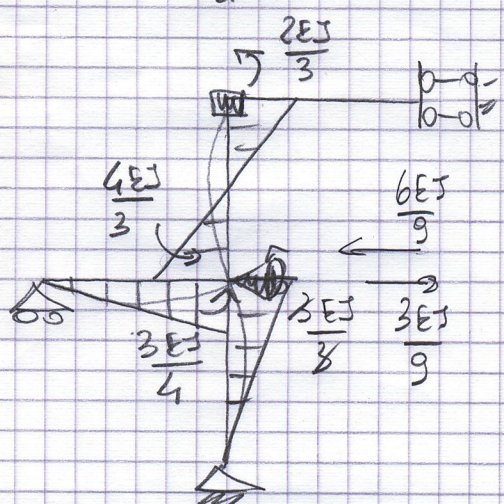


$$K_{11} = \frac{15}{27} EJ$$

$$K_{12} = -\frac{3}{9} EJ$$

$$K_{13} = -\frac{6EJ}{9}$$

(2)

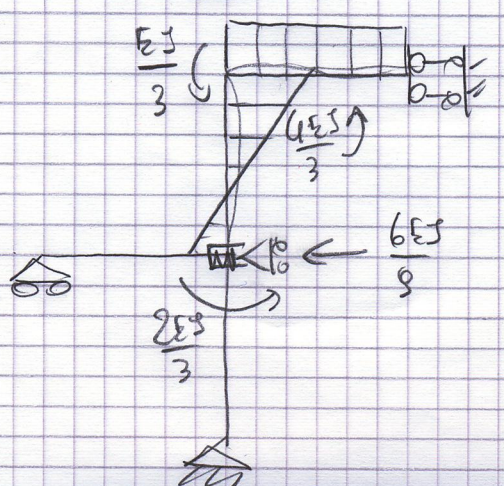


$$K_{21} = -\frac{3EJ}{9}$$

$$K_{22} = EJ + \frac{4}{3}EJ + \frac{3}{4}EJ = \frac{37}{12} EJ$$

$$K_{23} = \frac{2}{3} EJ$$

(3)



$$K_{31} = -\frac{6EJ}{9}$$

$$K_{32} = \frac{2EJ}{3}$$

$$K_{33} = \frac{4EJ}{3} + \frac{EJ}{3} = \frac{5EJ}{3}$$

$$EJ\begin{pmatrix} 15/27 & -3/9 & -6/9 \\ -3/9 & 37/12 & 2/3 \\ -6/9 & 2/3 & 5/3 \end{pmatrix}\begin{pmatrix} \mu_1 \\ \varphi_2 \\ \varphi_3 \end{pmatrix} = \begin{pmatrix} 50,625 \\ 5,625 \\ -26,25 \end{pmatrix}$$

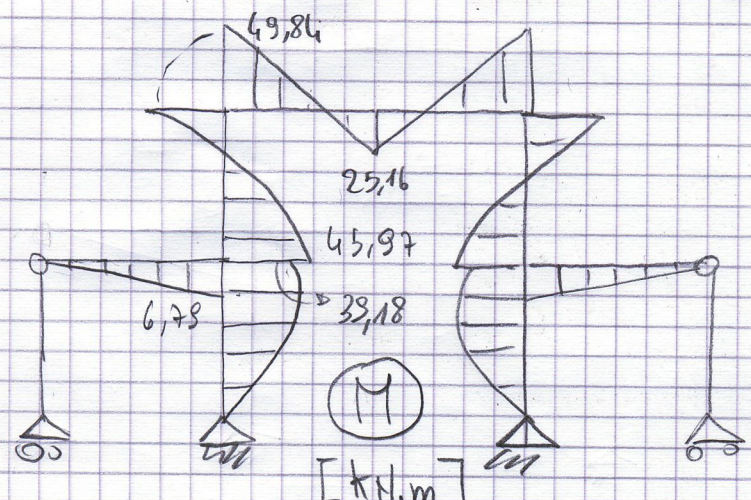
$$\begin{pmatrix} \mu_1 \\ \varphi_2 \\ \varphi_3 \end{pmatrix} = \frac{1}{EJ}\begin{pmatrix} 140,985 \\ 9,062 \\ 37,02 \end{pmatrix}$$

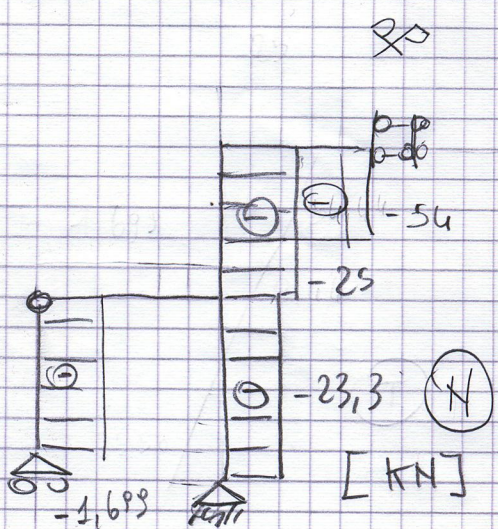
$$M_{FE} = \frac{3}{4}\cdot 9,062 = 6,79$$

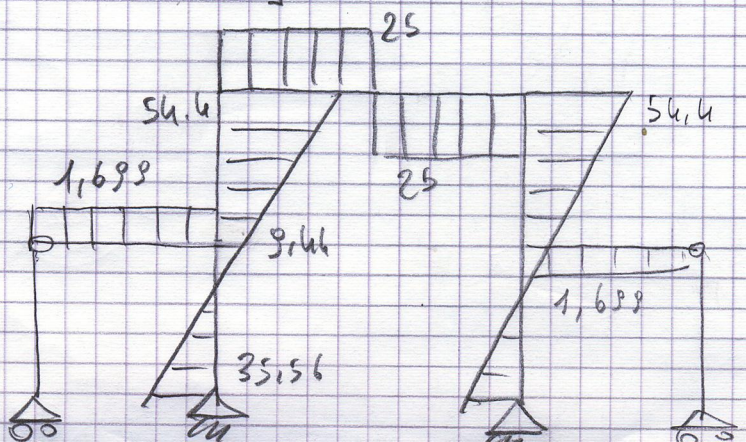
$$M_{FB} = -16,875 + \frac{3}{9}(140,985) + 1(9,062) = 39,18$$

$$M_{FI} = -11,25 + \frac{6}{9}(140,985) - \frac{4}{3}(9,062) - \frac{2}{3}(37,02) = 45,97$$

$$M_{IL} = -37,5 - \frac{1}{3}(37,02) = -49,84$$







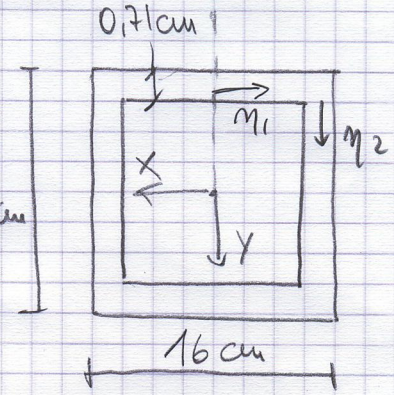
Progetto

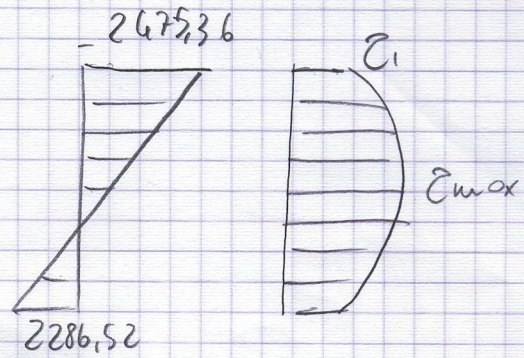
$M_{max} = 49,84$ kN.m

$$W_{min} = \frac{49,84 \cdot 10^4}{2600} = 191,7 \text{ cm}^3 \Rightarrow \text{Tubo } h = 160 \text{ mm}, \; s = 7,1 \text{ mm}$$

Verifica

$M = 49,84$ kN.m
$T = 25$ kN
$N = -54$ kN
$W_x = 212$ cm³
$J_x = 1696$ cm⁴
$A = 43,4$ cm²





$$\sigma_{max} = \frac{N}{A} \pm \frac{M}{W_x} = -\frac{5400}{43,4} \pm \frac{49,84 \cdot 10^4}{212}$$

$\sigma_{max}^{+} = 2286,52$ kg/cm²

$\sigma_{max}^{-} = -2475,36$ "

$$S_1 = -0,71 \cdot \eta_1 \cdot \left(8 - \frac{0,71}{2}\right) \Rightarrow S_{1max} = S_1(\eta_1 = 8) = -43,42 \text{ cm}^3$$

$$\tau_1 = -\frac{T \, S_1}{b \cdot J_x} = \frac{-2500 \cdot (-43,42)}{0,71 \cdot 1696} = 90,15 \text{ kg/cm}^2$$

$$S_2 = -0,71 \cdot \eta_2 \cdot \left(7,29 - \frac{\eta_2}{2}\right) \Rightarrow S_{2max} = S_2(\eta_2 = 7,29) = -18,87 \text{ cm}^3$$

$$\tau_{max} = \tau_1 + \frac{2500 \cdot 18,87}{0,71 \cdot 1696} = 129,33 \text{ kg/cm}^2$$

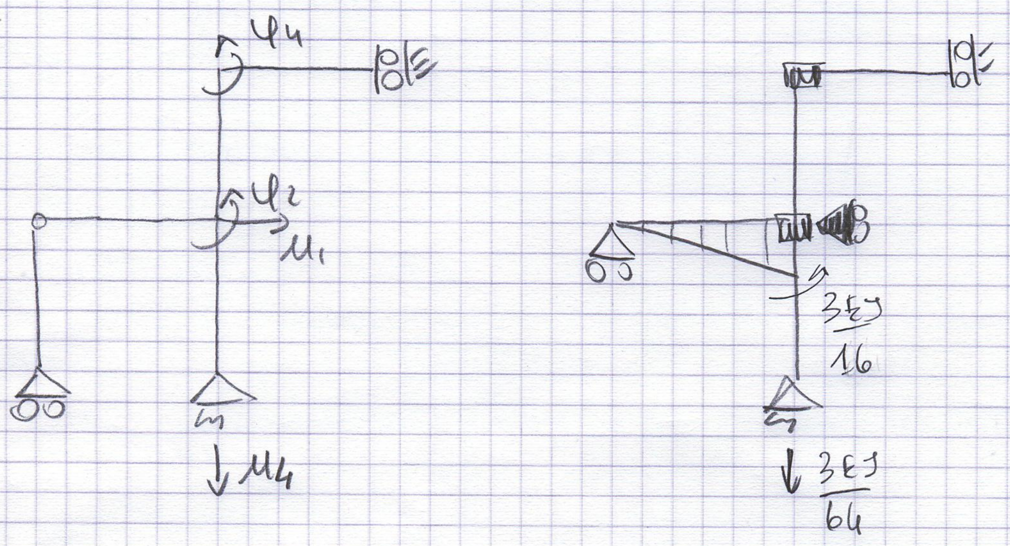
$|\sigma_{max}| = 2475,36$ kg/cm² < 2600 kg/cm²

$|\tau_{max}| = 129,33$ " $< \sigma_{am}/\sqrt{3}$

$$\sigma_{id} = \sqrt{\sigma_{max}^2 + 3\tau_1^2} = 2485,42 \text{ kg/cm}^2 < \sigma_{am}$$

Effetto del cedimento

Aggiungo uno spostamento



$K_{41} = 0$

$K_{42} = \frac{3}{16} EJ$

$K_{43} = 0$

$K_{44} = \frac{3EJ}{64}$

devo inoltre aggiungere $K_{40} = -25$

$$EJ \begin{pmatrix} 15/27 & -3/9 & -6/9 & 0 \\ -3/9 & 37/12 & 2/3 & 3/16 \\ -6/9 & 2/3 & 5/3 & 0 \\ 0 & 3/16 & 0 & 3/64 \end{pmatrix} \begin{pmatrix} u_1 \\ \varphi_2 \\ \varphi_3 \\ 0{,}02 \end{pmatrix} = \begin{pmatrix} 50{,}625 \\ 5{,}625 \\ -26{,}25 \\ 25 \end{pmatrix}$$

$$EJ \begin{pmatrix} 15/27 & -3/9 & -6/9 \\ -3/9 & 37/12 & 2/3 \\ -6/9 & 2/3 & 5/3 \end{pmatrix} \begin{pmatrix} u_1 \\ \varphi_2 \\ \varphi_3 \end{pmatrix} \begin{matrix} = \\ = \\ = \end{matrix} \begin{pmatrix} 50{,}625 \\ 5{,}625 - 0{,}00375 EJ \\ -26{,}25 \end{pmatrix}$$

$$\begin{pmatrix} u_1 \\ \varphi_2 \\ \varphi_3 \end{pmatrix} = \begin{pmatrix} 139{,}422 \\ 2{,}286 \\ 39{,}104 \end{pmatrix}$$

$-13{,}356$

$$M_{FE} = \frac{3}{4}(2{,}286) + \frac{3}{16} \cdot 0{,}02 \cdot E.J = 15{,}07$$

$$M_{FB} = -16{,}875 + \frac{3}{9}(139{,}422) + 1(2{,}286) = 31{,}88$$

$$M_{F1} = -11,25 + \frac{6}{9}(139,422) - \frac{4}{3}(2,286) - \frac{2}{3}(39,106)$$

$$= 52,58$$

$$M_{1C} = -37,5 - \frac{1}{3}(39,106) = -50,53$$

E) Lo spostamento orizzontale del nodo A, può essere assunto uguale ad u_1