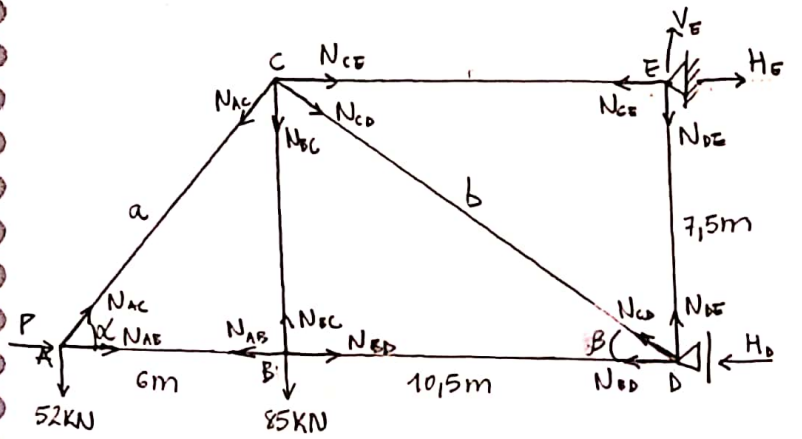
Prova 4 - Mec dos Sólidos 3

Aluno: Sérgio Everton da Silva Araújo

Engenharia Civil

Questão 1:



$a = \sqrt{6^2 + 7,5^2} = 9,60\,m$

$b = \sqrt{10,5^2 + 7,5^2} = 12,90\,m$

$A = 1600\,mm^2 = 0,0016\,m^2$

$E = 200\,GPa = 2 \cdot 10^8\,kPa$

$\sum F_v = 0 \Rightarrow V_E - 52 - 85 = 0 \Rightarrow V_E = 137\,KN$

$\sum M^E = 0 \Rightarrow -(H_D \cdot 7,5) + (85 \cdot 10,5) + (52 \cdot 16,5) + (P \cdot 7,5) = 0$

$-7,5\,H_D = -1750,5 - 7,5P$

$H_D = (233,4 + P)\,KN$

$\sum F_H = 0 \Rightarrow H_E - H_D + P = 0 \Rightarrow H_E = 233,4\,KN$

Reações nos nós:

$\sum F_{V_E} = 0 \Rightarrow V_E - N_{DE} = 0 \Rightarrow N_{DE} = V_E = 137\,KN$

$\sum F_{H_E} = 0 \Rightarrow H_E - N_{CE} = 0 \Rightarrow N_{CE} = H_E = 233,4\,KN$

$\sum F_{V_D} = 0 \Rightarrow N_{DE} + N_{CD} \cdot \frac{7,5}{12,9} = 0 \Rightarrow 137 + 0,58\,N_{CD} = 0 \Rightarrow N_{CD} = -235,70\,KN$

$\sum F_{H_D} = 0 \Rightarrow -N_{BD} - N_{CD} \cdot \frac{10,5}{12,9} - H_D = 0 \Rightarrow -N_{BD} - 41,6 - P = 0 \Rightarrow N_{BD} = -41,6 - P$

$\sum F_{V_B} = 0 \Rightarrow N_{BC} - 85 = 0 \Rightarrow N_{BC} = 85\,KN$

$\sum F_{H_B} = 0 \Rightarrow -N_{AB} + N_{BD} = 0 \Rightarrow N_{AB} = N_{BD} = -41,6 - P$

$\sum F_{V_A} = 0 \Rightarrow N_{AC} \cdot \frac{7,5}{9,6} - 52 = 0 \Rightarrow N_{AC} = 66,59\,KN$

Segundo Teorema de Castiliano:

$$\Delta_j = \sum_{i=1}^{m} \int_0^{L_i} \frac{N_i}{EA} \cdot \frac{dN_i}{dP}\, dx$$

para $P = 0$.

$$\Delta_{AB} = N_{AB} \cdot \frac{dN_{AB}}{dP} \cdot \frac{c}{EA} = 0,00078\,m$$

$$\Delta_{BC} = N_{BC} \cdot \frac{dN_{BC}}{dP} \cdot \frac{7,5}{EA} = 0$$

$$\Delta_{CD} = N_{CD} \cdot \frac{dN_{CD}}{dP} \cdot \frac{12,9}{EA} = 0$$

$$\Delta_{DE} = N_{DE} \cdot \frac{dN_{DE}}{dP} \cdot \frac{7,5}{EA} = 0$$

$$\Delta_{BD} = N_{BD} \cdot \frac{dN_{BD}}{dP} \cdot \frac{10,5}{EA} = 0,001365\,m$$

$$\Delta_{CE} = N_{CE} \cdot \frac{dN_{CE}}{dP} \cdot \frac{10,5}{EA} = 0$$

$$\Delta_{AC} = N_{AC} \cdot \frac{dN_{AC}}{dP} \cdot \frac{9,6}{EA} = 0$$

$$\Delta = \Delta_{AB} + \Delta_{BC} + \Delta_{CD} + \Delta_{DE} + \Delta_{BD} + \Delta_{CE} + \Delta_{AC}$$

$$\Delta = 0,00078 + 0,001365\,m$$

$$\Delta = 2,145 \cdot 10^{-3}\,m = 2,145\,mm$$

Portanto, o deslocamento no ponto A é 2,145mm no sentido de P.

Questão 2:

$\sigma_{adm} = 250 MPa$

$E = 200 GPa = 200000 N/mm^2$

$I_z = 128 \cdot 10^6 mm^4$

$I_y = 18,4 \cdot 10^6 mm^4$

$r_z = 130 mm$

$n = 2$

Flambagem em z, considerando $K = 2$:

$$P_{cr_z} = \frac{\pi^2 E I}{(KL)^2} = \frac{\pi^2 \cdot 200000 \cdot 128 \cdot 10^6}{(2 \cdot 9000)^2} = 779,82 KN$$

Flambagem em y:

$$P_{cr_y} = \frac{\pi^2 \cdot 200000 \cdot 18,4 \cdot 10^6}{(2 \cdot 700)^2}$$

$P_{cr_y} = 18530,68 KN$

Logo, $P_{cr} = P_{cr_z} = 779,82 KN$

Índice de esbeltez da coluna:

$$\lambda = \frac{KL}{r_z} = \frac{2 \cdot 9000}{130} = 138,46$$

Tensão crítica na coluna:

$$\sigma_{cr} = \frac{\pi^2 E}{\lambda^2} = \frac{\pi^2 \cdot 200000}{138,46^2} = 102,96 MPa$$

Logo, $\sigma_{cr} < \sigma_{adm}$.

Critério de estabilidade:

$$\sigma \leq \frac{\sigma_{cr}}{n} \Rightarrow \frac{P}{A} \leq \frac{\sigma_{cr}}{An} \Rightarrow P \leq \frac{\sigma_{cr}}{n} \Rightarrow P \leq \frac{779,82}{2}$$

$P \leq 389,91 KN$

Portanto, a carga admissível é 389,91 KN