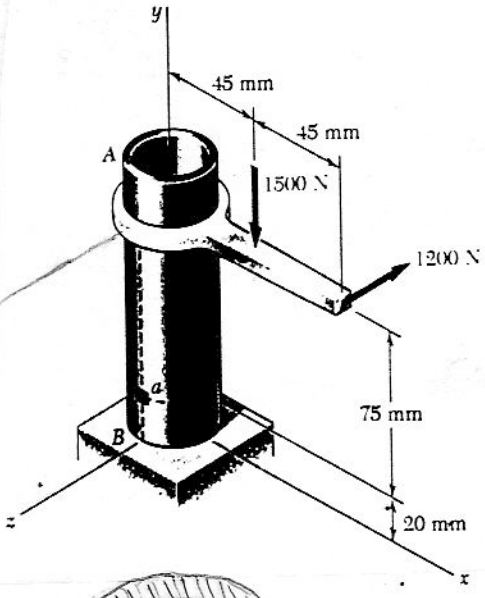
Problem 8.39

8.39 Two forces are applied to the pipe *AB* as shown. Knowing that the pipe has inner and outer diameters equal to 35 and 42 mm, respectively, determine the normal and shearing stresses at (*a*) point *a*, (*b*) point *b*.

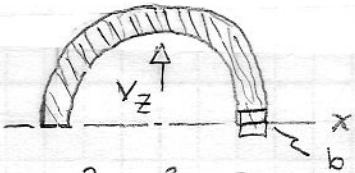


$r_o = d_o/2 = 21\text{ mm}$, $r_i = d_i/2 = 17.5\text{ mm}$,

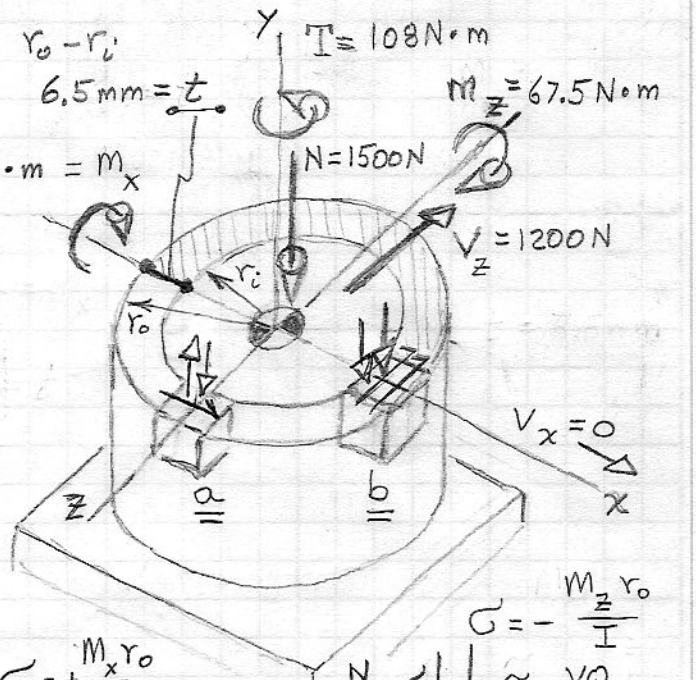
$A = \pi(r_o^2 - r_i^2) = 423.3\text{ mm}^2 = 423.33\times10^{-6}\text{ m}^4$

$J = \pi/2\,(r_o^4 - r_i^4) = 158.17\times10^3\text{ mm}^4 = 158.17\times10^{-9}\text{ m}^4$

$I = J/2 = 79.08\times10^3\text{ mm}^4 = 79.08\times10^{-9}\text{ m}^4$



$Q = \frac{2}{3}(r_o^3 - r_i^3) = 2.601\times10^3\text{ mm}^3$



a) Point a:

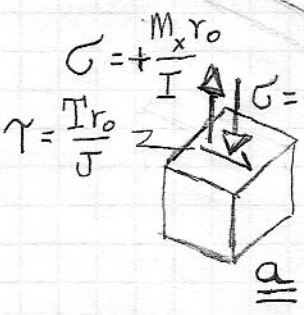
$$\sigma = -\frac{N}{A} + \frac{M_x r_o}{I}$$

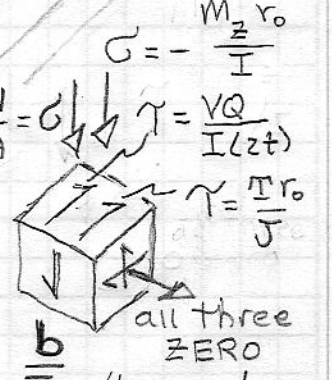
$$\sigma = -\frac{1500}{423.3\times10^{-6}} + \frac{90\,(0.021)}{79.08\times10^{-9}}$$

$$\boxed{\sigma = 20.4\text{ MPa}}$$

$$\tau = +\frac{T r_o}{J} = \frac{108\,(0.021)}{158.17\times10^{-9}}$$

$$\boxed{\tau = 14.34\text{ MPa}}$$





b) Point b:

$$\sigma = -\frac{N}{A} - \frac{M_z r_o}{I} = -\frac{1500}{423.3\times10^{-6}} - \frac{67.5\,(0.21)}{79.08\times10^{-9}}$$

$$\boxed{\sigma = -21.5\text{ MPa}}$$

$$\tau = \frac{Tc}{J} + \frac{V_z Q}{I(2t)} = \frac{108\,(0.021)}{158.17\times10^{-9}} + \frac{1200\,(2.601\times10^{-6})}{(79.08\times10^{-9})(0.007)}$$

$$\boxed{\tau = 19.98\text{ MPa}}$$