Cargas Combinadas – Pilares — Flexão Parte 4

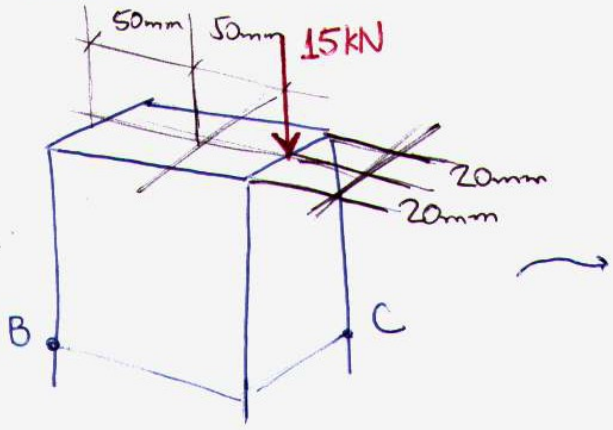
Hibeller: 304-320
Aula Online: 7

→ Princípio da Superposição

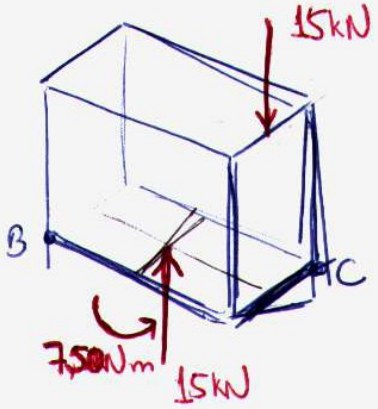
Saint-Vennant: { • relação linear tensão x deformação
• geometria do elemento não pode variar significativamente

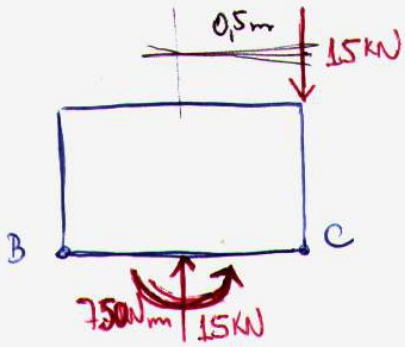
→ (revisão) { normal (axial)
momento fletor

a)



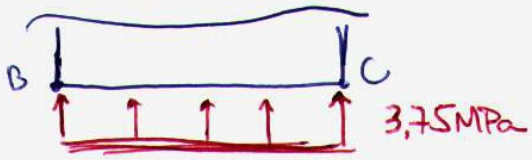
I) CARGAS INTERNAS

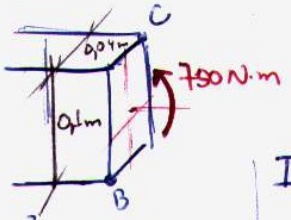




II) FORÇA NORMAL

$$\sigma = \frac{P}{A} = \frac{15000}{0,1 \times 0,04} = 3,75 MPa$$

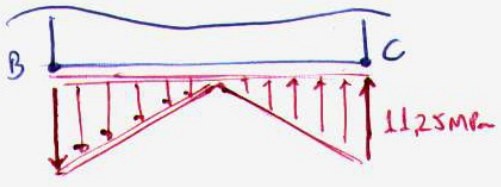




III) MOMENTO FLETOR

$$\sigma_{máx} = \frac{M.y}{I} \; ; \; I = \frac{b.h^3}{12} \; ; \; y = \frac{h}{2}$$

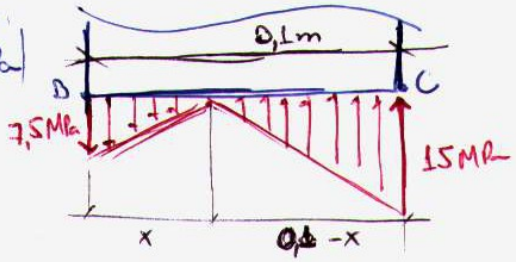
$$\sigma_{máx} = M.\frac{h}{2}.\frac{12}{b.h^3} = \frac{M.6}{b.h^2} = \frac{750.6}{0,04.(0,1)^2} = 11,25 MPa$$



IV) SUPERPOSIÇÃO

EM B: $\sigma = -3,75 + 11,25 = 7,5 MPa$

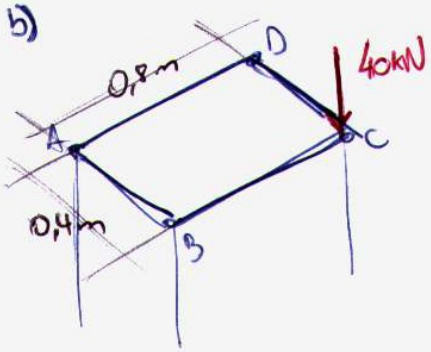
EM C: $\sigma = -3,75 - 11,25 = -15 MPa$



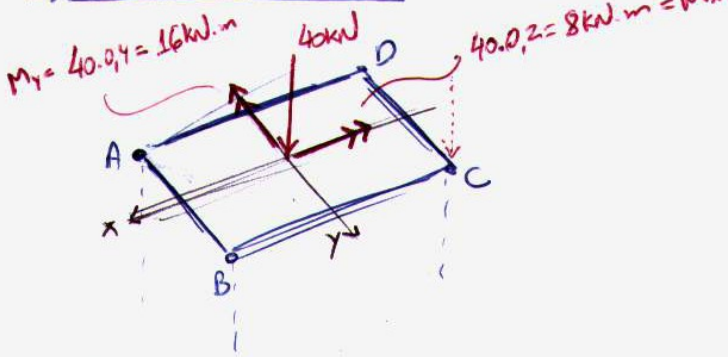
$$\frac{7,5}{x} = \frac{15}{(0,1-x)} \Rightarrow 15x = 0,75 - 7,5x \Rightarrow 22,5x = 0,75$$

$$x = 3,33 \times 10^{-2} m$$

b)



I) CARGAS INTERNAS



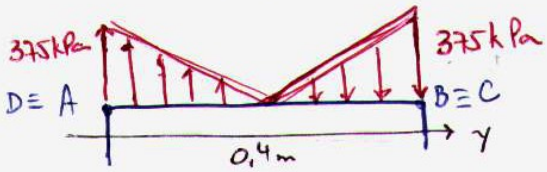
II) FORÇA NORMAL

$$\sigma = \frac{P}{A} = \frac{40.000}{0,8 \cdot 0,4} = 125kPa$$

III) MOMENTO Mx

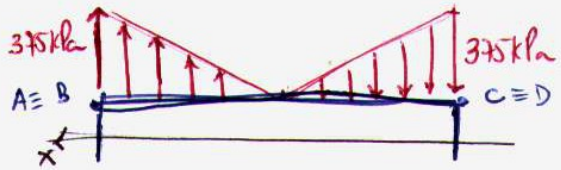
$$\sigma = \frac{Mx}{I} \; ; \; I = \frac{b.h^3}{12} \; ; \; y = \frac{h}{2}$$

$$\sigma = \frac{6M}{b.h^2} = \frac{6.8.000}{0,8.(0,4)^2} = 375kPa$$



IV) MOMENTO FLETOR My

$$\sigma = \frac{M.y}{I} \Rightarrow \sigma = \frac{6.M}{b.h^2} = \frac{6.16000}{0,4.(0,8)^2} = 375kPa$$



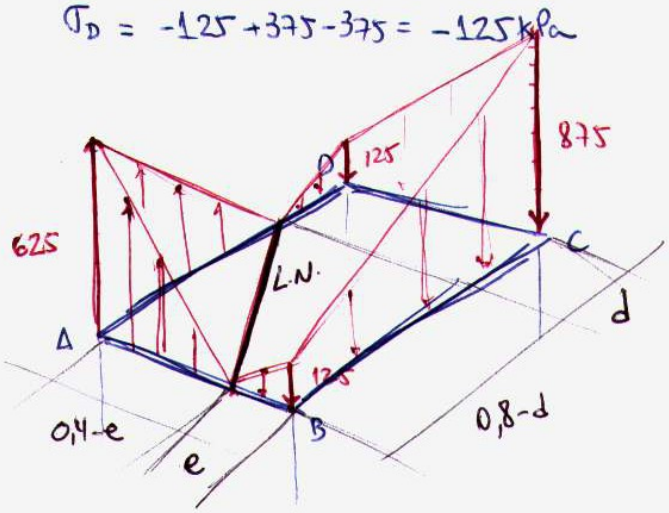
V) SUPERPOSIÇÃO

$$\sigma_A = -125 + 375 + 375 = +625kPa$$

$$\sigma_B = -125 - 375 + 375 = -125kPa$$

$$\sigma_C = -125 - 375 - 375 = -875kPa$$

$$\sigma_D = -125 + 375 - 375 = -125kPa$$



VI) EXCENTRICIDADES

$$\frac{125}{d} = \frac{625}{(0,8-d)} \Rightarrow 625d = 100 - 125d$$

$$750d = 100 \Rightarrow d = 0,13m$$

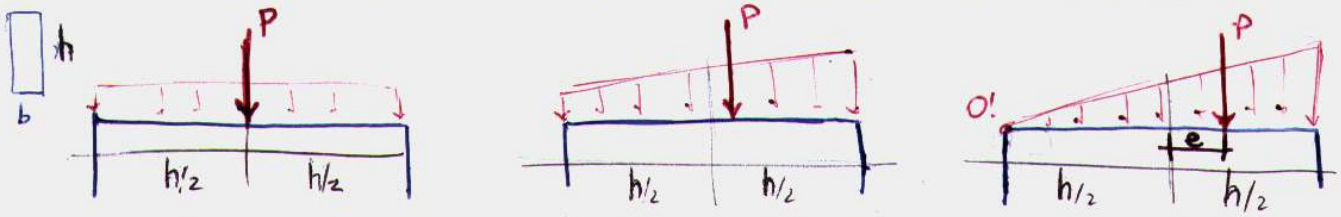
$$\frac{125}{e} = \frac{625}{(0,4-e)} \Rightarrow 625e = 50 - 125e$$

$$750e = 50 \Rightarrow e = 0,067m$$

NÚCLEO CENTRAL

QUAL A MAIOR EXCENTRICIDADE PARA A QUAL NÃO APARECE TRAÇÃO?

→ IMPORTANTE PARA PEDRA OU CONCRETO NÃO ARMADO EM ARCOS E PILARES



$$\sigma_{min} = -\frac{P}{A} + \frac{M \cdot c}{I_x} \quad ; \quad I_x = \frac{b \cdot h^3}{12} = \frac{A \cdot h^2}{12}$$

$$M = P \cdot e$$

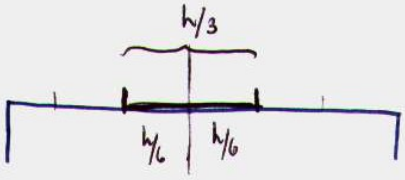
$$c = \frac{h}{2}$$

$$\sigma_{min} = -\frac{P}{A} + P \cdot e \cdot \frac{h}{2} \cdot \frac{12}{A h^2} = -\frac{P}{A} + \frac{P}{A} \cdot \frac{6e}{h} \leq 0$$ ← DESEJAMOS ISSO

Logo

$$\sigma_{min} \leq 0 \text{ se } \frac{P}{A} \cdot \frac{6e}{h} \leq \frac{P}{A} \Rightarrow \sigma_{min} \leq 0 \text{ se } \frac{6e}{h} \leq 1$$

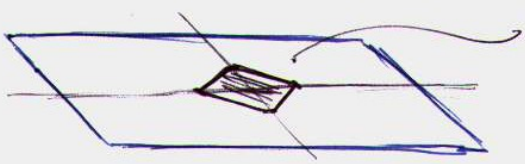
$$\text{ou } \sigma_{min} \leq 0 \text{ se } \boxed{e \leq \frac{h}{6}}$$



ESSE CONCEITO PODE SER EXTENDIDO PARA AMBAS AS DIREÇÕES

$$\sigma_{min} = -\frac{P}{A} + \frac{P}{A} \cdot \frac{6e_y}{h} + \frac{P}{A} \cdot \frac{6e_x}{b} \leq 0$$

$$\Rightarrow \frac{P}{A} \cdot \frac{6e_y}{h} + \frac{P}{A} \cdot \frac{6e_x}{b} \leq \frac{P}{A} \Rightarrow \frac{6e_y}{h} + \frac{6e_x}{b} \leq 1$$

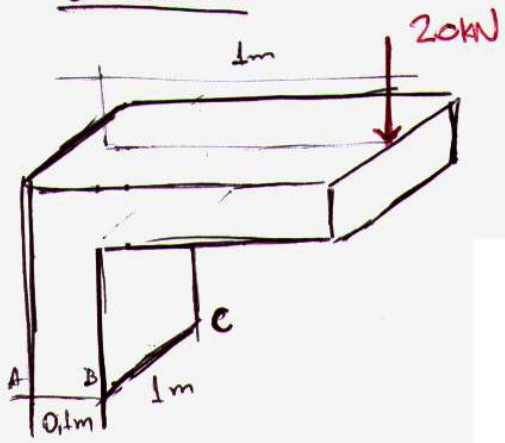


NÚCLEO CENTRAL

EXERCÍCIOS: 8.15, 8.21, 8.22

EXTRAS: 8.25, 8.31, 8.62

EXERCÍCIO



QUAL A DISTRIBUIÇÃO DE TENSÕES NORMAIS EM ABCD