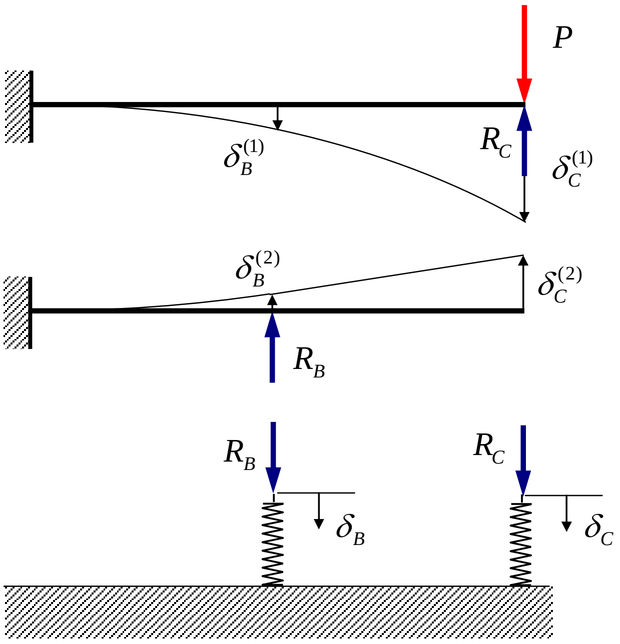
Problema 1.



$$\delta_C^{(1)} = \frac{(P-R_C)L^3}{3EI} \qquad \delta_B^{(1)} = \frac{5(P-R_C)L^3}{48EI}$$

$$\delta_C^{(2)} = \frac{5R_B L^3}{48EI} \qquad \delta_B^{(2)} = \frac{R_B L^3}{24EI}$$

$$\delta_C = R_C/k \qquad \delta_C = \delta_C^{(1)} - \delta_C^{(2)}$$

$$\delta_B = R_B/k \qquad \delta_B = \delta_B^{(1)} - \delta_B^{(2)}$$

$$\frac{R_C}{k} = \frac{(P-R_C)L^3}{3EI} - \frac{5R_B L^3}{48EI}$$

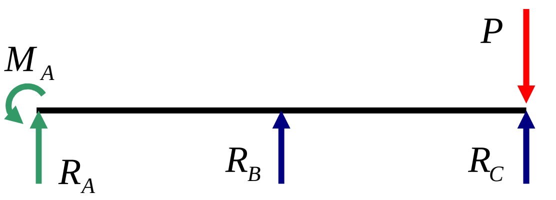
$$\frac{R_B}{k} = \frac{5(P-R_C)L^3}{48EI} - \frac{R_B L^3}{24EI}$$

Resolvendo para R_B e R_C:

$$R_B = \frac{80\left(kL^3/3EI\right)}{7\left(kL^3/3EI\right)^2 + 288\left(kL^3/3EI\right) + 256} P$$

$$R_C = \frac{7\left(kL^3/3EI\right)^2 + 256\left(kL^3/3EI\right)}{7\left(kL^3/3EI\right)^2 + 288\left(kL^3/3EI\right) + 256} P$$

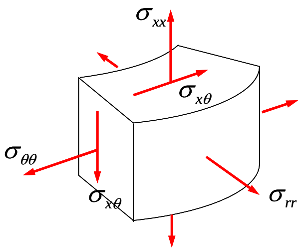
As reações de apoio são:



$$R_A = P - (R_B + R_C) = \frac{256 - 48\left(kL^3/3EI\right)}{7\left(kL^3/3EI\right)^2 + 288\left(kL^3/3EI\right) + 256} P$$

$$M_A = (P - R_C - \frac{1}{2}R_B)L = \frac{256 - 8\left(kL^3/3EI\right)}{7\left(kL^3/3EI\right)^2 + 288\left(kL^3/3EI\right) + 256} PL$$

Problema 2.



$\sigma_{\theta\theta}$ - Tensão circunferencial devido à pressão interna

σ_{rr} - Tensão radial devido à pressão interna

σ_{xx} - Tensão axial devido à pressão interna

$\sigma_{x\theta}$ - Tensão cisalhante devido à torção

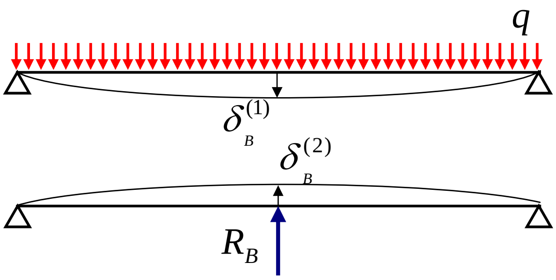
$$[\sigma]=\begin{bmatrix}\sigma_{xx} & \sigma_{x\theta} & 0\\ \sigma_{x\theta} & \sigma_{\theta\theta} & 0\\ 0 & 0 & \sigma_{rr}\end{bmatrix}$$

Tensão	***Parede Interna do Tubo***	***Parede Externa do Tubo***
$\sigma_{\theta\theta}$	$\sigma_{\theta\theta}=\dfrac{(b^2/a^2+1)}{(b^2/a^2-1)}P=83.3\ MPa$	$\sigma_{\theta\theta}=\dfrac{2}{(b^2/a^2-1)}P=33.3\ MPa$
σ_{rr}	$\sigma_{rr}=-P=-50.0\ MPa$	$\sigma_{rr}=0$
σ_{xx}	$\sigma_{xx}=\dfrac{1}{(b^2/a^2-1)}P=16.7\ MPa$	$\sigma_{xx}=\dfrac{1}{(b^2/a^2-1)}P=16.7\ MPa$
$\sigma_{x\theta}$	$\sigma_{x\theta}=a\dfrac{T}{\pi(b^4-a^4)/2}=34.0\ MPa$	$\sigma_{x\theta}=b\dfrac{T}{\pi(b^4-a^4)/2}=67.9\ MPa$
σ_M	$\sigma_M=\dfrac{\sigma_{\theta\theta}+\sigma_{xx}}{2}=50.0\ MPa$	$\sigma_M=\dfrac{\sigma_{\theta\theta}+\sigma_{xx}}{2}=25.0\ MPa$
R	$R=\sqrt{(\dfrac{\sigma_{\theta\theta}-\sigma_{xx}}{2})^2+\sigma_{x\theta}^{\ 2}}=47.6\ MPa$	$R=\sqrt{(\dfrac{\sigma_{\theta\theta}-\sigma_{xx}}{2})^2+\sigma_{x\theta}^{\ 2}}=68.4\ MPa$
σ_1	$\sigma_1=\sigma_M+R=97.6\ MPa$	$\sigma_1=\sigma_M+R=93.4\ MPa$
σ_2	$\sigma_2=\sigma_M-R=2.4\ MPa$	$\sigma_2=\sigma_{rr}=0$
σ_3	$\sigma_3=\sigma_{rr}=-50.0\ MPa$	$\sigma_3=\sigma_M-R=-43.4\ MPa$
σ_{VM}	$\sigma_{VM}=130\ MPa$	$\sigma_{VM}=121\ MPa$
$\tau_{\max}$	$\tau_{\max}=73.8\ MPa$	$\tau_{\max}=68.4\ MPa$

A parede interna é a mais carregada. Portanto, os fatores de segurança são:

$$FS_{VM}=\frac{S_Y}{\sigma_{VM}}=1.9 \qquad FS_{Tresca}=\frac{S_Y/2}{\tau_{\max}}=1.6$$

Problema 3.

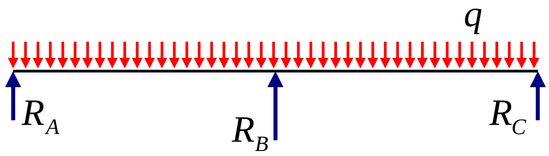


$$\delta_B^{(1)} = \frac{5qL^4}{384EI} \qquad \delta_B^{(2)} = \frac{R_B L^3}{48EI}$$

$$\delta_B = \delta_B^{(1)} - \delta_B^{(2)} = 0 \Rightarrow R_B = \frac{5}{8}qL$$

As demais reações de apoio são:

$$R_A = R_C = \frac{3}{16}qL$$



O momento fletor máximo ocorre na seção central da viga ($x = L/2$): $M_{\max} = M(L/2) = \dfrac{qL^2}{32}$

$$\max\{|\sigma_{xx}(x,z)|\} = \left|\sigma_{xx}\left(\frac{L}{2}, \pm\frac{h}{2}\right)\right| = \frac{h}{2}\frac{qL^2/32}{bh^3/12} = \frac{3}{16}\frac{qL^2}{bh^2} \leq S_Y \quad \Rightarrow \quad q_{\max} = \frac{16}{3}\frac{S_Y bh^2}{L^2}$$