Problema 1.

Ponto 1

$$\sigma_{xx} = \frac{N}{A} - \frac{D}{2}\frac{PL}{I} = -71{,}3\ \text{MPa} \qquad \sigma_m = \frac{\sigma_{xx}+\sigma_{zz}}{2} = -35{,}7\ \text{MPa}$$

$$\sigma_{xz} = \frac{D}{2}\frac{T}{J} = 40{,}7\ \text{MPa} \qquad R = \sqrt{\left(\frac{\sigma_{xx}+\sigma_{zz}}{2}\right)^2 + \sigma_{xz}^2} = 54{,}1\ \text{MPa}$$

$$\sigma_{zz} = 0 \qquad \sigma_I = \sigma_m + R = 18{,}5\ \text{MPa}, \quad \sigma_{II} = \sigma_m - R = -89{,}8\ \text{MPa}$$

$$\sigma_1 = \sigma_I = 18{,}5\ \text{MPa}, \sigma_2 = 0, \sigma_3 = \sigma_{II} = -89{,}9\ \text{MPa}, \tau_{\max} = (\sigma_1 - \sigma_3)/2 = 54{,}1\ \text{MPa}$$

Ponto 2

$$\sigma_{xx} = \frac{N}{A} = 10{,}2\ \text{MPa} \qquad \sigma_m = \frac{\sigma_{xx}+\sigma_{yy}}{2} = 5{,}09\ \text{MPa}$$

$$\sigma_{xy} = -\frac{D}{2}\frac{T}{J} = -40{,}7\ \text{MPa} \qquad R = \sqrt{\left(\frac{\sigma_{xx}+\sigma_{zz}}{2}\right)^2 + \sigma_{xz}^2} = 41{,}1\ \text{MPa}$$

$$\sigma_{yy} = 0 \qquad \sigma_I = \sigma_m + R = 46{,}2\ \text{MPa}, \quad \sigma_{II} = \sigma_m - R = -36{,}0\ \text{MPa}$$

$$\sigma_1 = \sigma_I = 46{,}2\ \text{MPa}, \sigma_2 = 0, \sigma_3 = \sigma_{II} = -36{,}0\ \text{MPa}, \tau_{\max} = (\sigma_1 - \sigma_3)/2 = 41{,}1\ \text{MPa}$$

Ponto 3

$$\sigma_{xx} = \frac{N}{A} + \frac{D}{2}\frac{PL}{I} = 91{,}7\ \text{MPa} \qquad \sigma_m = \frac{\sigma_{xx}+\sigma_{zz}}{2} = 45{,}8\ \text{MPa}$$

$$\sigma_{xz} = -\frac{D}{2}\frac{T}{J} = -40{,}7\ \text{MPa} \qquad R = \sqrt{\left(\frac{\sigma_{xx}+\sigma_{zz}}{2}\right)^2 + \sigma_{xz}^2} = 61{,}3\ \text{MPa}$$

$$\sigma_{zz} = 0 \qquad \sigma_I = \sigma_m + R = 107\ \text{MPa}, \quad \sigma_{II} = \sigma_m - R = -15{,}5\ \text{MPa}$$

$$\sigma_1 = \sigma_I = 107\ \text{MPa}, \sigma_2 = 0, \sigma_3 = \sigma_{II} = -15{,}5\ \text{MPa}, \tau_{\max} = (\sigma_1 - \sigma_3)/2 = 61{,}3\ \text{MPa}$$

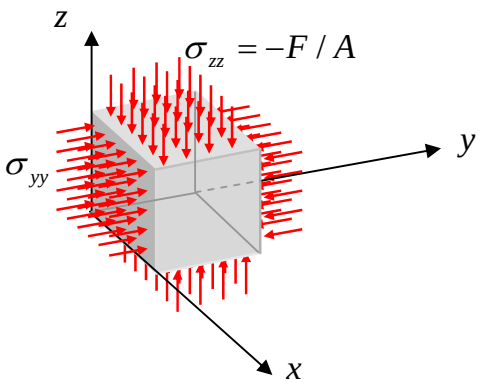
Problema 2.

$$\sigma_{xx}^A = \frac{h}{2}\frac{PL}{\left(bh^3/12\right)} = \frac{6PL}{bh^2}, \quad \sigma_{xx}^B = \frac{h}{2}\frac{P(L+a)}{\left(bh^3/12\right)} = \frac{6P(L+a)}{bh^2}$$

$$\varepsilon_{xx}^A = \frac{\sigma_{xx}^A}{E} + \alpha\Delta T, \quad \varepsilon_{xx}^B = \frac{\sigma_{xx}^B}{E} + \alpha\Delta T$$

$$\varepsilon_{xx}^B - \varepsilon_{xx}^A = \frac{\sigma_{xx}^B - \sigma_{xx}^A}{E} = \frac{6Pa}{Ebh^2} \Rightarrow P = \frac{E(\varepsilon_{xx}^B - \varepsilon_{xx}^A)bh^2}{6a}$$

Problema 3.



$$\sigma_{xx} = 0, \sigma_{yy} = ?, \sigma_{zz} = -F / L^2$$

$$\varepsilon_{xx} = ?, \varepsilon_{yy} = 0, \varepsilon_{zz} = -\Delta L / L$$

$$\varepsilon_{xx} = -\nu \frac{\sigma_{yy}}{E} + \nu \frac{F}{EL^2}$$

$$0 = \frac{\sigma_{yy}}{E} + \nu \frac{F}{EL^2}$$

$$-\frac{\Delta L}{L} = -\nu \frac{\sigma_{yy}}{E} - \frac{F}{EL^2}$$

$$\Rightarrow$$

$$\Delta L = \frac{(1-\nu^2)F}{EL}$$

$$\sigma_{yy} = -\nu \frac{F}{L^2}$$

$$\varepsilon_{xx} = \frac{\nu(1+\nu)F}{EL^2}$$