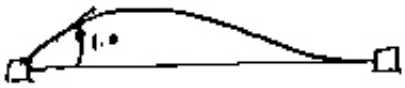
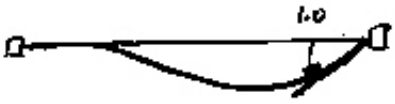


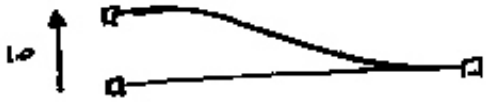
$$l_1(x) = -\frac{1}{L^2}\left[L^2 x - 2Lx^2 + x^3\right]$$

$$\frac{dl_1}{dx^2} = -\frac{1}{L^2}\left[-4L + 6x\right]$$



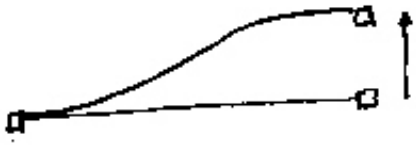
$$l_2(x) = -\frac{1}{L^2}\left(-Lx^2 + x^3\right)$$

$$\frac{dl_2}{dx^2} = -\frac{1}{L^2}\left[-2L + 6x\right]$$



$$l_3(x) = -\frac{1}{L^3}\left(L^3 - 3Lx^2 + 2x^3\right)$$

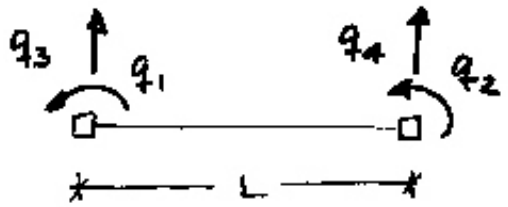
$$\frac{dl_3}{dx^2} = -\frac{1}{L^3}\left[-6L + 12x\right]$$



$$l_4(x) = -\frac{1}{L^3}\left(3Lx^2 - 2x^3\right)$$

$$\frac{dl_4}{dx^2} = -\frac{1}{L^3}\left[6L - 12x\right]$$

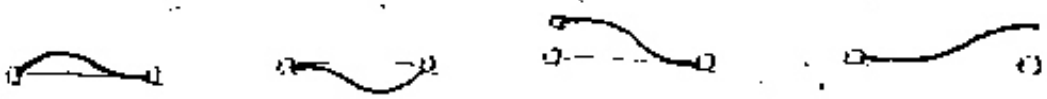
ELEMENTO DE VIGA



MATRIZ DE RIGIDEZ ELEMENTAR

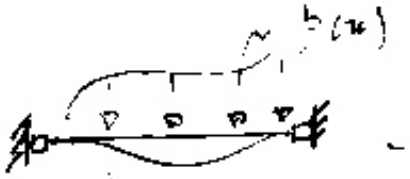
$$K^{(e)} = \int_0^L \left[\frac{1}{L^2}(-4L+6x) \;\middle|\; \frac{1}{L^2}(-2L+6x) \;\middle|\; \frac{1}{L^3}(-6L+12x) \;\middle|\; \frac{1}{L^3}(6L-12x) \right] EI \begin{bmatrix} \frac{1}{L^2}(-4L+6x) \\ \hline \frac{1}{L^2}(-2L+6x) \\ \hline +\frac{1}{L^3}(-6L+12x) \\ \hline \frac{1}{L^3}(6L-12x) \end{bmatrix}$$

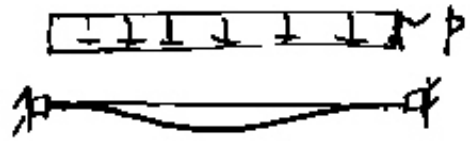
$$K^{(e)} = \left[\begin{array}{c|c|c|c} 4EI/L & 2EI/L & 6EI/L^2 & -6EI/L^2 \\ 2EI/L & 4EI/L & 6EI/L^2 & -6EI/L^2 \\ 6EI/L^2 & 6EI/L^2 & 12EI/L^3 & -12EI/L^3 \\ -6EI/L^2 & -6EI/L^2 & -12EI/L^3 & 12EI/L^3 \end{array}\right]$$



VECTOR DAS FORÇAS NODAIS EQUIVALENTES

$$F^{(e)} = \int_0^L \left[\begin{array}{c} -\frac{1}{L^2}\left[L^2x - 2Lx^2 + x^3\right] \\ \hline -\frac{1}{L^2}\left[-Lx^2 + x^3\right] \\ \hline -\frac{1}{L^3}\left[L^3 - 3Lx^2 + 2x^3\right] \\ \hline -\frac{1}{L^3}\left[3Lx^2 - 2x^3\right] \end{array}\right] \left[p(x)\right] dx$$





$$F^{(e)} = \int_0^L \begin{bmatrix} f_1(x) \times p(x) \\ f_2(x) \times p(x) \\ f_3(x) \times p(x) \\ f_4(x) \times p(x) \end{bmatrix} dx$$

$$F^{(e)} = \begin{bmatrix} -pL^2/12 \\ pL^2/12 \\ -pL/2 \\ -pL/2 \end{bmatrix}$$