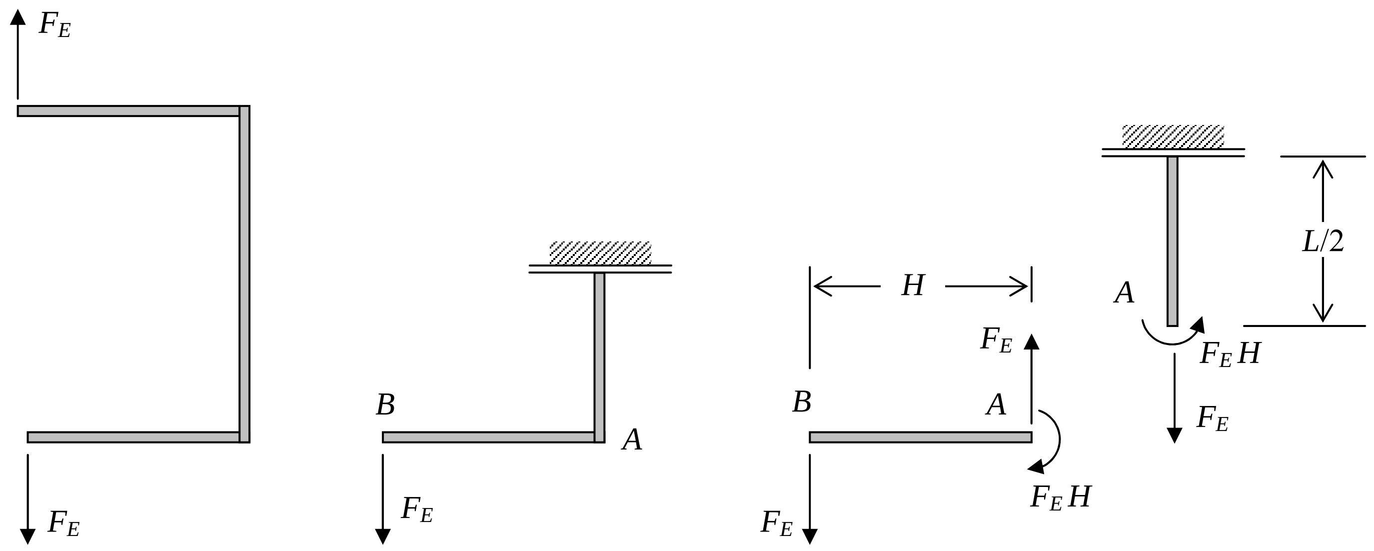
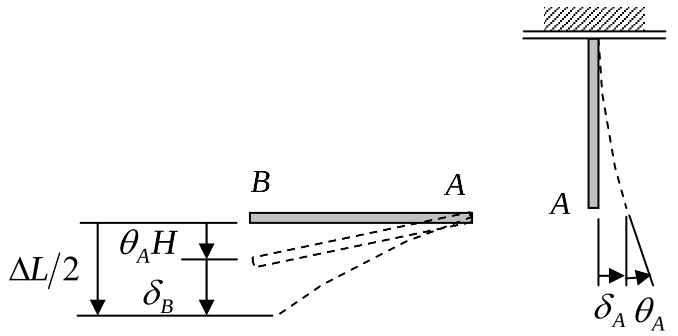
Problema 1.





$$\theta_A = \frac{F_E H (L/2)}{EI}$$

$$\frac{\Delta L}{2} = \delta_B + H\theta_A + \cancelto{\approx 0}{\frac{F_E L}{2EA}} = \frac{F_E H^3}{3EI} + \frac{F_E H^2 L}{2EI}$$

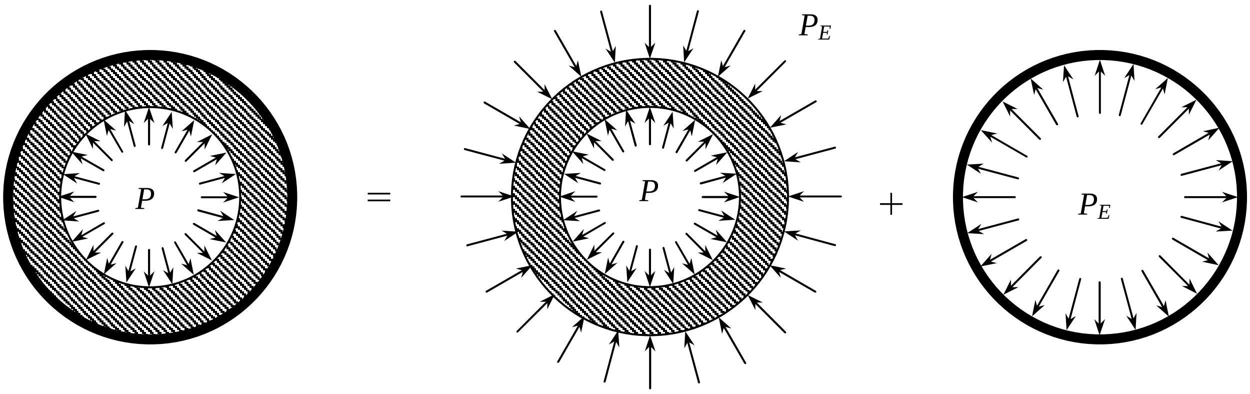
$$\varepsilon = \frac{\Delta L}{L} = \frac{F_E H^3}{EIL}\left(\frac{2}{3} + \frac{L}{H}\right)$$

$$\varepsilon_E = \frac{h}{2}\frac{F_E H}{EI}$$

$$\boxed{\frac{\varepsilon_E}{\varepsilon} = \frac{Lh}{2H^2}\left(\frac{2}{3} + \frac{L}{H}\right)^{-1}}$$

$$\varepsilon = \frac{P}{E_{CP}A_{CP}} \Rightarrow \frac{F_E H^3}{EIL}\left(\frac{2}{3} + \frac{L}{H}\right) = \frac{P}{E_{CP}A_{CP}} \Rightarrow \boxed{\frac{F_E}{P} = \frac{EIL}{E_{CP}A_{CP}H^3}\left(\frac{2}{3} + \frac{L}{H}\right)^{-1}}$$

Problema 2.



$$u_r(b_T) = \frac{1-\nu_T}{E_T}\frac{\left(Pa_T^2 - P_E b_T^2\right)}{\left(b_T^2 - a_T^2\right)} b_T + \frac{1+\nu_T}{E_T}\frac{a_T^2 b_T^2 \left(P - P_E\right)}{\left(b_T^2 - a_T^2\right) b_T}, \quad \Delta D_J = \frac{P_E D_J^2}{2E_J t_J}$$

$$u_r(b_T) = \frac{\Delta D}{2} \Rightarrow \frac{1-\nu_T}{E_T}\frac{\left(Pa_T^2 - P_E b_T^2\right)}{\left(b_T^2 - a_T^2\right)} b_T + \frac{1+\nu_T}{E_T}\frac{a_T^2 b_T^2 \left(P - P_E\right)}{\left(b_T^2 - a_T^2\right) b_T} = \frac{P_E D_J^2}{4E_J t_J}$$

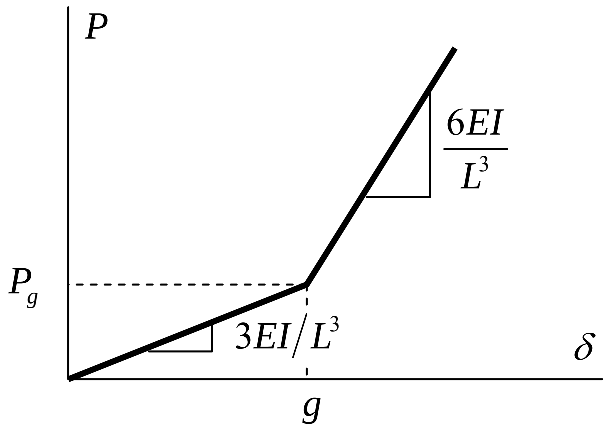
$$P_E = \frac{2a_T^2 b_T \big/ E_T(b_T^2 - a_T^2)}{\dfrac{b_T\left((1-\nu_T)b_T^2 + (1+\nu_T)a_T^2\right)}{E_T(b_T^2 - a_T^2)} + \dfrac{D_J^2}{4E_J t_J}} P = 2.18\,\text{MPa}$$

$$\sigma_{\theta\theta} = \frac{P_E D_J}{2t_J} = 56.7\,\text{MPa}$$

Problema 3.

(a) $$P_g = \frac{3EI}{L^3} g$$

(b) $$P = \begin{cases} \dfrac{3EI}{L^3}\delta & 0 < \delta < g \\ P_g + 2\left(\dfrac{3EI}{L^3}\right)(\delta - g) & \delta > g \end{cases}$$



Problema 4.

$$\sigma_{av} = \frac{\sigma_{xx} + \sigma_{yy}}{2} = 35.0 \text{ MPa}$$

$$R = \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \sigma_{xy}^2} = 175 \text{ MPa}$$

$$\sigma_1 = \sigma_I = \sigma_{av} + R = 210 \text{ MPa}$$

$$\sigma_2 = \sigma_{zz} = 0$$

$$\sigma_3 = \sigma_{II} = \sigma_{av} - R = -140 \text{ MPa}$$

$$\tau_{\max} = \frac{\sigma_1 - \sigma_3}{2} = 175 \text{ MPa} > \mathrm{S_y}/2$$

$$\sigma_{\mathrm{VM}} = \sqrt{\frac{1}{2}\left((\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2\right)} = 305 \text{ MPa} < \mathrm{S_y}$$

De acordo com o critério de Tresca, o componente estaria operando no regime plástico. Por outro lado, pelo critério de von Mises, o componente estaria ainda dentro do regime elástico.