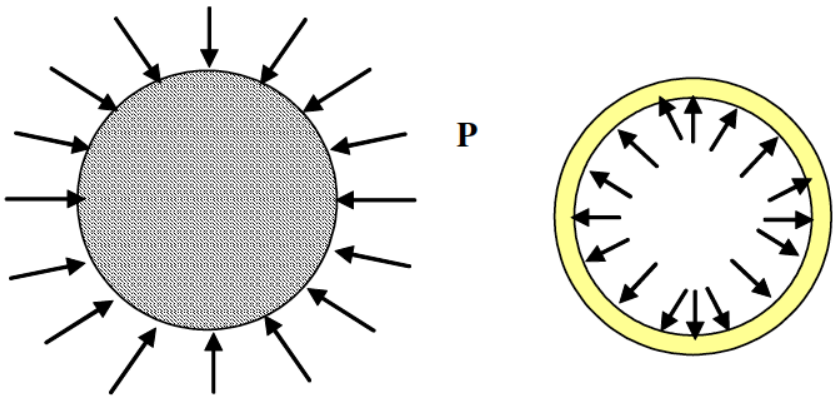
Solução de alguns exercícios da lista referente ao capítulo V

(1)

Estado plano de tensão : $\sigma_{zm} = \sigma_{za} = 0$



$\sigma_{rm} = \sigma_{\theta m} = -p$

$\sigma_a = \dfrac{p \cdot R}{t}$

Na interface: $\varepsilon_{\theta m} = \varepsilon_{\theta a}$

$\varepsilon_{\theta m} = -\dfrac{1 - \nu_m}{E_m} \cdot p + \alpha_m \cdot \Delta T$

$\varepsilon_{\theta a} = \dfrac{R}{E_a \cdot t} \cdot p + \alpha_a \cdot \Delta T$

$$-\frac{1-\nu_m}{E_m}\cdot p+\alpha_m\cdot\Delta T=\frac{R}{E_a\cdot t}\cdot p+\alpha_a\cdot\Delta T$$

$$p:=\frac{(\alpha_m-\alpha_a)\cdot\Delta T}{\frac{R}{E_a\cdot t}+\frac{1-\nu_m}{E_m}}$$

Força do anel sobre a membrana

$p = 4\,\text{MPa}$

$$\sigma_a:=\frac{p\cdot R}{t}$$

Tensão circunferencial no anel

$\sigma_a = 210\,\text{MPa}$

$$\Delta R:=R\cdot\left(\frac{\sigma_a}{E_a}+\alpha_a\cdot\Delta T\right)$$

$\Delta R = 0.316\,\text{mm}$

$$R_f:=R+\Delta R$$

Raio final do conjunto

$R_f = 150.316\,\text{mm}$

(3)

$t := 15\,\text{mm}$ $p := 1.70\,\text{MPa}$ $F := 40\cdot\pi\,\text{kN}$ $R := 0.6\,\text{m}$

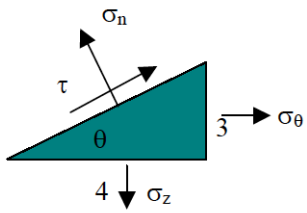
$$\sigma_\theta:=\frac{p\cdot R}{t}$$

$$\sigma_z\cdot 2\pi\cdot R\cdot t+40\pi\,\text{kN}=p\cdot\pi R^2$$

$$\sigma_z:=\frac{1}{2}\cdot\frac{\left(-40\,\text{kN}+p\cdot R^2\right)}{(R\cdot t)}$$

$\sigma_\theta = 68\,\text{MPa}$ $\sigma_z = 32\,\text{MPa}$

Plano da Solda



$$\theta:=\text{acos}\left(\frac{4}{5}\right)$$

$\theta = 36.8699\,\text{deg}$

$$\sigma_n:=\frac{\sigma_\theta+\sigma_z}{2}+\frac{\sigma_z-\sigma_\theta}{2}\cdot\cos(2\theta)$$

$\sigma_n = 45\,\text{MPa}$

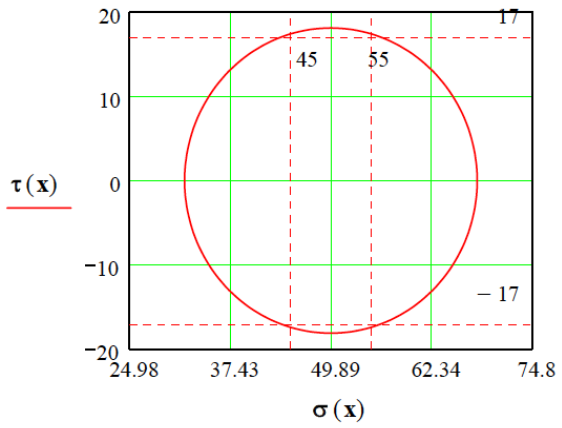
$$\tau := -\frac{\sigma_z - \sigma_\theta}{2} \cdot \sin(2 \cdot \theta) \qquad \tau = 17\,\text{MPa}$$

Círculo de Mohr

$$c := \frac{\sigma_\theta + \sigma_z}{2} \qquad r := \sqrt{\left(\frac{\sigma_z - \sigma_\theta}{2}\right)^2} \qquad x := 0, \frac{\pi}{90} .. 2\pi$$

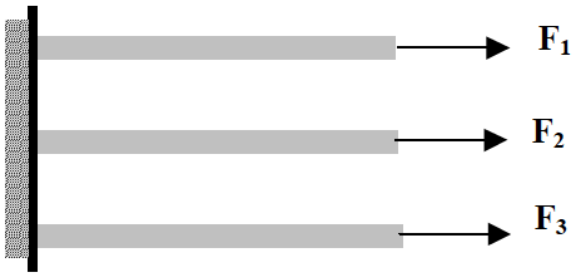
$$\tau(x) := \frac{r \cdot \sin(x)}{\text{MPa}} \qquad \sigma(x) := \frac{c + r \cdot \cos(x)}{\text{MPa}}$$

$$\sigma_1 := \frac{c + r}{\text{MPa}} \qquad \sigma_2 := \frac{c - r}{\text{MPa}} \qquad \text{mim} := \sigma_2 - 0.1 \cdot \sigma_1 \qquad \text{max} := \sigma_1 + 0.1 \cdot \sigma_1$$



(5)

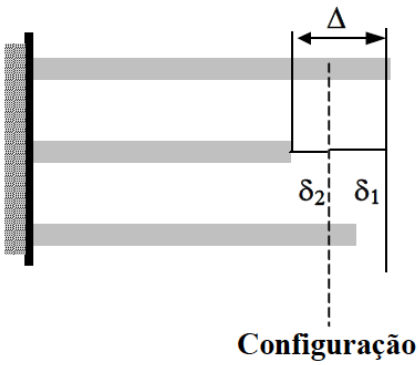
Equilíbrio :



$F_1 = F_3$

$2 \cdot F_1 + F_2 = 0$

Cinemática



$$\delta_1 + \delta_2 = \Delta$$

Relação Constitutiva Elástica Linear :

$$\delta_1 = -\frac{F_1 \cdot L}{E \cdot A} \qquad \delta_2 = \frac{F_2 \cdot L}{E \cdot A}$$

Solução:

$$-\frac{F_1 \cdot L}{E \cdot A} + \frac{F_2 \cdot L}{E \cdot A} = \Delta \qquad F_1 = -\frac{\Delta \cdot E \cdot A}{L} + F_2$$

Cinemática e Constitutiva

Substituindo no equilíbrio:

$$2\cdot\left(-\frac{\Delta\cdot E\cdot A}{L}+F_2\right)+F_2=0 \qquad F_2:=\frac{2}{3}\cdot\Delta\cdot\frac{E\cdot A}{L} \qquad F_2=2.527\,kN$$

$$F_1=F_3 \qquad F_1:=-\frac{1}{3}\cdot\Delta\cdot\frac{E\cdot A}{L} \qquad F_1=-1.263\,kN$$

$$\sigma_1:=\frac{F_1}{A} \qquad \sigma_2:=\frac{F_2}{A}$$

$$\sigma_1=-6.5\,MPa \qquad \sigma_2=12.9\,MPa$$