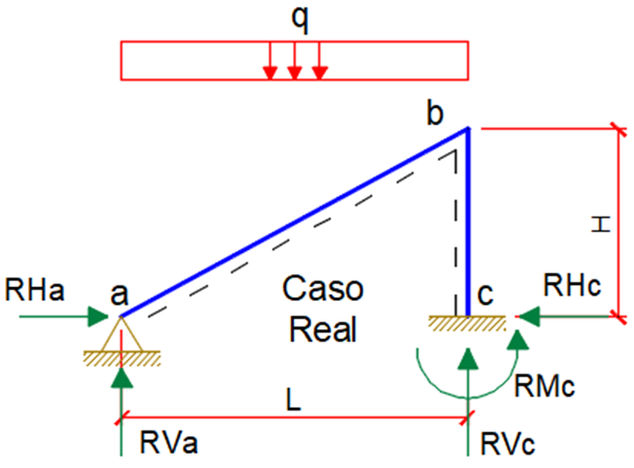
B1T4MA0921A

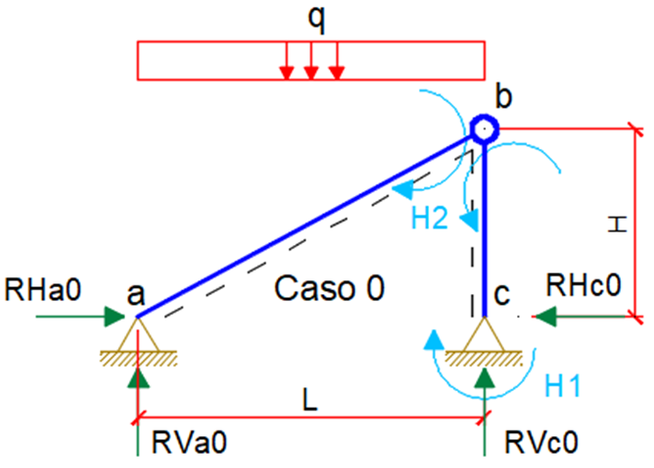
Empregando o método das forças com as redundantes hiperestáticas indicadas (H1 e H2) responda os questionamentos:
* Considerar somente efeitos de flexão nos cálculos;

Para barra "ab": $EI_ab := 30000\ kN\ m^2$

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

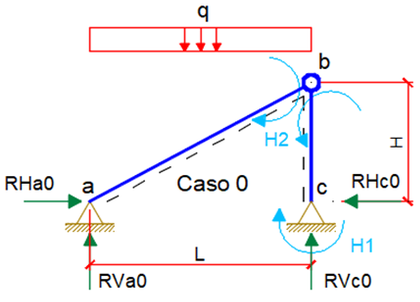
$L := 6,0\ m$ $H := 4,0\ m$ $q := 30\ \frac{kN}{m}$

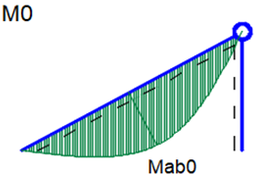




Q01) Qual o valor do deslocamento de rotação que ocorre no ponto "c" do caso 0 de carregamento [em rad e em módulo]?
Q02) Qual o valor do deslocamento de rotação relativa que ocorre no ponto "b" do caso 0 de carregamento [em rad em módulo]?
Q03) Considerando as redundantes hiperestáticas indicadas, qual 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 RVc [em "kN" e com positivo para cima]?

Deslocamentos do Caso 0 e Coeficientes de Flexibilidade:

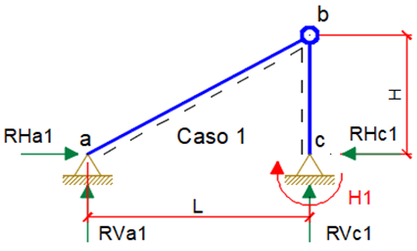


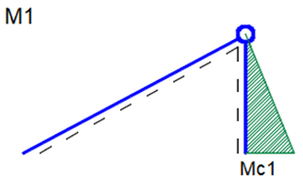


$RVa0 := q \cdot \frac{L}{2} = 90\ kN$

$RVc0 := q \cdot \frac{L}{2} = 90\ kN$

$Mab0 := q \cdot \frac{L^2}{8} = 135\ kN\ m$



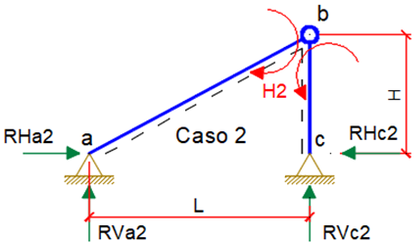


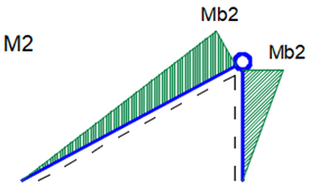
$Mc1 := -1\ \text{kN m}$

$RVa1 := \frac{-1\ \text{kN m}}{L} = -0,16667\ \text{kN}$

$RVc1 := \frac{1\ \text{kN m}}{L} = 0,1667\ \text{kN}$

$RHc1 := \frac{-1\ \text{kN m}}{H} = -0,25\ \text{kN}$





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

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

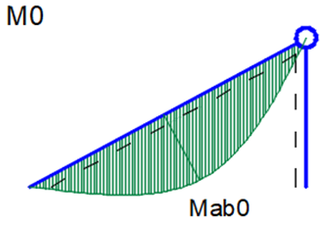
ΣMb (esq) = 0 (+) horário

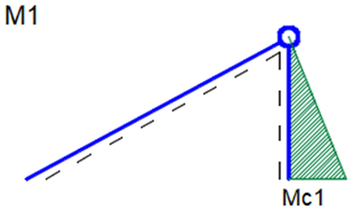
$1\ \text{kN m} + RVa2 \cdot L - RHa2 \cdot H = 0$

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

$RVc2 := 0$ $\qquad Mb2 := -1\ \text{kN m}$

Combinando os diagramas M0 e M1:

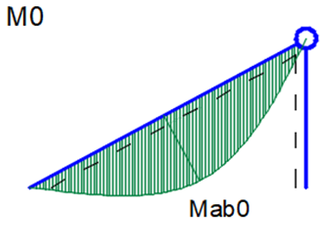


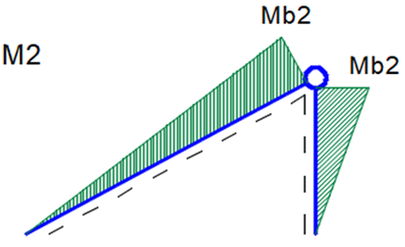


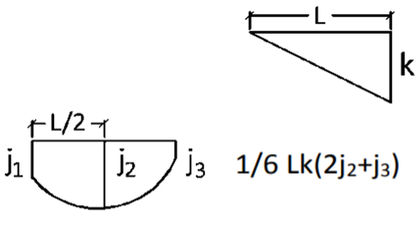
$\varphi 10 := 0 = 0$

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

Combinando os diagramas M0 e M2:







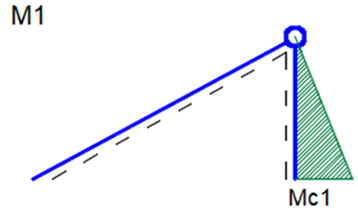
$k := Mb2 = -1\ \text{kN m}$ $\qquad Lab := \sqrt{L^2 + H^2} = 7,2111\ \text{m}$

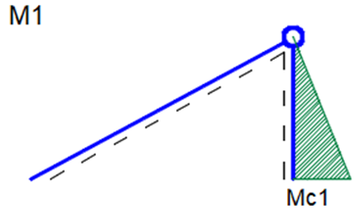
$j1 := 0\ \text{kN m}$ $\qquad j2 := Mab0 = 135\ \text{kN m}$ $\qquad j3 := 0\ \text{kN m}$

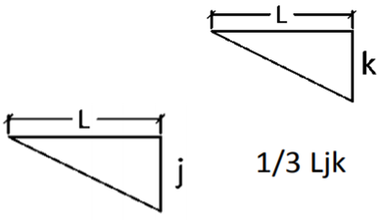
$\varphi 20 := \frac{1}{EI_ab} \cdot \frac{1}{6} \cdot Lab \cdot k \cdot (2 \cdot j2 + j3) \cdot \frac{1}{\text{kN m}} = -0,010817$

$Q02 := |\varphi 20| = 0,010817$

Combinando os diagramas M1 e M1:





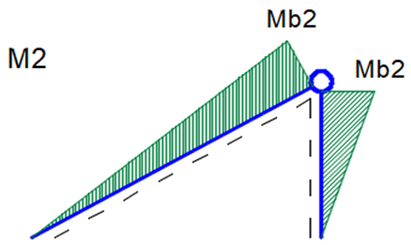


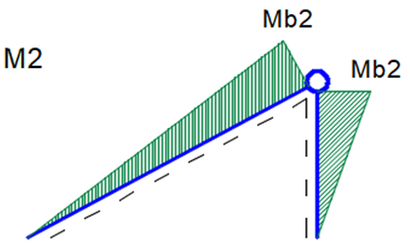
$k := Mc1 = -1\ \text{kN m} \quad j := Mc1 = -1\ \text{kN m} \quad H = 4\ \text{m}$

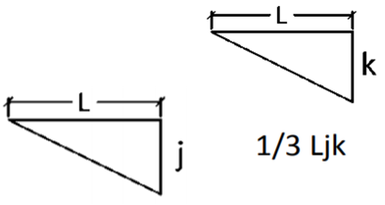
$f11 := \frac{1}{EI_bc} \cdot \frac{1}{3} \cdot H \cdot j \cdot k \cdot \frac{1}{1\ \text{kN m}} = 0,0001$

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

Combinando os diagramas M2 e M2:

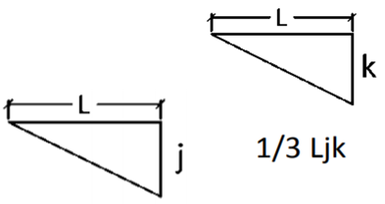






$k := Mb2 = -1\ \text{kN m} \quad j := Mb2 = -1\ \text{kN m}$

$f22ab := \frac{1}{EI_ab} \cdot \frac{1}{3} \cdot Lab \cdot j \cdot k \cdot \frac{1}{1\ \text{kN m}} = 8,0123 \cdot 10^{-5}$

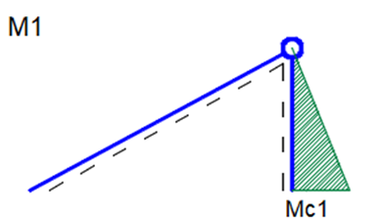


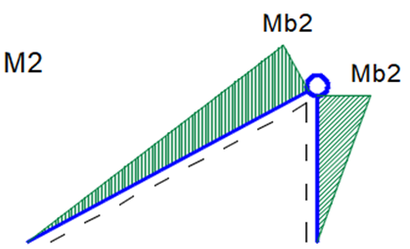
$k := Mb2 = -1\ \text{kN m} \quad j := Mb2 = -1\ \text{kN m}$

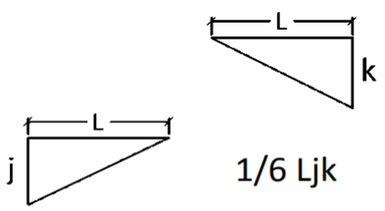
$f22bc := \frac{1}{EI_bc} \cdot \frac{1}{3} \cdot H \cdot j \cdot k \cdot \frac{1}{1\ \text{kN m}} = 0,00013333$

$f22 := f22ab + f22bc = 0,00021346$

Combinando os diagramas M1 e M2:







$k := Mb2 = -1\ \text{kN m} \quad j := Mc1 = -1\ \text{kN m}$

$f12 := \frac{1}{EI_bc} \cdot \frac{1}{6} \cdot H \cdot j \cdot k \cdot \frac{1}{1\ \text{kN m}} = 6,6667 \cdot 10^{-5}$

$Q04 := |f12| = 6,6667 \cdot 10^{-5}$

Solução do Sistema de Equações:

$$A := \begin{bmatrix} f11 & f12 \\ f12 & f22 \end{bmatrix} = \begin{bmatrix} 0,00013333 & 6,6667 \cdot 10^{-5} \\ 6,6667 \cdot 10^{-5} & 0,00021346 \end{bmatrix}$$

$$b := \begin{bmatrix} -\varphi 10 \\ -\varphi 20 \end{bmatrix} = \begin{bmatrix} 0 \\ 0,010817 \end{bmatrix}$$

$R := A^{-1} \cdot b = \begin{bmatrix} -30,026 \\ 60,051 \end{bmatrix}$ $RMc := R_1 = -30,026$ $RMb := R_2 = 60,0514$

Cálculo de RVa por Sobreposição de Efeitos:

$RVa := RVa0 + RVa1 \cdot RMc + RVa2 \cdot RMb = 95,004 \text{ kN}$

$Q05 := RVa = 95,004 \text{ kN}$

$RVc := RVc0 + RVc1 \cdot RMc + RVc2 \cdot RMb = 84,9957 \text{ kN}$

$Q06 := RVc = 84,9957 \text{ kN}$

$Q01 = 0$

$Q02 = 0,01081665$

$Q03 = 0,0001$

$Q04 = 6,6667 \cdot 10^{-5}$

$Q05 = 95,0043 \text{ kN}$

$Q06 = 84,9957 \text{ kN}$
