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D L M M J V S

24*09*21

Mecânica dos Sólidos 3

AB2 - P2

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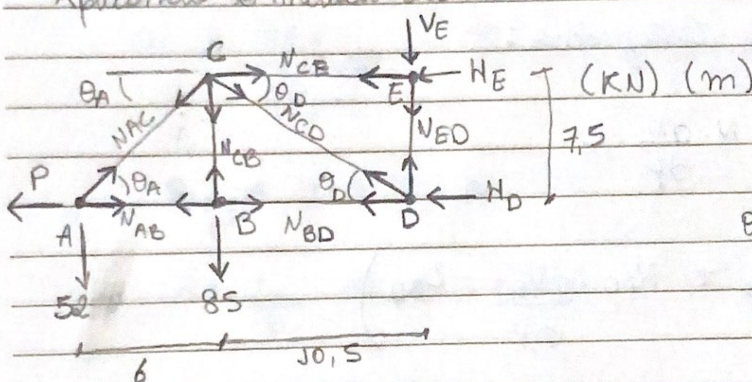
1) Dados:

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

$E = 200\ GPa = 200 \cdot 10^6\ kN/m^2$

$EA = 3{,}2 \times 10^5\ kN$

Aplicando o método dos nós:



$$\theta_A = tg^{-1}\left(\frac{7{,}5}{6}\right) = 0{,}896$$

$$\theta_D = tg^{-1}\left(\frac{7{,}5}{10{,}5}\right) = 0{,}62$$

$\Sigma F_{HA}: N_{AB} - P + N_{AC} \cos\theta_A = 0$

$\Sigma F_{VA}: -52 + N_{AC} \sin\theta_A = 0$

$\Sigma F_{HB}: -N_{AB} + N_{BD} = 0$

$\Sigma F_{VB}: N_{CB} - 85 = 0 \Rightarrow N_{CB} = 85.$

$\Sigma F_{HC}: -N_{AB} \cos\theta_A + N_{CE} + N_{CD} \cos\theta_D = 0$

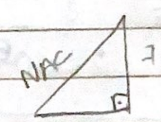
$\Sigma F_{VC}: -N_{CB} - N_{AC} \sin\theta_A - N_{CD} \sin\theta_D = 0$

$\Sigma F_{HD}: -N_{BD} - H_D - N_{CD} \cdot \cos\theta_D = 0$

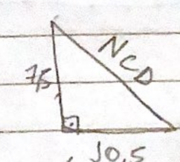
$\Sigma F_{VD}: N_{ED} + N_{CD} \cdot \sin\theta_D = 0$

$\Sigma F_{HE}: -H_E - N_{CE} = 0$

$\Sigma F_{VE}: -V_E - N_{ED} = 0$



$\hookrightarrow N_{AC} = 9{,}6\,m$



$\hookrightarrow N_{CD} = 12{,}9\,m$

$\therefore\ H_E = 233{,}4\ kN\ (\rightarrow)$

$V_E = 137{,}0\ kN\ (\uparrow)$

$H_D = P + 233{,}4\ (\leftarrow)$

↗ comprimento dos trechos

Trecho	N (kN)	$\partial N / \partial P$	N (para P=0)	L (m)
AB	$-P - 41,6$	-1	$-41,6$	6
AC	66,5925	0	66,5925	9,6
CB	85,0	0	85,0	7,5
CE	233,40	0	233,4	10,5
CD	$-235,7037$	0	$-235,7037$	12,9
BD	$-P - 41,6$	-1	$-41,6$	10,5
ED	137,0	0	137,0	7,5

Pelo segundo teorema de Castigliano:

$$\Delta_A = \frac{1}{AE} \cdot \sum N \cdot \frac{\partial N}{\partial P} \cdot L$$

$$\Delta_A = \frac{1}{AE} \left(N_{AB} \frac{\partial N_{AB}}{\partial P} \cdot L_{AB} + N_{BD} \cdot \frac{\partial N_{BD}}{\partial P} \cdot L_{BD} \right)$$

$$\Delta_A = \frac{1}{3,2 \times 10^5} \cdot \left((-41,6)(-1) \cdot (6) + (-41,6)(-1) \cdot (10,5) \right)$$

$$\boxed{\Delta_A = 0,002145 \text{ m}}$$

2) Dados:

$\sigma_{adm} = 250$ MPa

$E = 200$ GPa $= 200.000$ N/mm²

$I_z = 128 \times 10^6$ mm⁴

$I_y = 18,4 \times 10^6$ mm⁴

$r_z = 130$ mm

$n_f = 2$

$L = 9$ m $= 9000$ mm

Para $K_1 = 2$

$$P_{cr} = \frac{\pi^2 E I_z}{(K_1 \cdot L)^2} = \frac{\pi^2 (200.000 \times 128 \times 10^6)}{(2 \times 9000)^2}$$

$P_{cr_1} = 779,821$ N | Para $K_2 = 0,7$ e $I_y = 18,4 \times 10^6$

$P_{cr_2} = 915.096$ N

$$\lambda = \frac{L_e}{r} \Rightarrow \lambda = \frac{K_1 \times L}{r_z} = \frac{(2 \times 9000)}{130} = 138,5$$

Utilizando o maior comprimento ($K_1 = 2$):

$$\sigma_{cr} = \frac{\pi^2 \cdot E}{\lambda^2} = \frac{\pi^2 (200.000)}{(138,5)^2} = 102,9 \text{ MPa}$$

Como $102,9$ MPa ≤ 250 MPa então pelo critério de resistência é válido que:

$$\boxed{\sigma_{cr} = 102,9 \text{ MPa}}$$

Pelo critério de estabilidade: $\sigma \leq \frac{\sigma_{cr}}{n_f}$

$$\sigma \leq \frac{\sigma_{cr}}{n_f} \Rightarrow \frac{P}{\cancel{A}} \leq \frac{P_{cr}}{\cancel{A} \cdot n_f} \Rightarrow P \leq \frac{779,821 \text{ KN}}{2}$$

$$\boxed{P \leq 389,911}$$