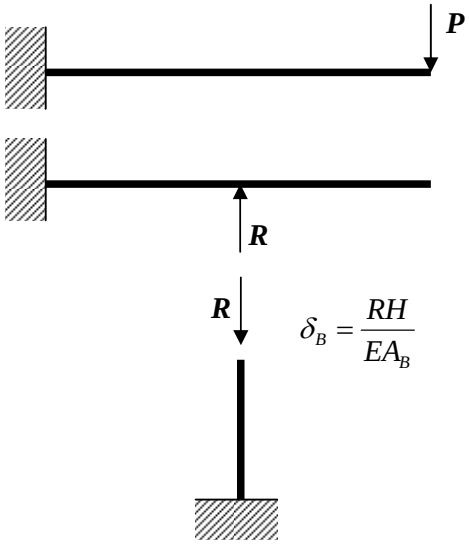
Problema 1. (3.0 pontos)



$$\delta_B^P = \frac{P(L/2)^2}{6EI_V}(3L - L/2) = \frac{5PL^3}{48EI_V}$$

$$\delta_B^R = \frac{R(L/2)^3}{3EI_V} = \frac{RL^3}{24EI_V}$$

$$\delta_B = \frac{RH}{EA_B}$$

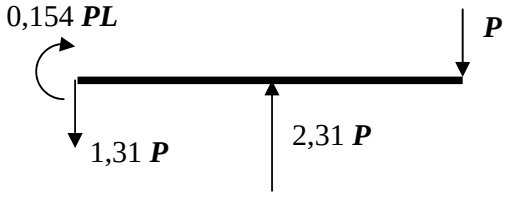
$$\delta_B = \delta_B^P - \delta_B^P \quad \Rightarrow \quad \frac{RH}{EA_B} = \frac{5PL^3}{48EI_V} - \frac{RL^3}{24EI_V}$$

$$R = \frac{5}{2}\left[1 + 24\frac{I_V H}{A_B L^3}\right]^{-1} P$$

$$I_V = \frac{bh^3}{12} = 2{,}08 \times 10^{-10}\,\text{m}^4,\ A_B = a^2 = 9{,}00 \times 10^{-6}\,\text{m}^2,\ H = 150\ \text{mm},\ L = 100\ \text{mm},\ I_B = \frac{a^4}{12} = 6{,}75 \times 10^{-12}\,\text{m}^4$$

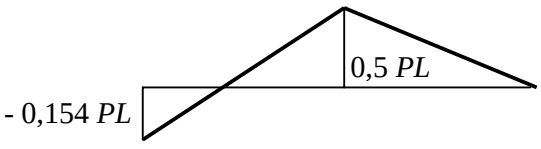
$$\boxed{R = 2{,}31P}$$

Reações na Viga



Reações na Barra

Distribuição de Momento Fletor na Viga



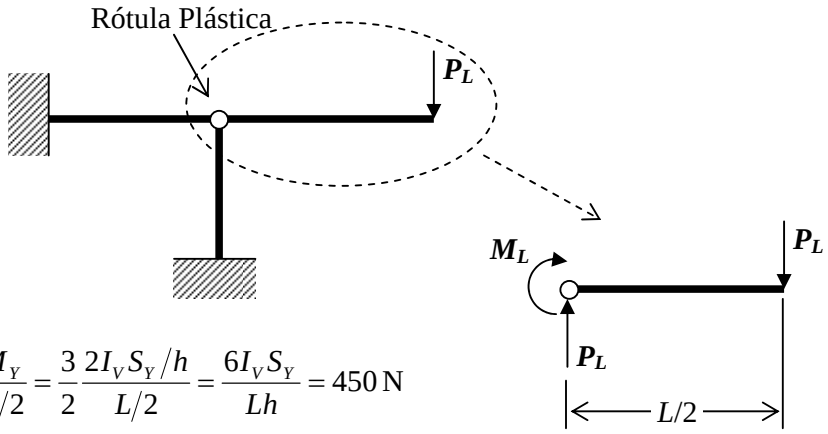
1) Falha por escoamento na viga: $\max\{|\sigma_{xx}|\} = \frac{h}{2}\frac{|M_{\max}|}{I_V} = \frac{h}{2}\frac{0{,}5PL}{I_V} < S_y \Rightarrow P < \frac{4S_y I_V}{Lh} = 300\,\text{N}$

2) Falha por escoamento na barra: $\max\{|\sigma|\} = \frac{R}{A_B} = \frac{2{,}31P}{A_B} < S_y \Rightarrow P < \frac{S_y A_B}{2{,}31} = 1404\,\text{N}$

3) Falha por flambagem na barra: $R = 2{,}31P < P_{\text{cr}} = \pi^2 \frac{EI_B}{H^2} \Rightarrow P < \frac{\pi^2}{2{,}31}\frac{EI_B}{H^2} = 257\,\text{N}$

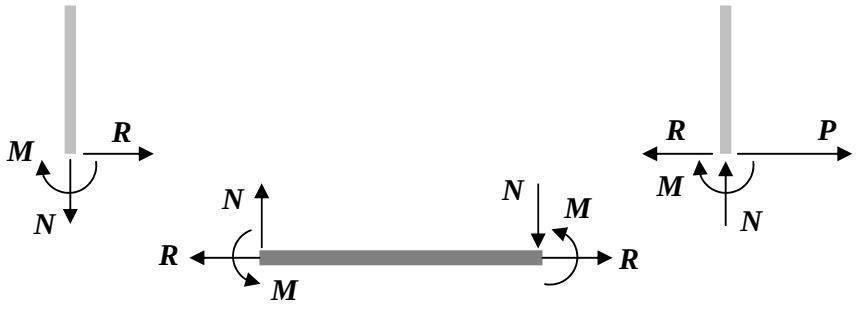
$$\boxed{P_{\max} = 257\,\text{N}}$$

Problema 2. (2.0 pontos)

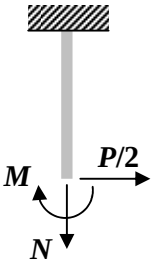


$$P_L = \frac{M_L}{L/2} = \frac{3}{2}\frac{M_Y}{L/2} = \frac{3}{2}\frac{2I_V S_Y/h}{L/2} = \frac{6I_V S_Y}{Lh} = 450\,\text{N}$$

Problema 3. (2.5 pontos)



Simetria $\Rightarrow R = P/2$

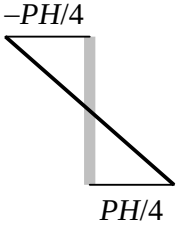


$$\delta = \frac{(P/2)H^3}{3EI} - \frac{MH^2}{3EI}$$

$$\theta = \frac{(P/2)H^2}{2EI} - \frac{MH}{EI}$$

$$\theta = 0 \Rightarrow M = \frac{PH}{4} \Rightarrow \delta = \frac{PH^3}{6EI} - \frac{PH^3}{12EI} = \frac{PH^3}{6EI}$$

Distribuição de Momento Fletor



Desprezando-se o efeito da força normal

$$\max\{|\sigma|\} = \frac{h}{2}\frac{|M_{\max}|}{I} = \frac{h}{2}\frac{PH/4}{I} < S_y \Rightarrow P < \frac{8IS_y}{Hh}$$

$$P = \frac{6EI}{H^3}\delta \Rightarrow \delta < \frac{4}{3}\frac{S_y H^2}{Eh}$$

$$\boxed{\delta_{\max} = \frac{4}{3}\frac{S_y H^2}{Eh} = 7{,}78\,\text{mm}}$$

Problema 4. (2.5 pontos)

Gráfico da Força *vs.* Deslocamento do conjunto

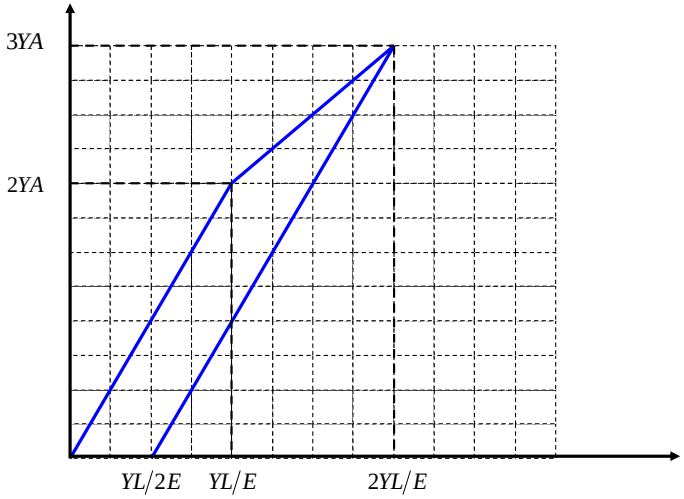
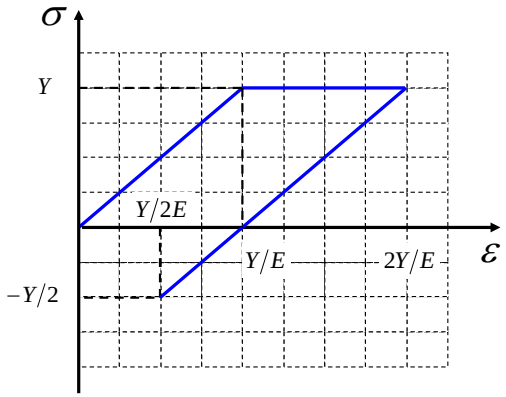


Gráfico da Tensão *vs*. Deformação da Barra 1



Deformação residual: $\delta^R = YL/2\,E$

Tensão residual na barra 1: $\sigma_1^R = -Y/2$

Tensão residual nas barras 2: $\sigma_1^R = Y/2$