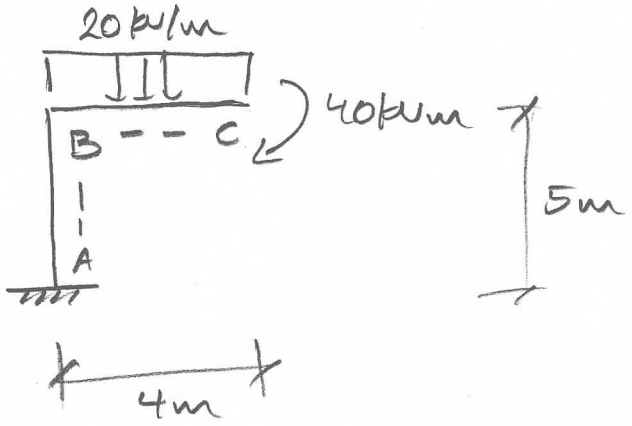
TE16 - B2 - 2000

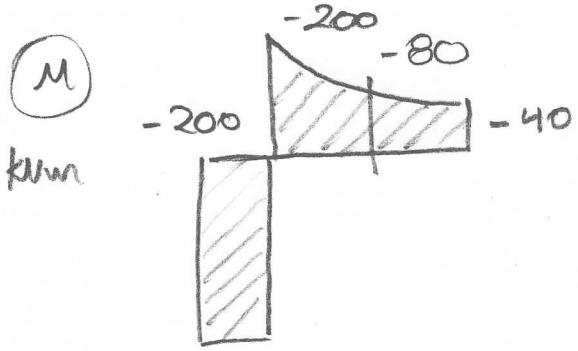


* CALCULAR O DESLOCAMENTO VERTICAL DO PONTO C;

$EI = 30000\ kNm^2$

→ CONSIDERAR SOMENTE EFEITOS DE FLEXÃO NOS CÁLCULOS;

CARREG. REAL

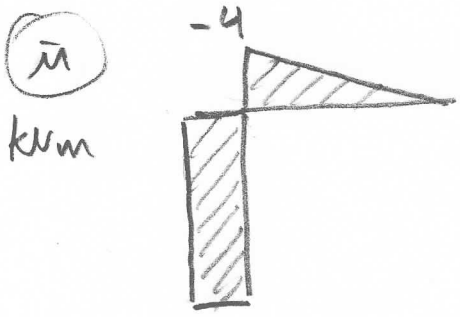


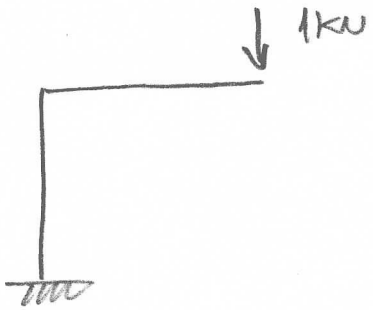
$M_{BC} = -40 - 20 \times 2 \times 1 = -80\ kNm$

$M_B = -40 - 20 \times 2 \times 4 =$

$M_A = M_B$

CARREG. VIRTUAL



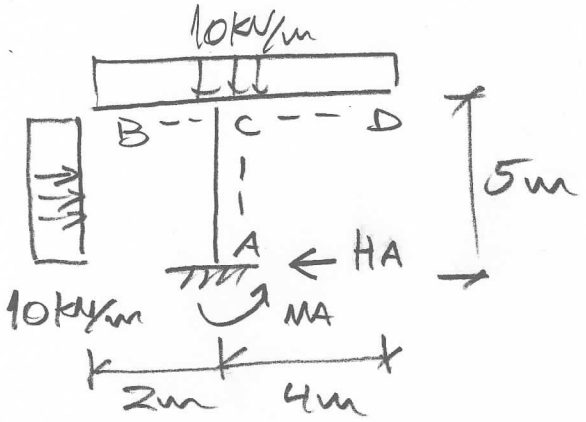


$$\delta_C = \frac{1}{EI}\left[\frac{1}{6} L_{BC}\, k(2j_2 + j_3) + L_{AB}\, j\, k\right]$$

$$\delta_C = \frac{1}{EI}\left[\frac{1}{6} \times 4 \times (-4)(2 \times (-80) - 200) + 5 \times (-4) \times (-200)\right]$$

$$\delta_C = \frac{1}{EI}\left[4960\right] = \frac{4960}{30000} = \underline{0{,}16533\ m \downarrow}$$

TE16-B3-2001 CALCULAR A ROTAÇÃO DO PONTO B;

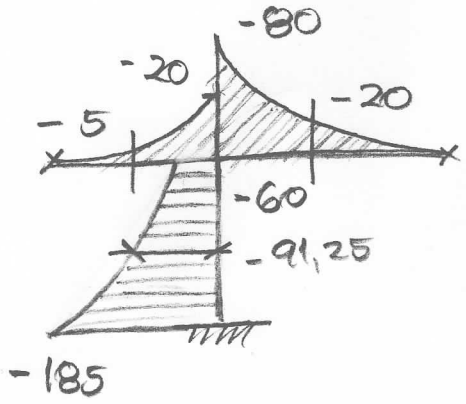


→ CONSIDERAR SOMENTE EFEITOS DE FLEXÃO;

→ TODAS AS BARRAS POSSUEM $EI = 40000\ kNm^2$;

- CARREGAMENTO REAL:

(M)



$M_{C\_CD} = 10 \times 4^2/2 = 80\ kNm$

$M_{C\_BC} = 10 \times 2^2/2 = 20\ kNm$

$M_{CD} = 10 \times 2^2/2 = 20\ kNm$

$M_{BC} = 10 \times 1^2/2 = 5\ kNm$

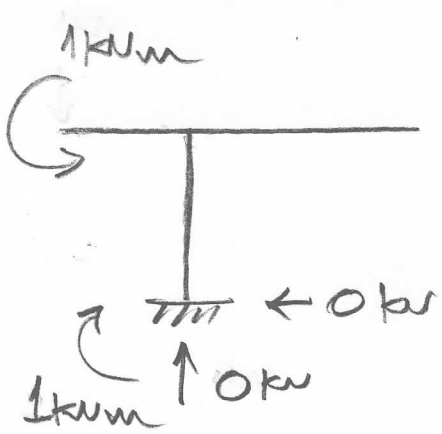
$MA = 10 \times 6 \times 1 + 10 \times 5^2/2$

$MA = 185\ kNm$

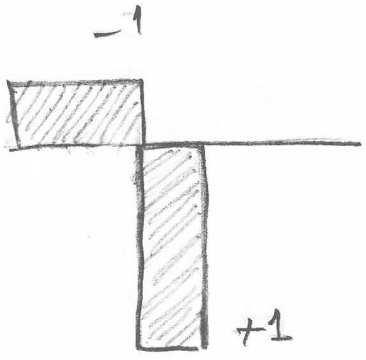
$HA = 10 \times 5 = 50\ kN$

$M_{C\_AC} = -185 + 50 \times 5 - 10 \times 5^2/2 = -60\ kNm$

- CARREGAMENTO VIRTUAL:



($\bar{M}$)



SOMENTE AS BARRAS BC E AC INFLUENCIAM;

$$\int_0^2 \bar{M}_{BC} M_{BC}\, dx = \frac{1}{6} Lk(j_1 + 4j_2 + j_3)$$

$$= \frac{1}{6} \times 2 \times (-1)(0 + 4(-5) + (-20)) = \frac{40}{3}\ kNm^3$$

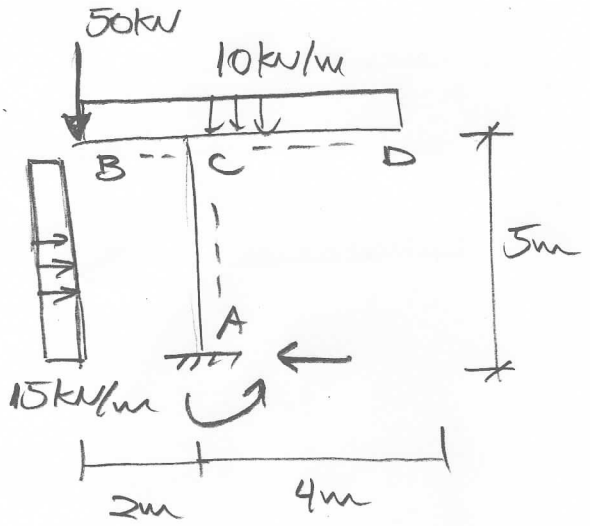
$$\int_0^5 \bar{M}_{AC} M_{AC}\, dx = \frac{1}{6} Lk(j_1 + 4j_2 + j_3)$$

$$= \frac{1}{6} \times 5 \times (+1)(-185 + 4(-91{,}25) - 60) = -\frac{1525}{3}\ kNm^3$$

$$\phi_B = \frac{1}{40000\ kNm^2 \times 1\ kNm} \times \left(\frac{40}{3} - \frac{1525}{3}\right) kNm^3$$

$$\phi_B = -0{,}012375\ rad \curvearrowright$$

TE16-B3-2002 CALCULAR A ROTAÇÃO DO PONTO B;



→ TODAS AS BARRAS POSSUEM O MESMO EJ = 50000 kNm²;

→ CONSIDERAR SOMENTE EFEITOS DE FLEXÃO NOS CÁLCULOS;

- CARREGAMENTO REAL:

$M_{C_{CD}} = 10 \times 4^2/2 = -80\ kNm$

$M_{\bar{C}D} = 10 \times 2^2/2 = -20\ kNm$

$M_{C_{BC}} = -50 \times 2 - 10 \times 2^2/2 = -120\ kNm$

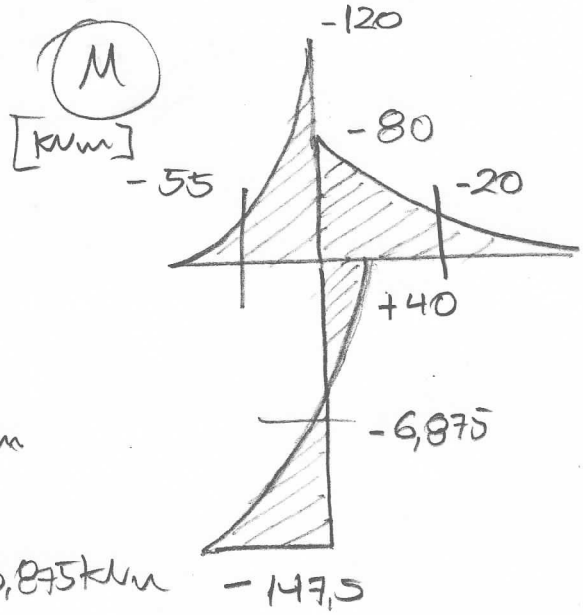
$M_{\bar{B}C} = -50 \times 1 - 10 \times 1^2/2 = -55\ kNm$

$M_A = 10 \times 6 \times 1 - 50 \times 2 + 15 \times 5^2/2 = 147{,}5\ kNm$

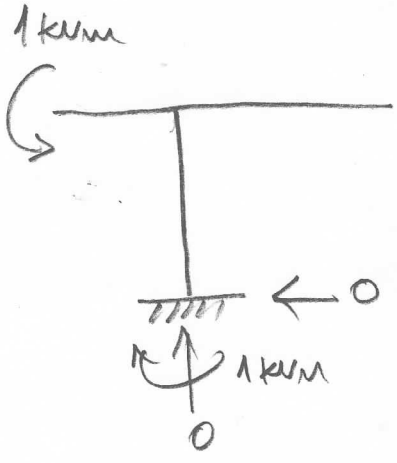
$H_A = 15 \times 5 = 75\ kN$

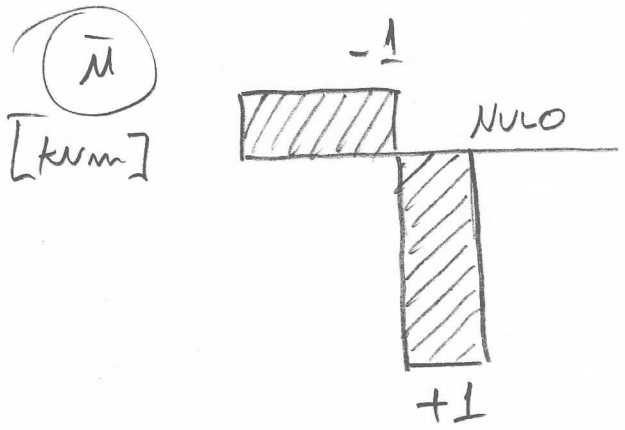
$M_{\bar{A}C} = -147{,}5 + 75 \times 2{,}5 - 15 \times 2{,}5^2/2 = -6{,}875\ kNm$

$M_{C_{AC}} = -147{,}5 + 75 \times 5 - 15 \times 5^2/2 = 40\ kNm$



- CARREGAMENTO VIRTUAL:





A BARRA CD NÃO INFLUENCIA NA ROTAÇÃO DE B;

$$\int_0^2 \bar{M}_{BC} M_{BC}\, dx = \frac{1}{6} L k (j_1 + 4j_2 + j_3)$$

$$= \frac{1}{6} \cdot 2 \cdot (-1)\,(0 + 4(-55) + (-120))$$

$$= \frac{340}{3}\ kN^2 m^3$$

$$\int_0^4 \bar{M}_{AC} M_{AC}\, dx = \frac{1}{6} L k (j_1 + 4j_2 + j_3)$$

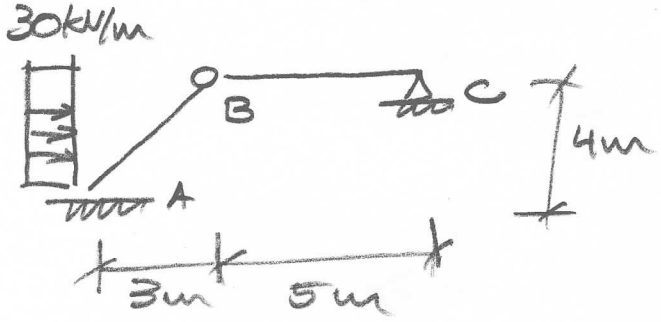
$$= \frac{1}{6} \cdot 5 \cdot (+1)\,(-147{,}5 + 4(-6{,}875) + 40)$$

$$= -\frac{225}{2}\ kN^2 m^3$$

$$\phi_B = \frac{\left(\frac{340}{3} - \frac{225}{2}\right) kN^2 m^3}{50000\ kN m^2 \times 1\ kN m} = 1{,}667 \times 10^{-5}\ rad$$

↶

TEIG-33-3000

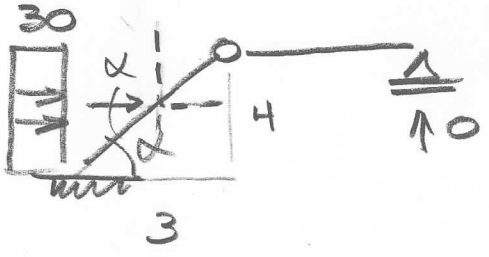


⇒ CALCULAR A REAÇÃO DE APOIO HORIZONTAL NO PONTO C

* CONSIDERAR SOMENTE EFEITOS DE FLEXÃO;
* TODAS AS BARRAS POSSUEM O MESMO EI;

→ ESTRUTURA HIPERESTÁTICA DE GRAU 1;

CASO 0



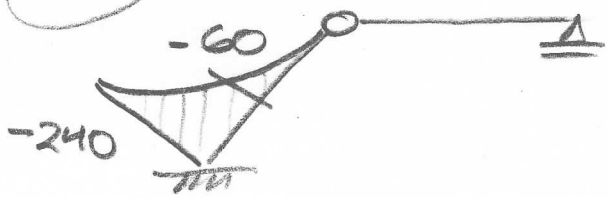
$M_{A_0} = 30 \times 4^2/2 = 240\ kNm$ ↺

$VA_0 = 0\ kN$ $\quad HA_0 = 30 \times 4 = 120\ kN$ ←

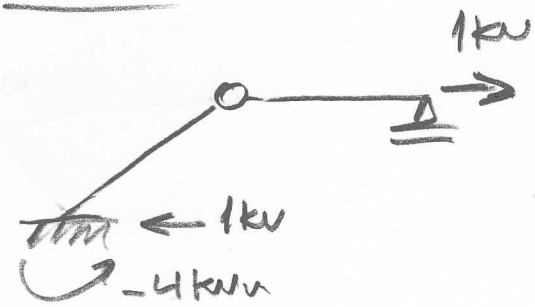
$M_{B_0} = 30 \times 2^2/2 = 60\ kNm$ ↻

$\cos\alpha = 3/5$ $\quad \sin\alpha = 3/5$

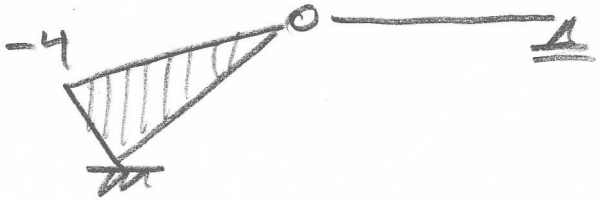
M0



CASO 1



M1



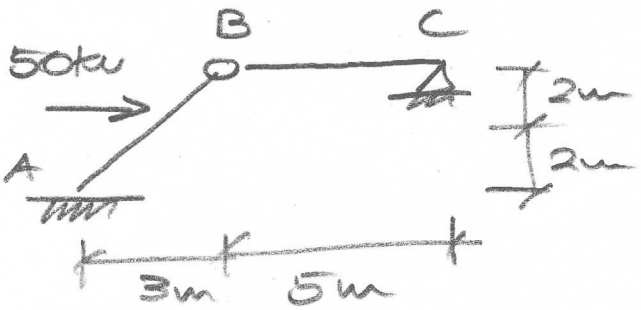
$$f_{11} = \frac{1}{3} \times 5 \times (-4)(-4) = \frac{5 \times 16}{3EI} = +80/3EI$$

$$\delta_{10} = \frac{1}{6} \times 5 \times (-4)(2 \times (-60) - 240) = +1200/EI$$

EQ DE COMP.: $f_{11} \times H_C + \delta_{10} = 0$

$$H_C = -\delta_{10}/f_{11} = \frac{-1200/EI}{80/3EI} = \frac{-3600}{80} = \boxed{-45\ kN} \leftarrow$$

TEIG-03-3001

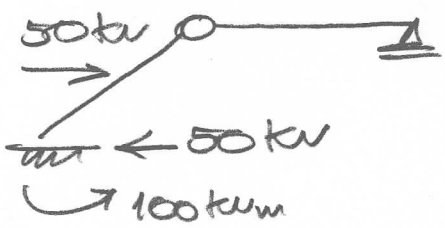


⇒ CALCULAR A REAÇÃO DE APOIO HORIZONTAL DO PONTO C

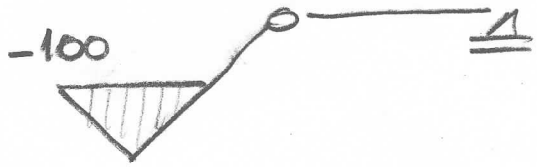
* CONSIDERAR SOMENTE EFEITOS DE FLEXÃO;
* TODAS AS BARRAS POSSUEM O MESMO EI;

↳ ESTRUTURA HIPERESTÁTICA DE GRAU 1;

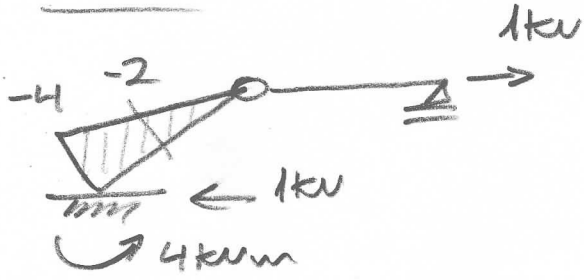
CASO 0



M_0



CASO 1



$$\delta_{10} = \frac{1}{6} L_j (2k_1 + k_2) \times \frac{1}{EI}$$

$$= \frac{1}{6} \times \frac{5}{2} \times -100(2 \times (-4) - 2)$$

$$= +\frac{2500}{6EI}$$

$$f_{11} = \frac{1}{3} \times 5 \times (-4)^2 / EI = 80/3EI$$

$$H_C \times f_{11} + \delta_{10} = 0 \qquad H_C = -\delta_{10}/f_{11}$$

$$H_C = -\frac{2500}{6EI} \times \frac{3EI}{80} = -\frac{2500}{160} = \boxed{-15{,}625\,kN} \leftarrow$$