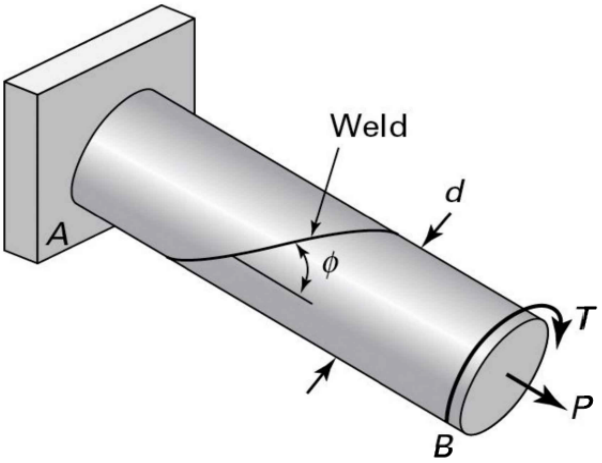
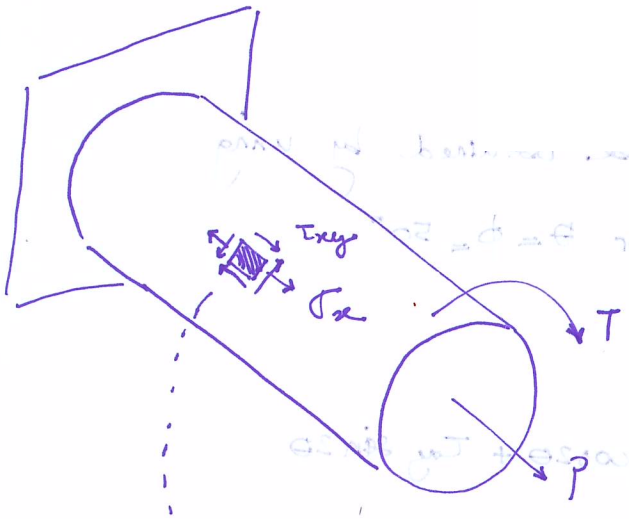
Question. What are the normal and shearing stresses on the spiral weld of the aluminum shaft of diameter d subjected to an axial load P and a torque T (figure). Given: P = 120 kN, T = 1.5 kN.m, d = 40 mm and $\phi = 50°$.





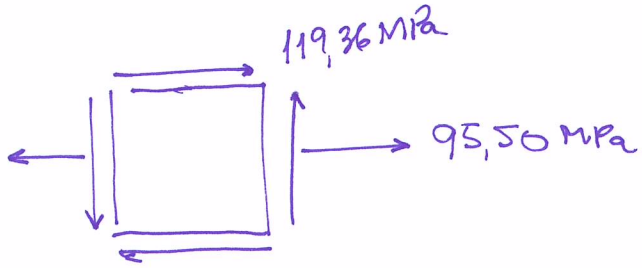
↳ An element located at the surface will suffer both the normal and shear stress due to the external load.

$$\sigma_x = \frac{P}{A} = \frac{120.10^3}{\frac{\pi}{4}(0{,}040)^2} \Rightarrow \sigma_x = 95{,}50\ MPa$$

$$\sigma_y = 0$$

$$\tau_{xy} = \frac{T.R}{J} = \frac{1{,}5.10^3.0{,}020}{\left(\frac{\pi.0{,}020^4}{2}\right)} \Rightarrow \tau_{xy} = 119.36\ MPa$$

Then, the plane stress is:



The stress on the weld can be obtained by using the general stress equations, for $\theta = \phi = 50°$

Then:

$$\begin{cases} \sigma_{x'} = \left(\frac{\sigma_x + \sigma_y}{2}\right) + \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos 2\theta + \tau_{xy}\sin 2\theta \\ \sigma_{y'} = \left(\frac{\sigma_x + \sigma_y}{2}\right) - \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos 2\theta - \tau_{xy}\sin 2\theta \\ \tau_{x'y'} = -\left(\frac{\sigma_x - \sigma_y}{2}\right)\sin 2\theta + \tau_{xy}\cos 2\theta \end{cases}$$

$$\therefore \begin{cases} \sigma_{x'} = 157\ \text{MPa} \\ \sigma_{y'} = -61,5\ \text{MPa} \\ \tau_{xy'} = -67,8\ \text{MPa} \end{cases}$$