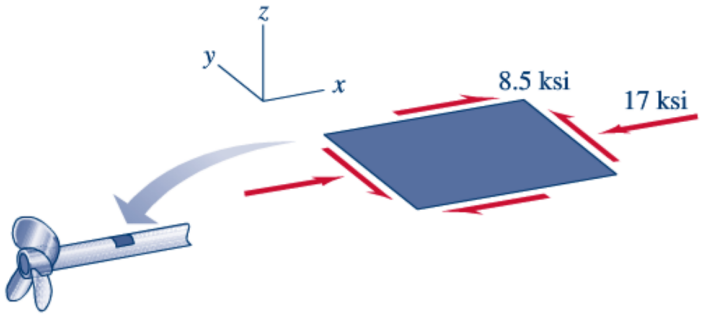
Example 15.5

The components of stress on a propeller shaft made up of a material having a yield strength of $\sigma_Y = 36ksi$ is as shown below. What is the factor of safety as predicted by the maximum shear stress theory for the material? What is the factor of safety as predicted by the maximum distortional energy for the material?



$\sigma_{ave} = \frac{17}{2} = 8.5\ ksi$

$R = \sqrt{\left(\frac{17}{2}\right)^2 + (8.5)^2} = 12.0\ ksi$

$\sigma_1 = \sigma_{ave} + R = 20.5\ ksi$

$\sigma_2 = \sigma_{ave} - R = -3.5\ ksi$

Since σ_1 & σ_2 of opposite sign $\Rightarrow$ in 4th quadrant of $\sigma_1 - \sigma_2$ plane

$\therefore \tau_{max} = (\tau_{max})_{in\text{-}plane} = R = 12.0 ksi$

- Since $\tau_{max} < \frac{\sigma_Y}{2} = \frac{36}{2} = 18\ ksi$, NOT failed by MSS

  & $FS = \frac{\sigma_Y/2}{\tau_{max}} = 1.50$

- $\sigma_M = \sqrt{\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2} = \sqrt{20.5^2 + (3.5)^2 - (20.5)(-3.5)}$

  $= 22.4\ ksi$

$\therefore$ for MDE: $F.S = \frac{\sigma_Y}{\sigma_M} = \frac{36}{22.4} = 1.60$