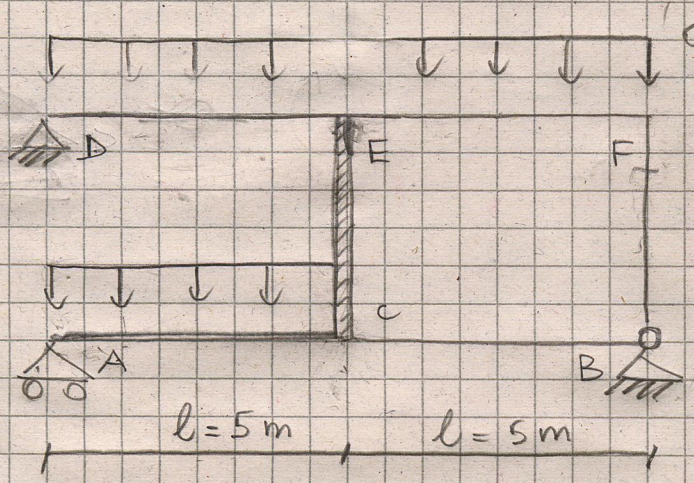
3/12/2010

PROVA (A)

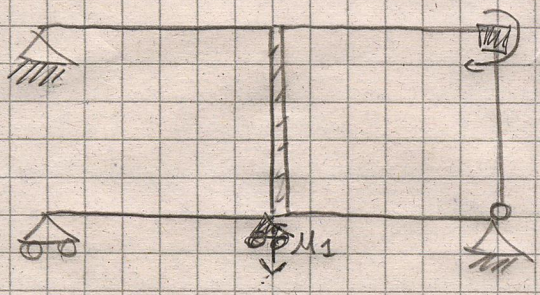


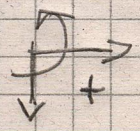
IPE

$\sigma_{adm} = 2600 \frac{kg}{cm^2}$

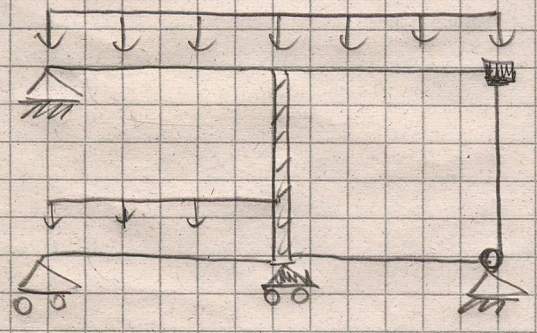
Soluzione con il metodo degli spostamenti

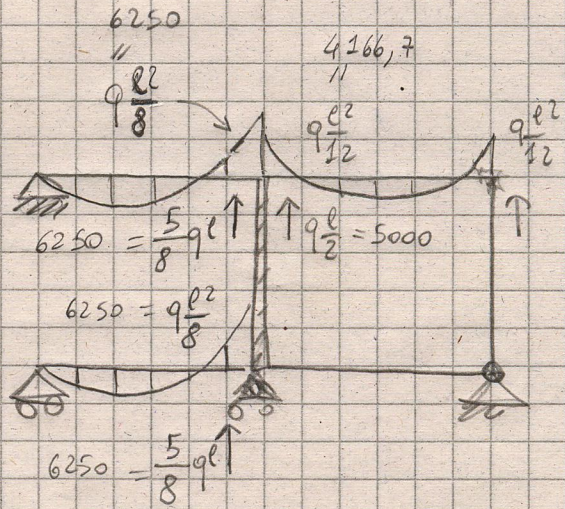
2 spostamenti





SISTEMA 0

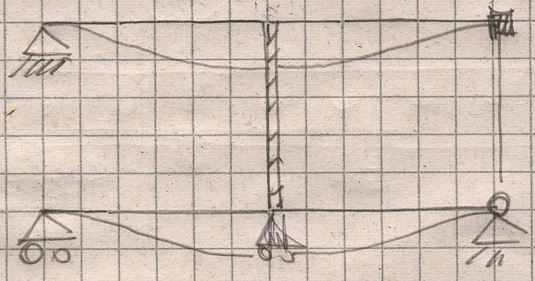


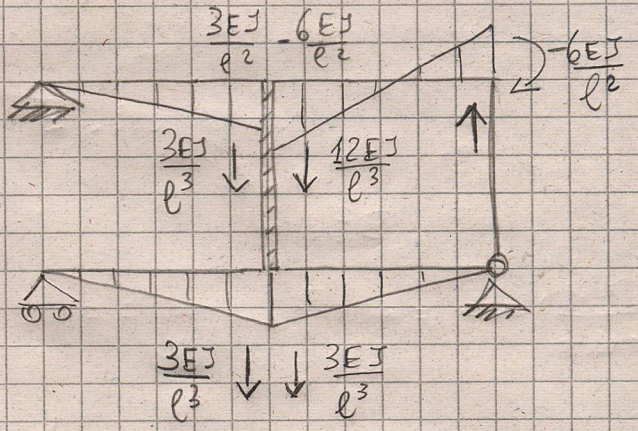


$K_{10} = -2.(6250) - 5000 = -17'500$

$K_{20} = -4166,7$

SISTEMA 1

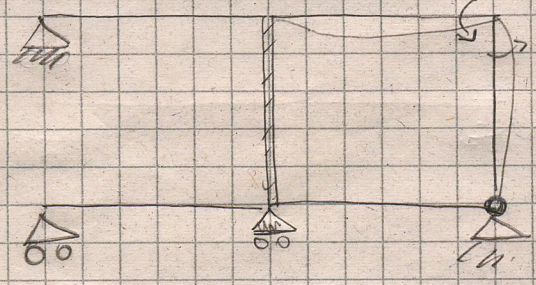


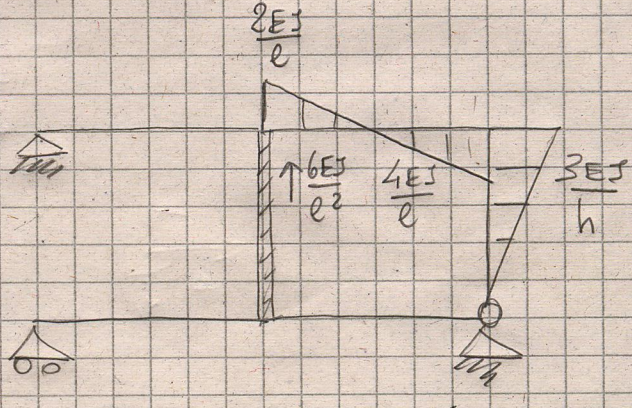


$$K_{11} = \frac{6EJ}{\ell^3} + \frac{15EJ}{\ell^3} = \frac{21}{125} EJ$$

$$K_{12} = -\frac{6EJ}{\ell^2} = -\frac{6}{25} EJ$$

SISTEMA 2





$$K_{12} = -\frac{6EJ}{\ell^2} = -\frac{6}{25} EJ$$

$$K_{22} = \frac{4EJ}{\ell} + \frac{3EJ}{h} = \frac{9}{5} EJ$$

$$EJ \begin{pmatrix} 21/125 & -6/25 \\ -6/25 & 9/5 \end{pmatrix} \begin{pmatrix} u_1 \\ \varphi_2 \end{pmatrix} = \begin{pmatrix} +17.500 \\ +4166,7 \end{pmatrix}$$

$$\Rightarrow \begin{pmatrix} u_1 \\ \varphi_2 \end{pmatrix} = \frac{1}{EJ} \begin{pmatrix} 132.761 \\ 20016,3 \end{pmatrix}$$

$$M_{ED} = -6250 + \frac{132761}{EJ}\left(\frac{3}{25}EJ\right) = 9681$$

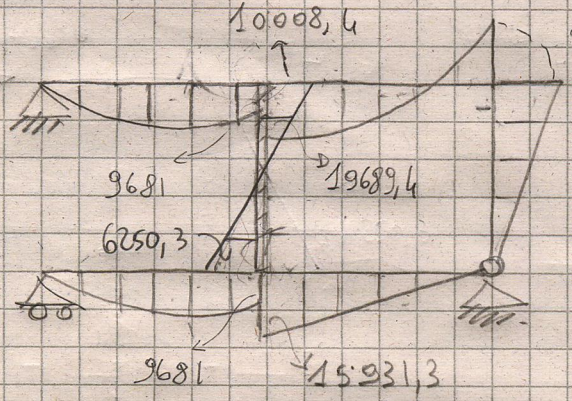
$$M_{EC} = 4166,7 + \frac{132761}{EJ}\left(-\frac{6}{25}EJ\right) + \frac{20016,3}{EJ}\left(\frac{2}{5}EJ\right) = -19689,4$$

$$M_{FE} = -4166,7 + \frac{132761}{EJ}\left(-\frac{6}{25}EJ\right) + \frac{20016,3}{EJ}\left(\frac{4}{5}EJ\right) = -20016,3$$

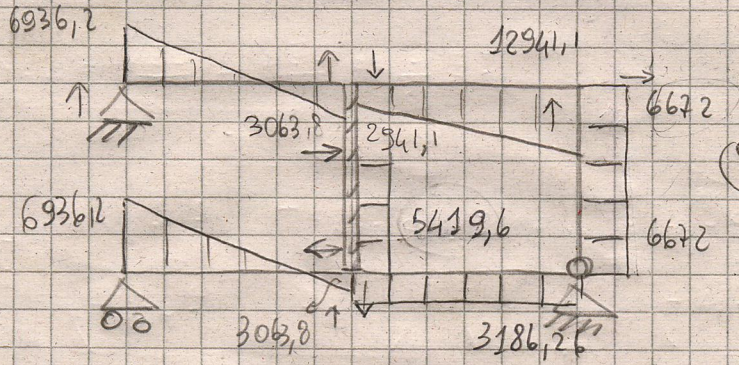
$$M_{CA} = -6250 + \frac{132761}{EJ}\left(\frac{3}{25}EJ\right) = 9681$$

$$M_{CB} = \frac{132761}{EJ}\left(-\frac{3}{25}EJ\right) = -15931,3$$

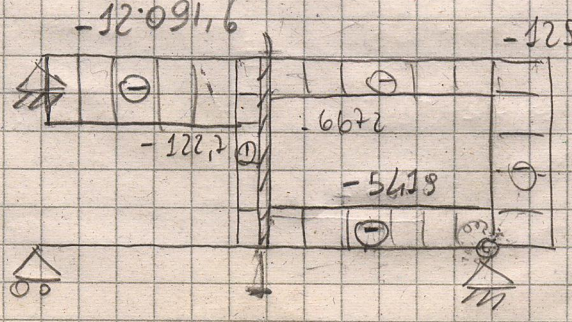
$$M_{FB} = \frac{20016,3}{EJ}\left(EJ\right) = 20016,3$$



(M) kg.m



(T) kg



(N) kg

c) Progetto con profilo IPE

$M_{max} = 20016$ kg.m

$\Rightarrow W_{min} = \frac{M_{max}}{\sigma_{adm}} = \frac{20016 \cdot 100}{2600} = 769,8$ cm³

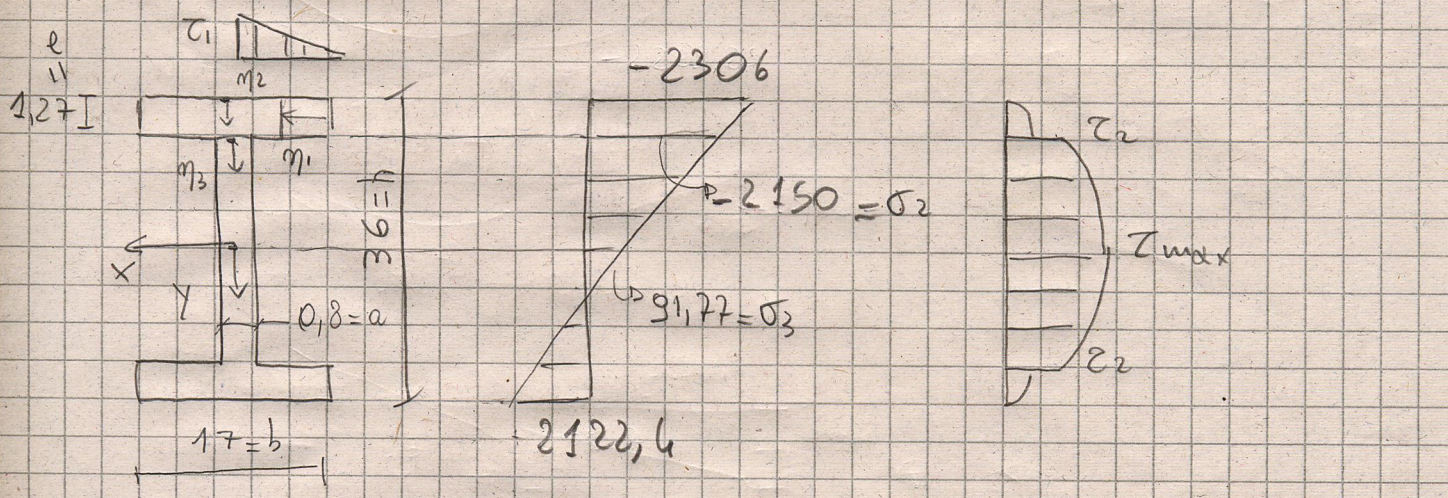
$\Rightarrow$ IPE 360: $W_x = 904$ cm³

Verifica a pressoflessione

$M = 20016$ kg.m
$N = -6672$ kg
$W_x = 904$ cm³
$A = 72,7$ cm²
$J_x = 16270$ cm⁴

$$\sigma = \frac{N}{A} \pm \frac{M}{W} = \frac{6672}{72,7} \pm \frac{20016 \cdot 100}{904}$$

$\sigma_{max}^{+} = 2122,38$ kg/cm² $\}$ $< 2600 \frac{kg}{cm^2}$
$\sigma_{max}^{-} = -2305,9$ " $\}$



$$S_1 = -\eta_1 \cdot e \left(\frac{h}{2} - \frac{e}{2}\right); \quad S_{1\,max}\left(\eta_1 = \frac{b}{2} - \frac{a}{2}\right) = -184,5 \text{ cm}^3$$

$$\tau_1 = -\frac{S_1 \cdot T}{e \cdot J_x} = \frac{184,5 \cdot 12941}{1,27 \cdot 16270} = 115,57 \text{ kg/cm}^2$$

$$S_2 = -\eta_2 \cdot b \cdot \left(\frac{h}{2} - \frac{\eta_2}{2}\right); \quad S_{2\,max}\left(\eta_2 = e\right) = -374,8 \text{ cm}^3$$

$$\tau_{ALA} = -\frac{S_2 \cdot T}{b \cdot J_x} = \frac{374,8 \cdot 12941}{17 \cdot 16270} = 17,54 \text{ kg/cm}^2$$

$$\tau_2 = \frac{-S_2 \cdot T}{a \cdot J_x} = \frac{374,8 \cdot 1294}{0,8 \cdot 16270} = 372,74 \text{ kg/cm}^2$$

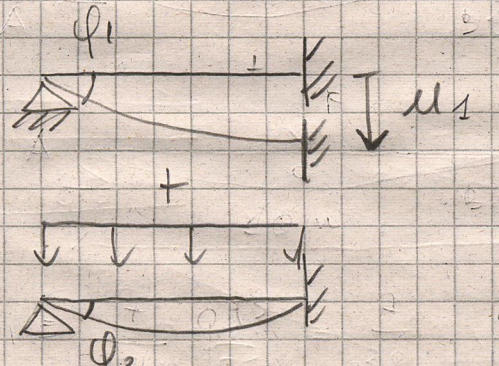
$$S_3 = -\eta_3 \cdot a \cdot \left(\frac{h}{2} - e - \frac{\eta_3}{2}\right); \quad S_{3max}\left(\eta_3 = \frac{h}{2} - e\right) = 111,96 \text{ cm}^3$$

$$\tau_{max} = \tau_2 + \left(-\frac{S_3 \cdot T}{a \cdot J_x}\right) = 372,74 + 111,31 = 484 \text{ kg/cm}^2$$

$$\left.\begin{aligned} \sigma_{id}^{(1)} &= \sqrt{\sigma_{max}^2 + 3\tau_1^2} = 2314,67 \text{ kg/cm}^2 \\ \sigma_{id}^{(2)} &= \sqrt{\sigma_2^2 + 3\tau_2^2} = 2244,62 \text{ "} \\ \sigma_{id}^{(3)} &= \sqrt{\sigma_3^2 + 3\tau_{max}^2} = 843,00 \text{ "} \end{aligned}\right\} < 2600 \frac{\text{kg}}{\text{cm}^2}$$

D) Calcolare la rotazione dei nodi A e D

In questo caso la rotazione dei due nodi è la stessa



$$\varphi_A = \varphi_D = \varphi_1 + \varphi_D$$

$$\varphi_1 = -\frac{3}{2\ell} \cdot u_1 = -0,01167$$

φ_D (vedi ultime 2 pagine)

$$\varphi_2 = -p\frac{\ell^3}{48EJ} = -0,001524$$

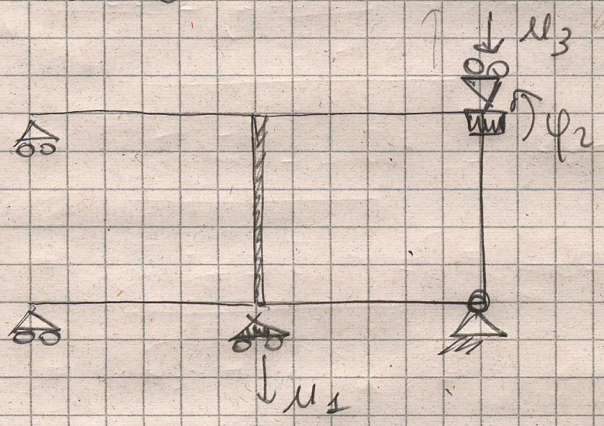
(vedi ultime 2 pagine)

$$\Rightarrow \varphi_A = -0,0132$$

E) Calcolare la reazione nel caso in cui l'arco BF sia soggetto ad una variazione termica

$\Delta T = -50°C \quad (\alpha = 1{,}2 \times 10^{-5}\ °C^{-1})$

A causa del carico termico, si ha uno spostamento ulteriore

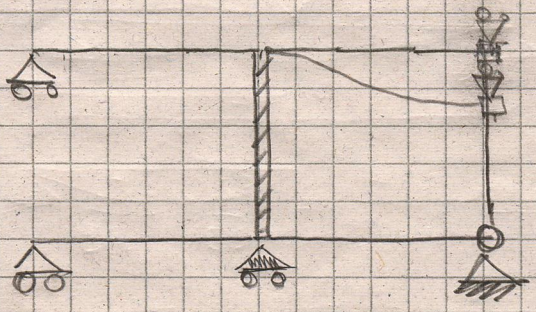


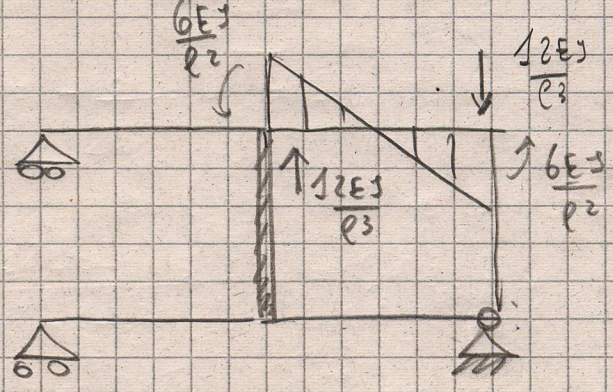
$$K_{30} = -q\frac{\ell}{2} = -5000 - EA\alpha\Delta T = -96.602$$

$$K_{31} = K_{13} = -\frac{12EJ}{\ell^3} = -\frac{12}{125}$$

$$K_{32} = K_{23} = \frac{6EJ}{\ell^2} = \frac{6}{25}EJ$$

SISTEMA 3





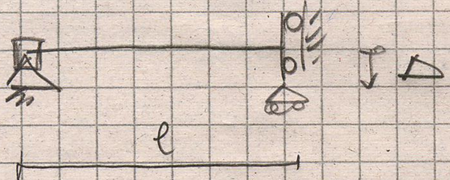
$$K_{33} = \frac{12EJ}{\ell^3} = \frac{12EJ}{125} + \frac{EA}{h}$$

$$EJ\begin{pmatrix} 21/125 & -6/25 & -12/125 \\ -6/25 & 9/5 & 6/25 \\ -12/125 & 6/25 & \frac{12}{125}+14,83 \end{pmatrix}\begin{pmatrix} u_1 \\ \varphi_2 \\ u_3 \end{pmatrix} = \begin{pmatrix} 17'500 \\ 4'166,7 \\ 96'602 \end{pmatrix}$$

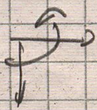
$$\Rightarrow \begin{pmatrix} u_1 \\ \varphi_2 \\ u_3 \end{pmatrix} = \frac{1}{EJ}\begin{pmatrix} 136058 \\ 19'521,9 \\ 7005,08 \end{pmatrix}$$

$$M_{ED} = -6250 + \frac{136058}{EJ}\left(\frac{3}{25}EJ\right) = 10'077$$

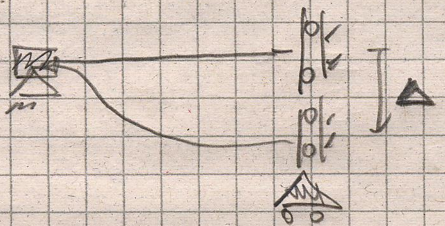
$$M_{FE} = -4166,7 + \frac{136058}{EJ}\left(-\frac{6}{25}EJ\right) + \frac{19521,9}{EJ}\left(\frac{4}{5}EJ\right) + \frac{7005,1}{EJ} \cdot \left(\frac{6}{25}EJ\right) = -19521,9$$

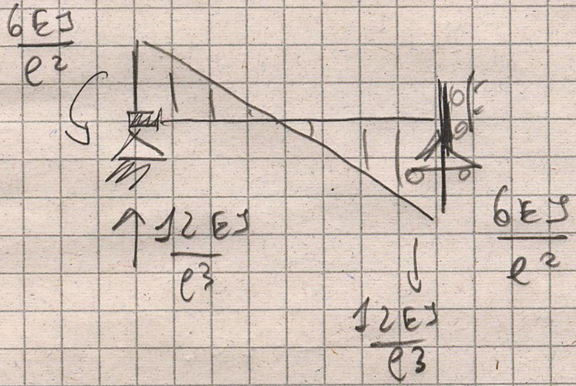


Stanje 0 [illegible] $K_{10} = K_{20} = 0$



Stanje 1

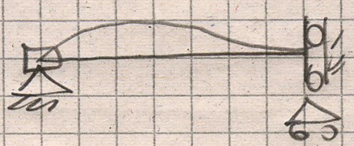


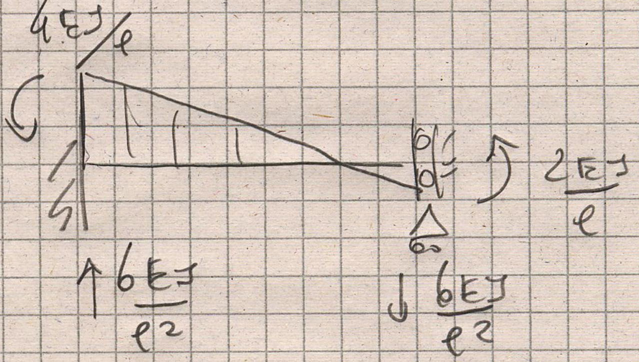


$K_{11} = \frac{12EJ}{l^3}$

$K_{12} = \frac{6EJ}{l^2}$

Stanje 2



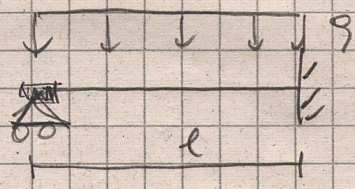


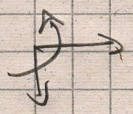
$K_{12} = K_{21} = \frac{6EJ}{l^2}$

$K_{22} = \frac{4EJ}{l}$

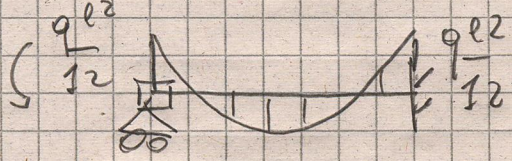
$$\begin{pmatrix} \frac{12EJ}{l^3} & \frac{6EJ}{l^2} \\ \frac{6EJ}{l^2} & \frac{4EJ}{l} \end{pmatrix} \begin{pmatrix} \Delta \\ \varphi_2 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$$\frac{6EJ}{l^2}\cdot\Delta + \frac{4EJ}{l}\varphi_2 = 0 \Rightarrow \varphi_2 = -\frac{6EJ}{l^2}\cdot\Delta\cdot\frac{l}{4EJ} = -\frac{3}{l\cdot 2}\cdot\Delta$$



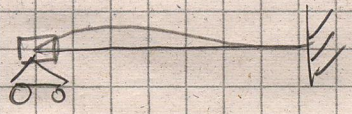


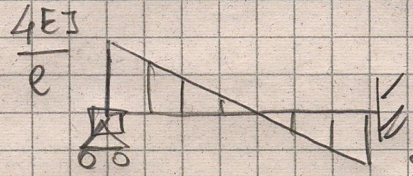
SISTEMA 0



$$K_{10} = \frac{ql^2}{12}$$

SISTEMA 1





$$K_{11} = 4\frac{EJ}{l}$$

$$\Rightarrow \frac{4EJ}{l} \cdot \varphi_1 = -\frac{ql^2}{12} \rightarrow \varphi_1 = -\frac{ql^2}{12} \cdot \frac{l}{4EJ} = -\frac{ql^3}{48EJ}$$