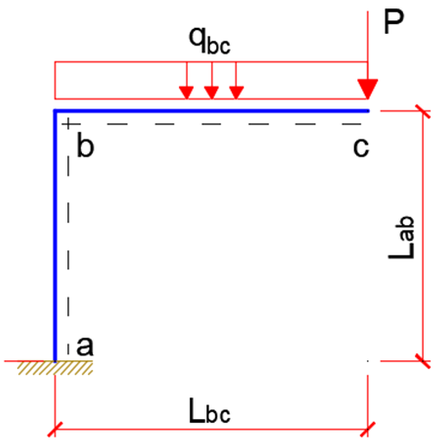
B2T4M0615B

- Calcular o deslocamento vertical do ponto "c".



$Lbc := 4,0$ m $\quad qbc := 10,0$ kN/m

$Lab := 6,0$ m

$P := 15,0$ kN

- Barra "bc": seção transversal retangular:

$b_bc := 0,20$ m $\quad h_bc := 0,50$ m

- Barra "ab": seção transversal retangular:

$b_ab := 0,20$ m $\quad h_ab := 0,20$ m

- Módulo de elasticidade e coef. de Poisson para todas as barras:

$E := 35 \cdot 10^{6}$ kN/m² $\quad \nu := 0,2$

OBS. b_bc e b_ab são entrantes no plano do papel e h_bc e h_ab são assentes ao plano do papel.

Q01 - Qual o valor do deslocamento vertical do ponto "c" devido aos efeitos de esforço cortante [em "mm" com positivo para cima] ?
Q02 - Qual o valor do deslocamento vertical do ponto "c" devido aos efeitos de esforço axial [em "mm" com positivo para cima] ?
Q03 - Qual o valor do deslocamento vertical do ponto "c" devido aos efeitos de momento fletor [em "mm" com positivo para cima] ?

Propriedades Geométricas e Rigidezes:

$G := \frac{E}{2 \cdot (1 + \nu)} = 1,4583 \cdot 10^{7} \ \frac{kN}{m^2}$

$\chi := \frac{6}{5}$

$A_bc := b_bc \cdot h_bc = 0,1 \ m^2$

$A_ab := b_ab \cdot h_ab = 0,04 \ m^2$

$I_bc := \frac{b_bc \cdot h_bc^3}{12} = 0,002083 \ m^4$

$I_ab := \frac{b_ab \cdot h_ab^3}{12} = 0,0001333 \ m^4$

$EI_bc := E \cdot I_bc = 72917 \ kN\,m^2$

$EI_ab := E \cdot I_ab = 4666,7 \ kN\,m^2$

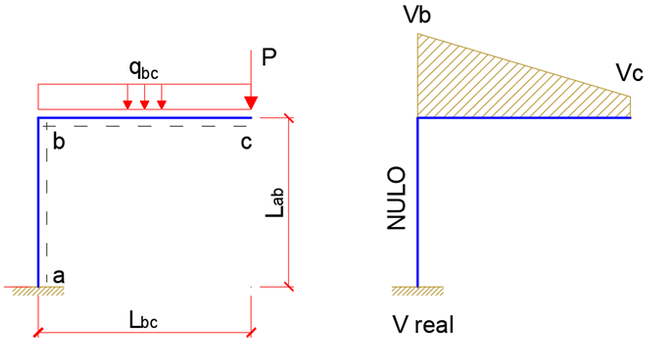
$EA_bc := E \cdot A_bc = 3,5000 \cdot 10^{6}$ kN

$EA_ab := E \cdot A_ab = 1,4000 \cdot 10^{6}$ kN

$GA_bc := G \cdot A_bc = 1,4583 \cdot 10^{6}$ kN

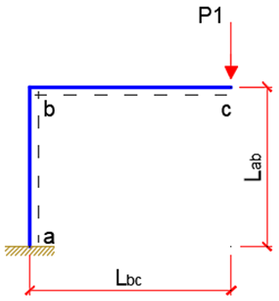
$GA_ab := G \cdot A_ab = 5,8333 \cdot 10^{5}$ kN

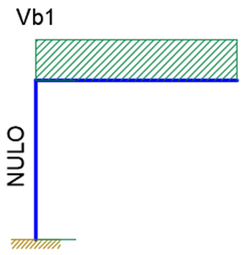
Efeitos de Esforços Cortantes:



$Vc := P = 15 \ kN$

$Vb := P + qbc \cdot Lbc = 55 \ kN$





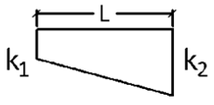
V virtual
(desloc. vert. em "c")

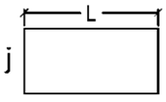
$P1 := 1$

$Vb1 := P1 = 1\ \text{kN}$

Barra "ab": $vab := 0$

Barra "bc":





$1/2\ Lj(k_1+k_2)$

$L := Lbc = 4$

$j := Vb1 = 1$

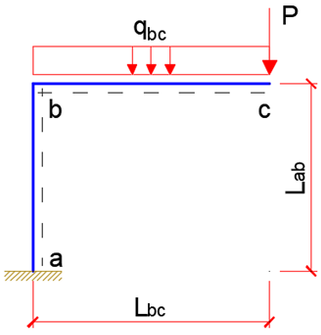
$k1 := Vb = 55$

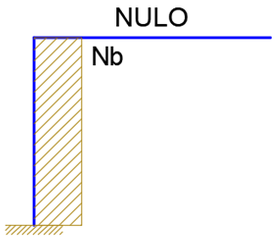
$k2 := Vc = 15$

$vbc := \frac{1}{2} \cdot L \cdot j \cdot (k1 + k2) \cdot \frac{1}{GA_bc} \cdot \chi = 0,0001152$

$\delta_vc_cor := -1000 \cdot (vbc + vab) = -0,1152\ \text{mm}$

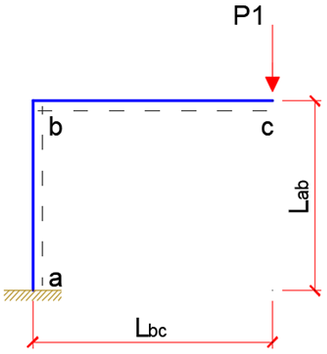
Efeitos de Esforços Axiais:

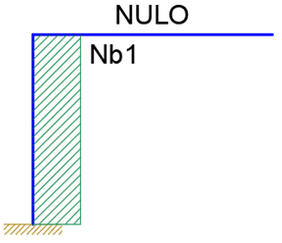




N real

$Nb := -P - qbc \cdot Lbc = -55$



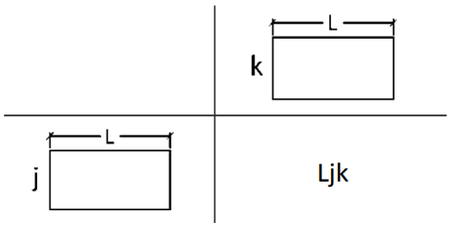


N virtual
(desloc. vert. em "c")

$Nb1 := -P1 = -1$

Barra "bc": $nbc := 0$

Barra "ab":



$L := Lab = 6$

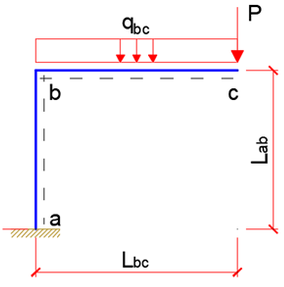
$j := Nb = -55$

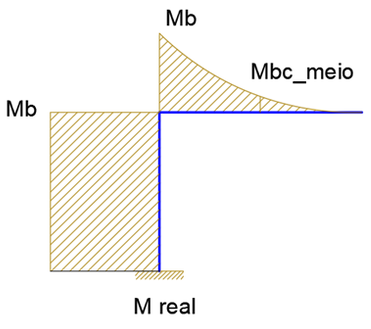
$k := Nb1 = -1$

$nab := \frac{L \cdot j \cdot k}{EA_ab} = 0,00023571$

$\delta_vc_axi := -1000 \cdot (nab + nbc) = -0,2357$ mm

Efeitos de Momentos Fletores:



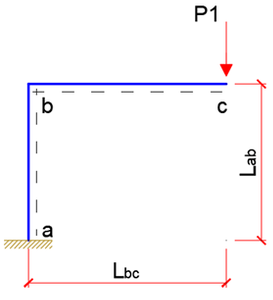


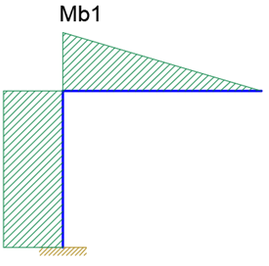
$Mc := 0$ kN m

$Mb := -P \cdot Lbc - qbc \cdot \frac{Lbc^2}{2} = -140$ kN m

$Mbc_meio := -P \cdot \frac{Lbc}{2} - qbc \cdot \frac{\left(\frac{Lbc}{2}\right)^2}{2} = -50$ kN m

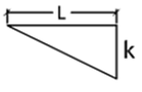
$Mbc_meio := \frac{Mb + Mc}{2} + \frac{qbc \cdot Lbc^2}{8} = -50$ kN m

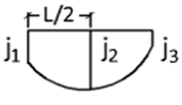




$Mb1 := -P1 \cdot Lbc = -4$ kN m

Barra "bc":





1/6 Lk(2j₂+j₃)

$L := Lbc = 4$ $\quad EI_bc = 72920$

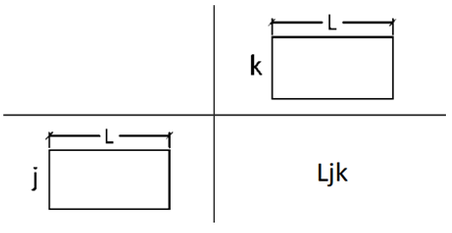
$k := Mb1 = -4$

$j3 := Mb = -140$

$j2 := Mbc_meio = -50$

$mbc := \frac{1}{6} \cdot L \cdot k \cdot (j2 + j3) \cdot \frac{1}{EI_bc} \cdot 1000 = 6,9486$ mm

Barra "ab":



$L := Lab = 6$ $\quad EI_ab = 4667$

$j := Mb = -140$

$k := Mb1 = -4$

$mab := \frac{L \cdot j \cdot k}{EI_ab} \cdot 1000 = 720,00$ mm

$\delta_vc_mom := -1 \cdot (mbc + mab) = -726,95$ mm

$Q01 := \delta_vc_cor = -0,11520$
$Q02 := \delta_vc_axi = -0,23571$
$Q03 := \delta_vc_mom = -726,95$

OBS : dada o deslocamento "exagerado" é necessário se levar em conta que o príoprio PTV já não se aplicada dado que o mesmo é válido para pequenos deslocamento e pequenas deformações para que seja aplicável o princípio de sobreposição de efeitos.
