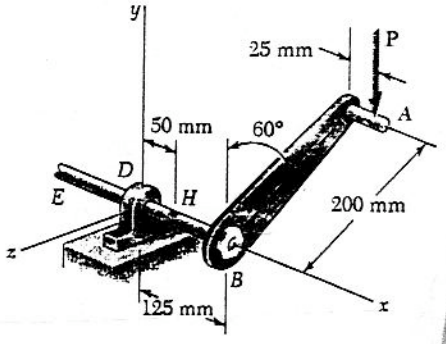
Problem 8.41

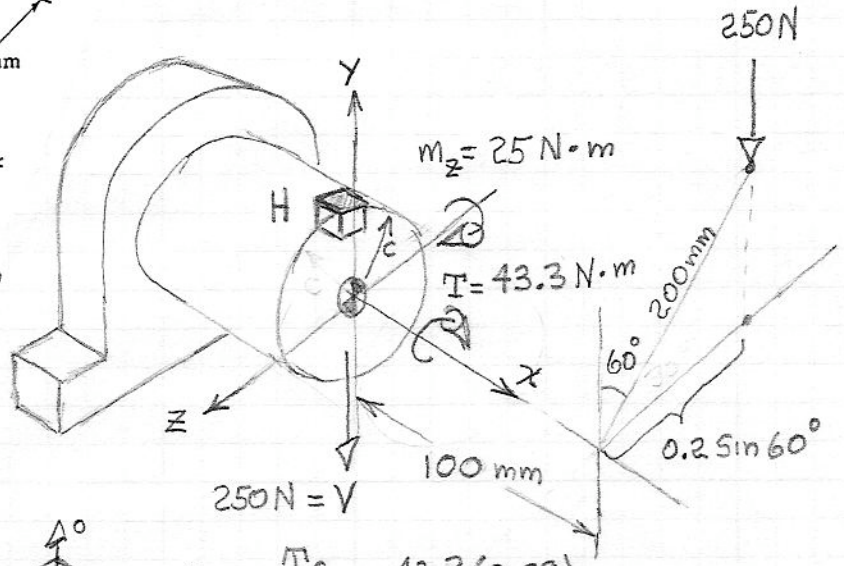
8.41 A vertical force **P** of magnitude 250 N is applied to the crank at point *A*. Knowing that the shaft *BDE* has a diameter of 18 mm, determine the principal stresses and the maximum shearing stress at point *H* located at the top of the shaft, 50 mm to the right of support *D*.

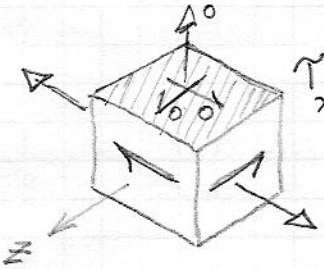


$C = \frac{0.018}{2} = 0.009\ m$

$I_x = \frac{\pi}{4} C^4 = 5.153 \times 10^{-9}\ m^4$

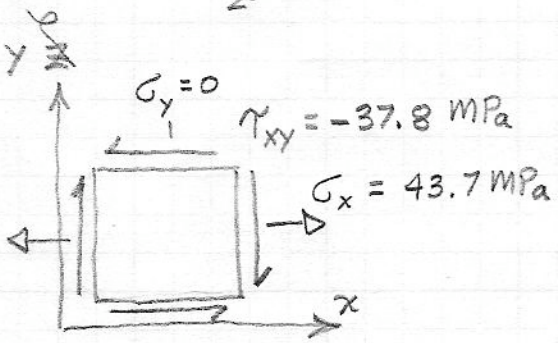
$J = 2I = 10.31 \times 10^{-9}\ m^4$





$\tau_{xy} = -\frac{Tc}{J} = -\frac{43.3(0.09)}{10.31 \times 10^{-9}}$ $\tau_{xy} = -37.8\ MPa$

$\sigma_x = \frac{M_z c}{I_x} = \frac{25(0.09)}{5.153 \times 10^{-9}}$ $\sigma_x = 43.7\ MPa$



$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2} = 21.8\ MPa$

$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$

$R = \sqrt{\left(\frac{43.7}{2}\right)^2 + (37.8)^2} = 43.7\ MPa$

$\sigma_{max} = \sigma_{avg} + R$ $\sigma_{min} = \sigma_{avg} - R$

$\sigma_{max} = 65.5\ MPa$ (+) $\sigma_{min} = -21.8\ MPa$ (−)

τ_{max} (in-plane) $= R$

$\tau_{max} = 43.7\ MPa$