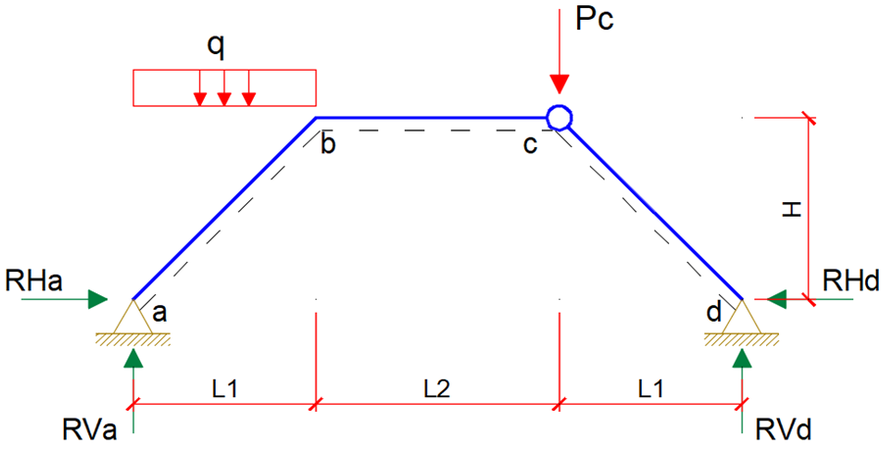
B2T4N0609A

- Considerando somente efeitos de momentos fletores, calcular o deslocamento horizontal do ponto "b" e o deslocamento vertical do ponto "c" do modelo estrutural abaixo.



- Dados:

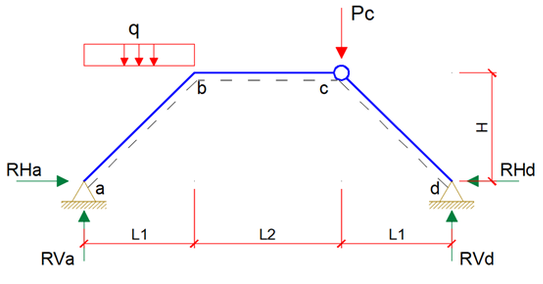
$L1 := 3,0$ m $L2 := 4,0$ m $H := 4,0$ m $Pc := 100,0$ kN $q := 30$ kN/m

- Todas as barras são de seção transversal retangular de base "b", altura "h" e Módulo de Elasticidade "E":

$b := 0,15$ m $h := 0,60$ m $E := 20 \cdot 10^{6}$ kN/m²

Q01 - Qual o valor do momento fletor no ponto "b" da barra "bc" devido ao carregamento real [em kNm e sinal conforme a convenção] ?
Q02 - Qual o valor do momento fletor no ponto "b" da barra "bc" devido ao carregamento virtual destinado ao cálculo do deslocamento horizontal do ponto "b" [em kNm e sinal conforme a convenção] ?
Q03 - Qual o valor do momento fletor no ponto "b" da barra "bc" devido ao carregamento virtual destinado ao cálculo do deslocamento vertical do ponto "c" [em kNm e sinal conforme a convenção] ?
Q04 - Qual o valor do deslocamento horizontal do ponto "b" [em "mm" e com positivo para direita] ?
Q05 - Qual o valor do deslocamento vertical do ponto "c" [em "mm" e com positivo para cima] ?

Diagrama de Momentos para o Carregamento Real:



ΣMd = 0 (+) horário

RVa.(2.L1+L2) - q.L1.(L1/2 + L2 + L1) - Pc.L1 = 0

$RVa := \frac{1}{(2 \cdot L1 + L2)} \cdot \left(q \cdot L1 \cdot \left(\frac{L1}{2} + L2 + L1 \right) + Pc \cdot L1 \right) = 106,5$ kN

ΣMc = 0 olhando para "a" (+) anti-horário

RHa.H - RVa.(L1+L2) + q.L1.(L1/2 + L2) = 0

$RHa := \frac{1}{H} \cdot \left(RVa \cdot (L1 + L2) - q \cdot L1 \cdot \left(\frac{L1}{2} + L2 \right) \right) = 62,625$ kN

$Ma := 0$

$Mb := RVa \cdot L1 - RHa \cdot H - \frac{q \cdot L1^{2}}{2} = -66$ kNm

$Mab_meio := RVa \cdot \frac{L1}{2} - RHa \cdot \frac{H}{2} - \frac{q \cdot (0,5 \cdot L1)^{2}}{2} = 0,75$

$Mab_meio := \frac{Mb + Ma}{2} + \frac{q \cdot L1^{2}}{8} = 0,75$ kNm

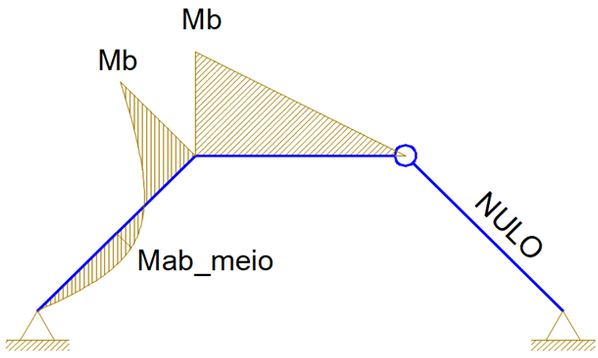
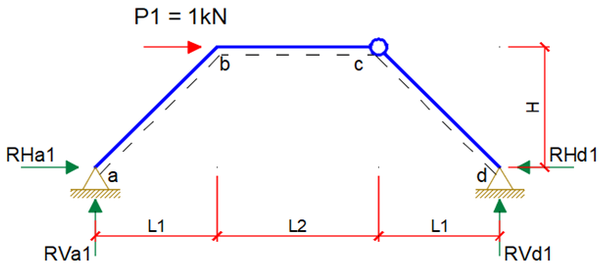


Diagrama de Momentos para o Carregamento Virtual destinado ao cálculo do Deslocamento Horizontal em "b":



ΣMd = 0 (+) horário $P1 := 1$

RVa1.(2.L1+L2) + P1.H = 0

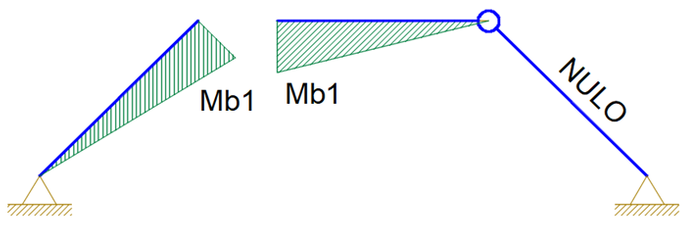
$RVa1 := \frac{1}{2 \cdot L1 + L2} \cdot (-P1) \cdot H = -0,4$ kN

ΣMc = 0 olhando para "a" (+) anti-horário

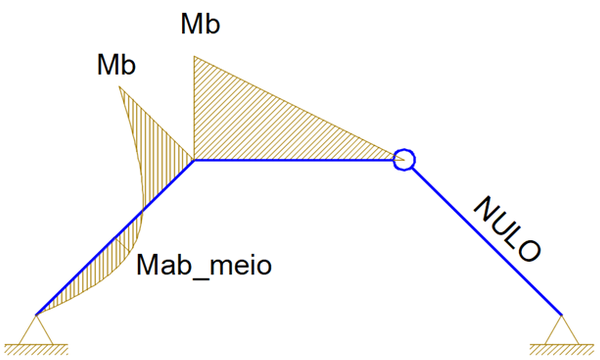
RHa1.H - RVa1.(L1+L2) = 0

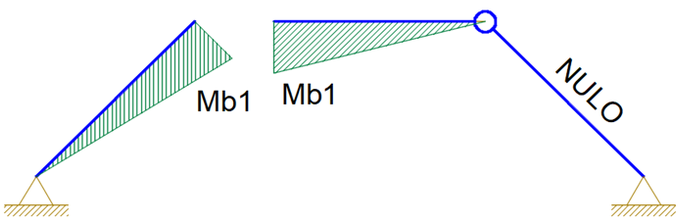
$RHa1 := \frac{1}{H} \cdot (RVa1 \cdot (L1 + L2)) = -0,7$ kN

$Mb1 := RVa1 \cdot L1 - RHa1 \cdot H = 1,6$ kNm

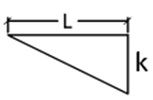


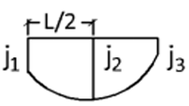
Cálculo do Deslocamento Horizontal do Ponto "b":





Barra "ab":





1/6 Lk(2j2+j3)

$Lab := \sqrt{L1^{2} + H^{2}} = 5$ m

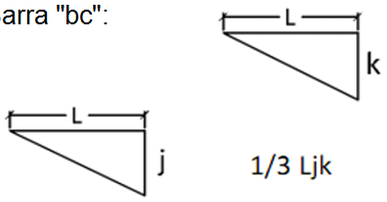
$k := Mb1 = 1,6$ $L := Lab = 5$

$j2 := Mab_meio = 0,75$ $j3 := Mb = -66$

$EI := \frac{E \cdot b \cdot h^{3}}{12} = 54000$ kNm^{2}

$mab1 := \frac{1}{6} \cdot L \cdot k \cdot (2 \cdot j2 + j3) \cdot \frac{1}{EI} = -0,001593$ m

Barra "bc":



1/3 Ljk

$k := Mb1$ $j := Mb$

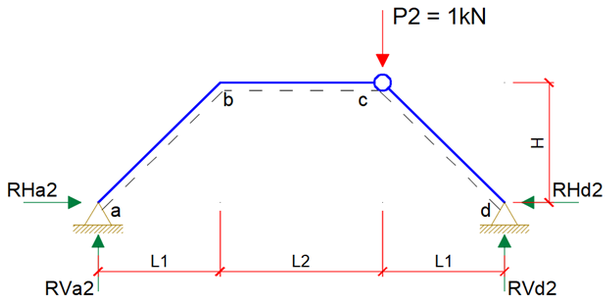
$L := L2 = 4$ m

$mbc1 := \frac{1}{3} \cdot L \cdot j \cdot k \cdot \frac{1}{EI} = -0,0026$ m

$\delta_hor_b := 1000 \cdot (mab1 + mbc1) = -4,2$ mm para esquerda

---

Diagrama de Momentos para o Carregamento Virtual destinado ao cálculo do Deslocamento Vertical em "c":



ΣMd = 0 (+) horário $P2 := 1$

RVa2.(2.L1+L2) - P2.L1 = 0

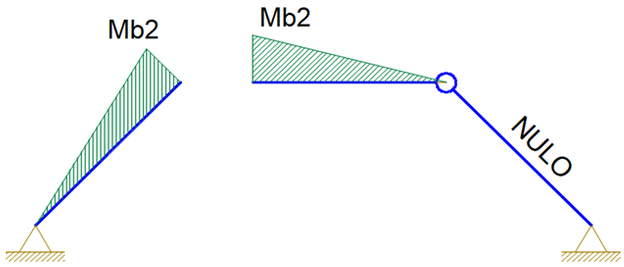
$RVa2 := \frac{1}{2 \cdot L1 + L2} \cdot P2 \cdot L1 = 0,3$ kN

ΣMc = 0 olhando para "a" (+) anti-horário

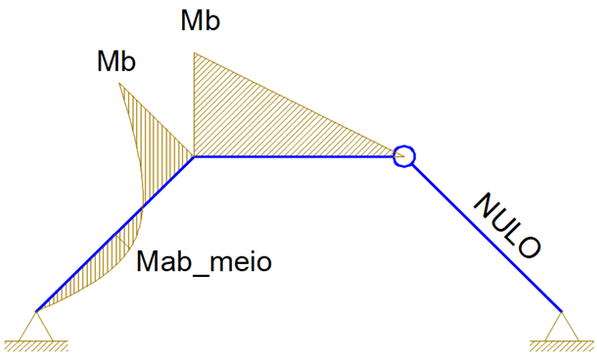
RHa2.H - RVa2.(L1+L2) = 0

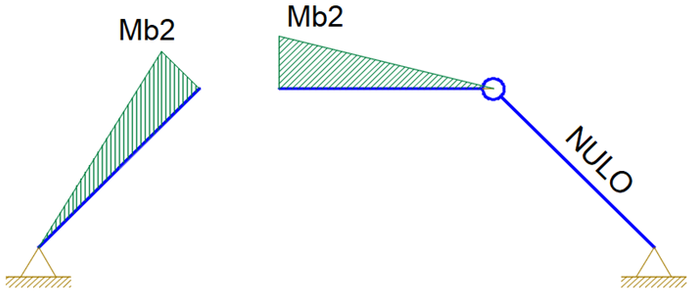
$RHa2 := \frac{1}{H} \cdot (RVa2 \cdot (L1 + L2)) = 0,525$ kN

$Mb2 := RVa2 \cdot L1 - RHa2 \cdot H = -1,2$ kN m

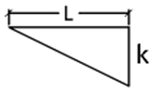


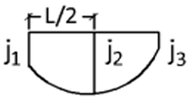
Cálculo do Deslocamento Vertical do Ponto "c":





Barra "ab":





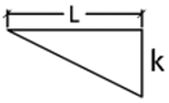
1/6 Lk(2j2+j3)

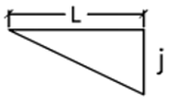
$k := Mb2 = -1,2$ $L := Lab = 5$

$j2 := Mab_meio = 0,75$ $j3 := Mb = -66$

$mab2 := \frac{1}{6} \cdot L \cdot k \cdot (2 \cdot j2 + j3) \cdot \frac{1}{EI} = 0,001194$ m

Barra "ef":





1/3 Ljk

$k := Mb2$ $j := Mb$

$L := L2 = 4$

$mbc2 := \frac{1}{3} \cdot L \cdot j \cdot k \cdot \frac{1}{EI} = 0,001956$ m

$\delta_ver_c := (-1000) \cdot (mab2 + mbc2) = -3,15$ mm para baixo

---

$Q01 := Mb = -66,000$
$Q02 := Mb1 = 1,6000$
$Q03 := Mb2 = -1,2000$
$Q04 := \delta_hor_b = -4,2000$
$Q05 := \delta_ver_c = -3,1500$
