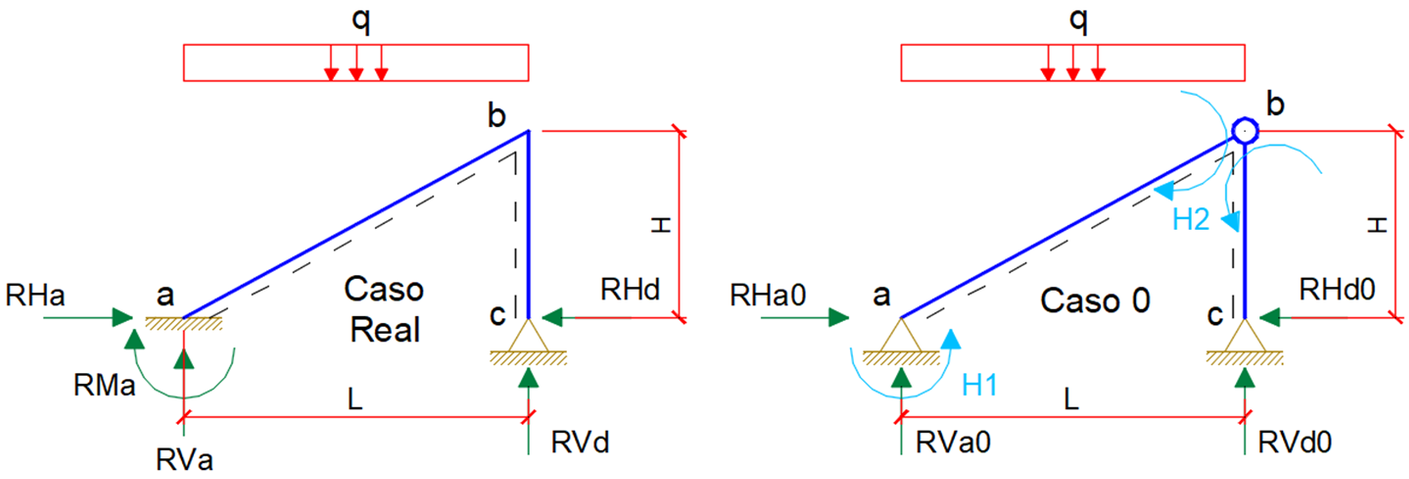
B1T4NA0917A

Empregando o método das forças com as redundantes hiperestáticas indicadas (H1 e H2) responda os questionamentos:
* Considerar somente efeitos de flexão nos cálculos;

Para barra "ab": $EI_ab := 20000\ \text{kN m}^2$

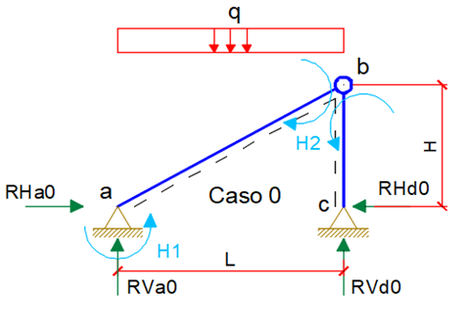
Para barra "bc": $EI_bc := 10000\ \text{kN m}^2$

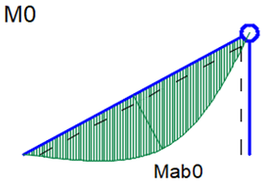
$L := 8,0\ \text{m}$ $H := 4,0\ \text{m}$ $q := 10\ \frac{\text{kN}}{\text{m}}$



Q01) Qual o valor do deslocamento de rotação que ocorre no ponto "a" do caso 0 de carregamento [em rad e em módulo]?
Q02) Qual o valor do deslocamento de rotação relativa que ocorre no ponto "b" do caso 0 de carregamento [em rad em módulo]?
Q03) Considerando as redundantes hiperestáticas indicadas, qual o valor do coeficiente de flexibilidade "f11" [em unidades de "kN" e "m" e em módulo]?
Q04) Considerando as redundantes hiperestáticas indicadas, qual o valor do coeficiente de flexibilidade "f12" [em unidades de "kN" e "m" e em módulo]?
Q05) Qual o valor da reação de apoio RVa [em "kN" e com positivo para cima]?
Q06) Qual o valor da reação de apoio RVd [em "kN" e com positivo para cima]?

Deslocamentos do Caso 0 e Coeficientes de Flexibilidade:

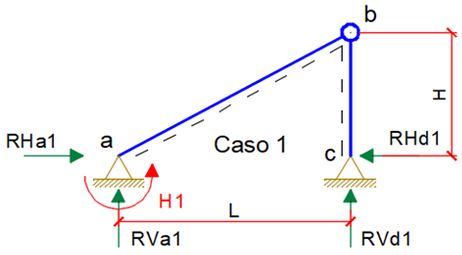


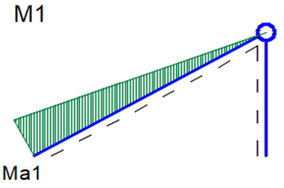


$RVa0 := q \cdot \frac{L}{2} = 40\ \text{kN}$

$RVd0 := q \cdot \frac{L}{2} = 40\ \text{kN}$

$Mab0 := q \cdot \frac{L^2}{8} = 80\ \text{kN m}$

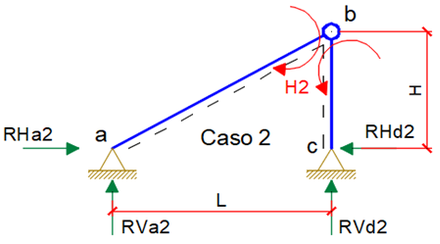


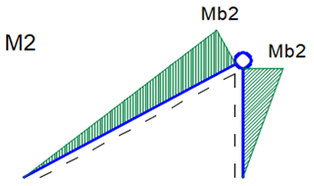


$Ma1 := -1\ \text{kN m}$

$RVa1 := \frac{1\ \text{kN m}}{L} = 0,125\ \text{kN}$

$RVd1 := \frac{-1\ \text{kN m}}{L} = -0,125\ \text{kN}$





$RHd2 := \frac{1\ \text{kN m}}{H} = 0,25\ \text{kN}$

$RHa2 := RHd2 = 0,25\ \text{kN}$

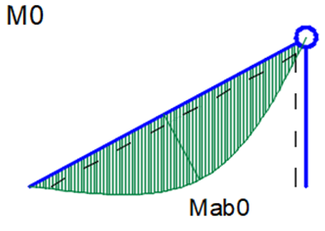
ΣMb (esq) = 0 (+) horário

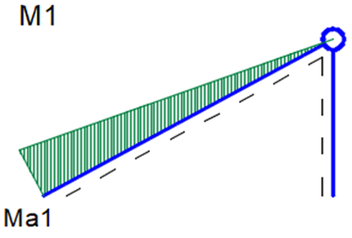
$1\ \text{kN m} + RVa2 \cdot L - RHa2 \cdot H = 0$

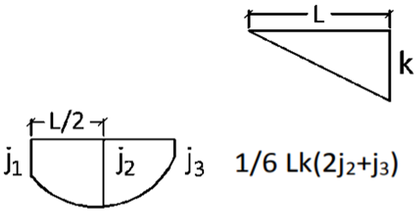
$RVa2 := \frac{1}{L} \cdot (-1\ \text{kN m} + RHa2 \cdot H) = 0$

$RVd2 := 0$ $\qquad$ $Mb2 := -1\ \text{kN m}$

Combinando os diagramas M0 e M1:







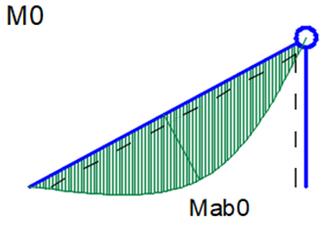
$k := Ma1 = -1\ \text{kN m}$ $\qquad$ $Lab := \sqrt{L^2 + H^2} = 8,9443\ \text{m}$

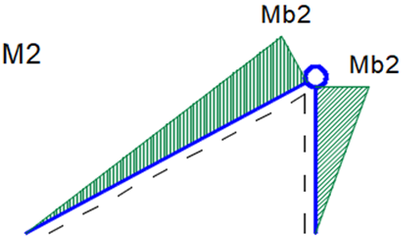
$j1 := 0\ \text{kN m}$ $\qquad$ $j2 := Mab0 = 80\ \text{kN m}$ $\qquad$ $j3 := 0\ \text{kN m}$

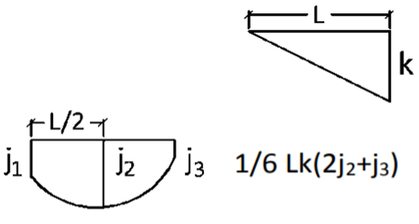
$\varphi 10 := \frac{1}{EI_ab} \cdot \frac{1}{6} \cdot Lab \cdot k \cdot (2 \cdot j2 + j3) \cdot \frac{1}{\text{kN m}} = -0,011926$

$Q01 := |\varphi 10| = 0,011926$

Combinando os diagramas M0 e M2:







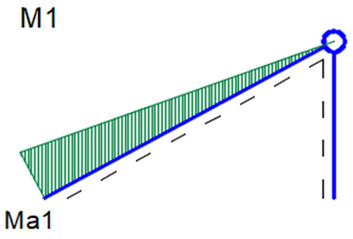
$k := Mb2 = -1\ \text{kN m}$

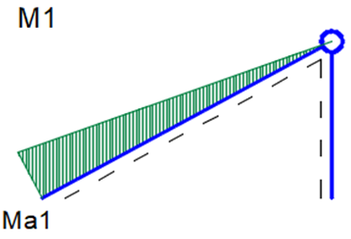
$j1 := 0\ \text{kN m}$ $\qquad$ $j2 := Mab0 = 80\ \text{kN m}$ $\qquad$ $j3 := 0\ \text{kN m}$

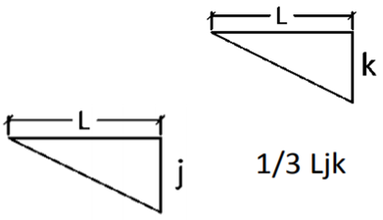
$\varphi 20 := \frac{1}{EI_ab} \cdot \frac{1}{6} \cdot Lab \cdot k \cdot (2 \cdot j2 + j3) \cdot \frac{1}{\text{kN m}} = -0,011926$

$Q02 := |\varphi 20| = 0,011926$

Combinando os diagramas M1 e M1:





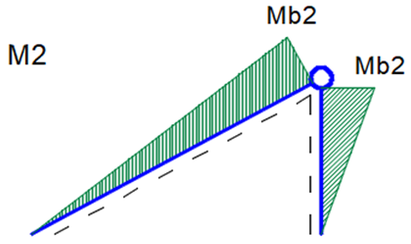


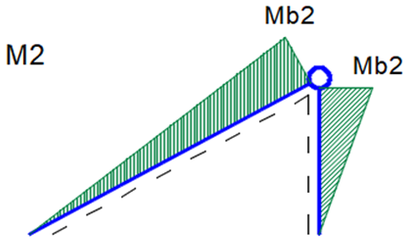
$k := Ma1 = -1\ \text{kN m} \qquad j := Ma1 = -1\ \text{kN m}$

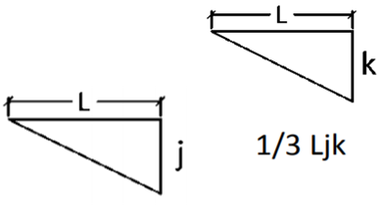
$$f11 := \frac{1}{EI_ab} \cdot \frac{1}{3} \cdot Lab \cdot j \cdot k \cdot \frac{1}{1\ \text{kN m}} = 0,0001$$

$$Q03 := |f11| = 0,0001$$

Combinando os diagramas M2 e M2:

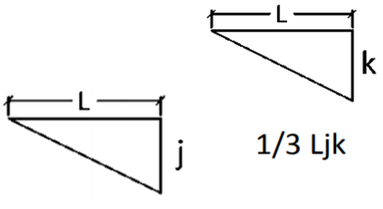






$k := Mb2 = -1\ \text{kN m} \qquad j := Mb2 = -1\ \text{kN m}$

$$f22ab := \frac{1}{EI_ab} \cdot \frac{1}{3} \cdot Lab \cdot j \cdot k \cdot \frac{1}{1\ \text{kN m}} = 0,00014907$$

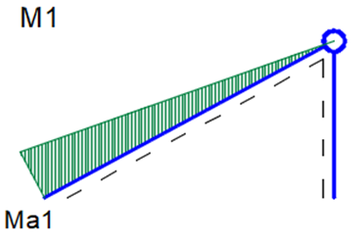


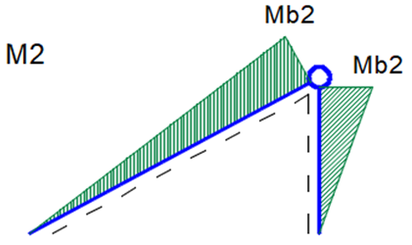
$k := Mb2 = -1\ \text{kN m} \qquad j := Mb2 = -1\ \text{kN m}$

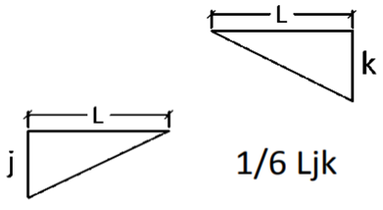
$$f22bc := \frac{1}{EI_bc} \cdot \frac{1}{3} \cdot H \cdot j \cdot k \cdot \frac{1}{1\ \text{kN m}} = 0,00013333$$

$$f22 := f22ab + f22bc = 0,0002824$$

Combinando os diagramas M1 e M2:







$k := Mb2 = -1\ \text{kN m} \qquad j := Ma1 = -1\ \text{kN m}$

$$f12 := \frac{1}{EI_ab} \cdot \frac{1}{6} \cdot Lab \cdot j \cdot k \cdot \frac{1}{1\ \text{kN m}} = 7,4536 \cdot 10^{-5}$$

$$Q04 := |f12| = 7,4536 \cdot 10^{-5}$$

Solução do Sistema de Equações:

$$A := \begin{bmatrix} f11 & f12 \\ f12 & f22 \end{bmatrix} = \begin{bmatrix} 0,00014907 & 7,4536 \cdot 10^{-5} \\ 7,4536 \cdot 10^{-5} & 0,0002824 \end{bmatrix}$$

$$b := \begin{bmatrix} -\varphi 10 \\ -\varphi 20 \end{bmatrix} = \begin{bmatrix} 0,011926 \\ 0,011926 \end{bmatrix}$$

$$R := A^{-1} \cdot b = \begin{bmatrix} 67,838 \\ 24,325 \end{bmatrix} \qquad RMa := R_1 = 67,838 \qquad RMb := R_2 = 24,3246$$

Cálculo de RVa por Sobreposição de Efeitos:

$$RVa := RVa0 + RVa1 \cdot RMa + RVa2 \cdot RMb = 48,48 \text{ kN}$$

$$Q05 := RVa = 48,480 \text{ kN}$$

$$RVd := RVd0 + RVd1 \cdot RMa + RVd2 \cdot RMb = 31,5203 \text{ kN}$$

$$Q06 := RVd = 31,5203 \text{ kN}$$

$$Q01 = 0,011926$$

$$Q02 = 0,0119257$$

$$Q03 = 0,0001$$

$$Q04 = 7,4536 \cdot 10^{-5}$$

$$Q05 = 48,4797 \text{ kN}$$

$$Q06 = 31,5203 \text{ kN}$$