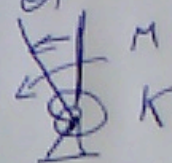


Apoios Elásticos p 380



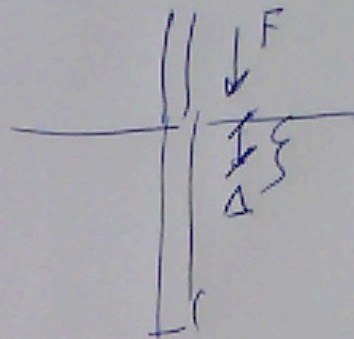
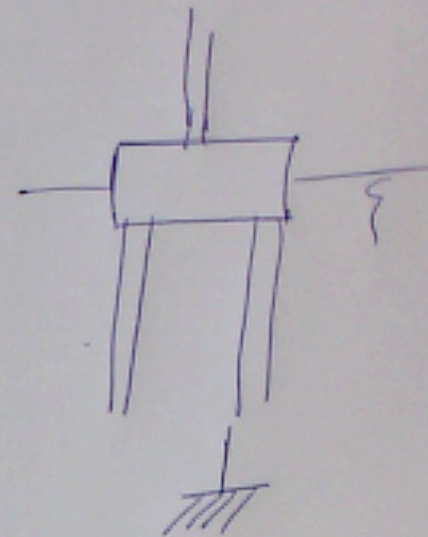
momento zero



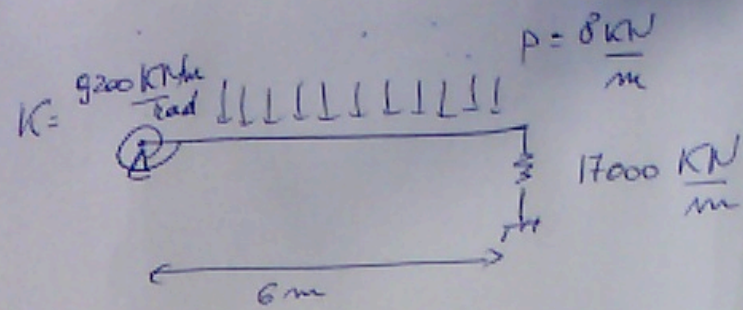
M

K

$$M = K\theta$$

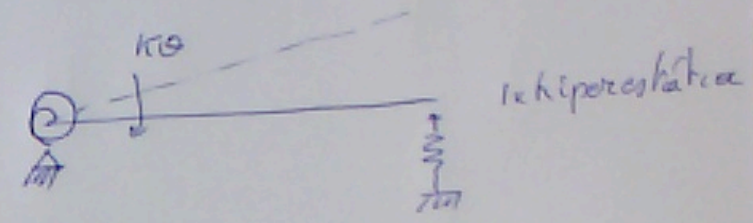
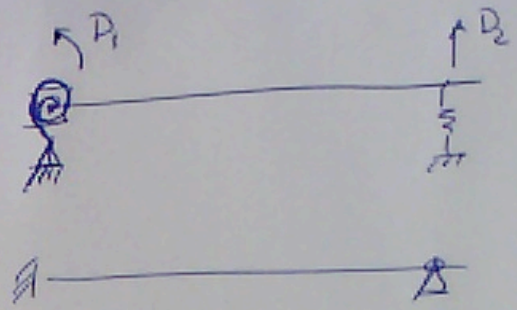


$$\Delta = \frac{F}{K}$$

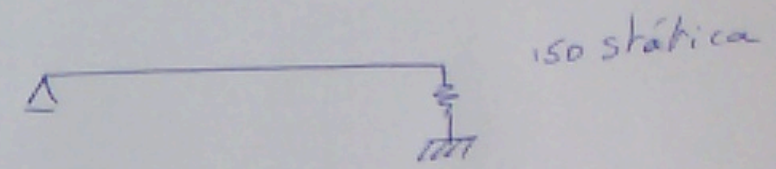


$EI = 2.16 \cdot 10^4 \text{ KNm}^2$
 Apoio direito não é engastado

Estrutura é hipostática



$M_A = \frac{3EI}{L}$
 $F_A = \frac{3EI}{L^2}$
 $F_B = \frac{3EI}{L^2}$



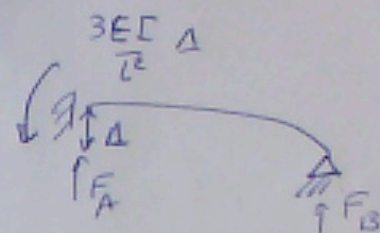
$M = -4EI$
 $\uparrow 6EI$
 $\downarrow \frac{6EI}{12}$
 $M_B = \frac{2EI}{L}$



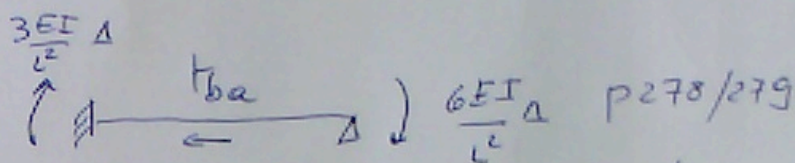
p278

$$M_A = \frac{6EI\Delta}{L^2} \quad M_B = \frac{6EI\Delta}{L^2}$$

$$F_A = \frac{12EI\Delta}{L^3} \quad F_B = -\frac{12EI\Delta}{L^3}$$



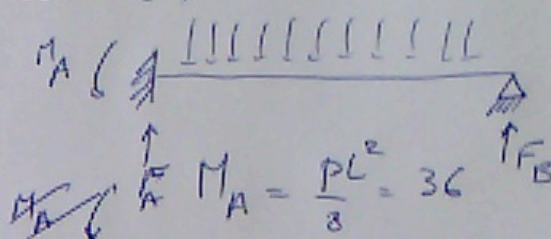
$$F_A = \frac{3EI\Delta}{L^2} \quad F_B = -\frac{3EI\Delta}{L^3}$$



p278/279

Cálculo das forças na barra

Caso (0) 8 kN/m

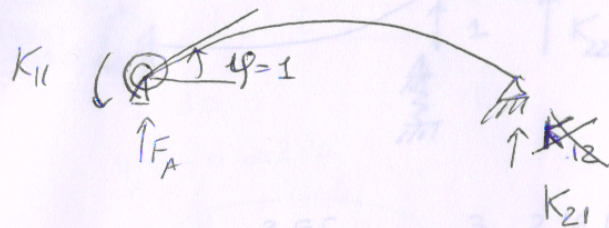


$$F_A = \frac{6 \times 8}{2} + \frac{M_A}{L} = 24 + \frac{6}{18} = 42 \text{ kN}$$

$$F_B = 48 - F_A = 18 \text{ kN}$$

caso (1)

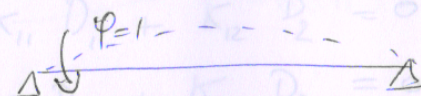
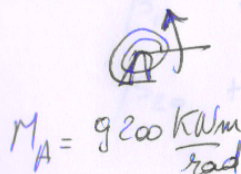
Grau de liberdade: giro do nó A



$$K_{11} = \frac{3EI}{L} + K_{Mda} = \frac{3 \cdot 2,16 \cdot 10^4}{6} + 9200 = \cancel{19600} \frac{\text{KNm}}{\text{rad}}$$

$$F_A = \frac{20000}{6} = 3333 \text{ KN/rad}$$

$$K_{21} = F_B = -3333 \text{ KN/rad}$$



$$M_A = \frac{3EI}{L}$$

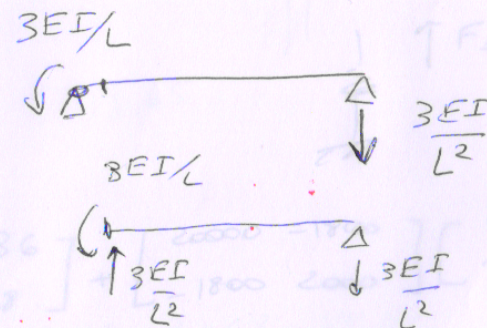
$$F_A = \frac{3EI}{L^2}$$

$$F_B = -\frac{3EI}{L^2}$$

$$M_A = 10800$$

$$F_A = 1800 \text{ KN}$$

$$F_B = -1800 \text{ KN} = K_{21}$$





$$K_{12} = -\frac{3EI}{L^2} = -\frac{3 \cdot 2.16 \cdot 10^4}{36} = -1800 \text{ KN}$$

$$K_{22} = 300 \frac{\text{KN}}{\text{m}} + 1700 \frac{\text{KN}}{\text{m}} = 2000 \frac{\text{KN}}{\text{m}}$$

$$\cos(0) + \cos(1) + \cos(2)$$

$$\beta_{10} + K_{11} D_1 + K_{12} D_2 = 0$$

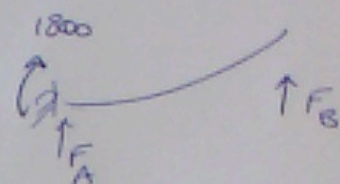
$$\beta_{20} + K_{21} D_1 + K_{22} D_2 = 0$$

$$\beta_{10} + \left(K_{Hda} + \frac{3EI}{L}\right) D_1 + K_{12} D_2 = 0$$

$$\beta_{20} + K_{21} D_1 + \left(K^Y + \frac{3EI}{L^2}\right) D_2 = 0$$

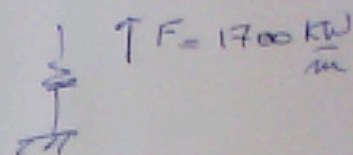
$$36 + 20000 D_1 - 1800 D_2 = 0$$

$$18 + (-1800) D_1 + 2000 D_2 = 0$$



$$F_B = \frac{1800}{6} = 300 \text{ KN/m}$$

$$F_A = -300 \text{ KN/m}$$

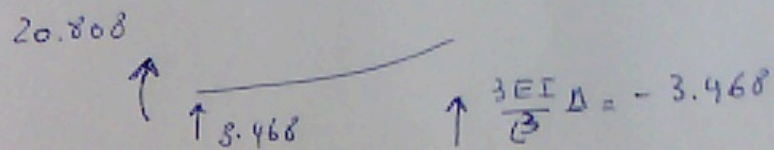
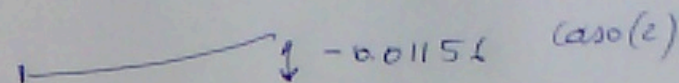
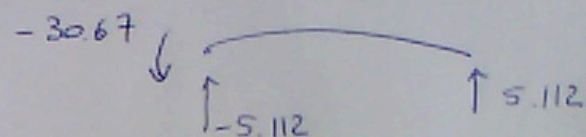
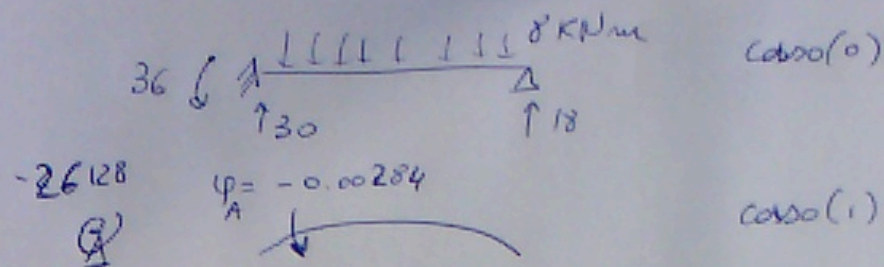


$$\begin{bmatrix} 36 \\ 18 \end{bmatrix} + \begin{bmatrix} 20000 & -1800 \\ -1800 & 2000 \end{bmatrix} \begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$D_1 = -0.00284$$

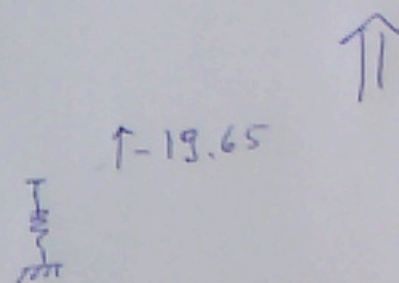
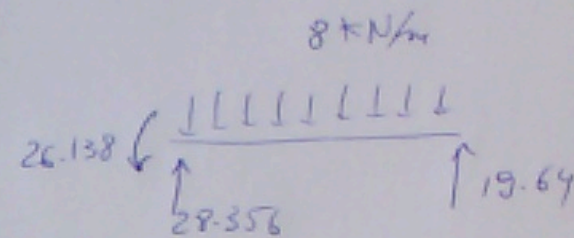
$$D_2 = -0.01156$$

Estado de tensão da viga



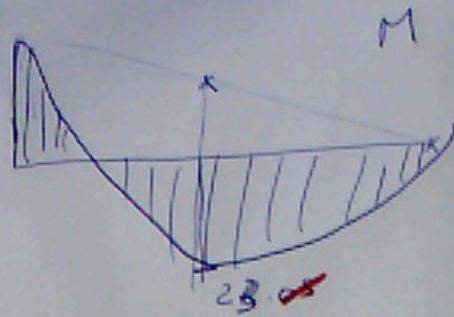
$$M_A = 36 - 30.67 + 20.808 = 26.138$$

$$F_A = 30 - 5.112 + 3.468 = 28.356$$



$$F_B = 18 + 5.112 - 3.468 = 19.64$$

26.1



28.36

