

ENGR 2243 – Mechanics of Materials  
Analysis of Stresses and Strains – Mohr's Circle

Mohr's Circle

- Graphical representation of the stress equations

$$\sigma_{x_1} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\tau_{x_1, y_1} = -\left(\frac{\sigma_x - \sigma_y}{2}\right) \sin 2\theta + \tau_{xy} \cos 2\theta$$

Square both sides of each equation, and add

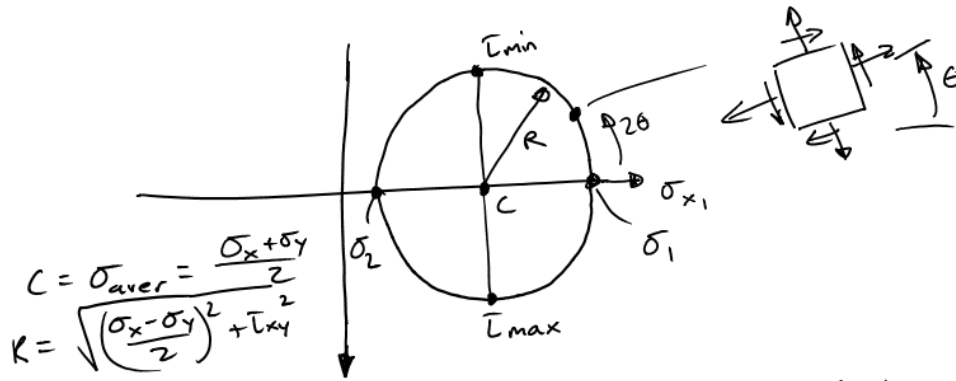
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$$\left[\sigma_{x_1} - \left(\frac{\sigma_x + \sigma_y}{2}\right)\right]^2 + \tau_{x_1, y_1}^2 = \left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2$$

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

$$\boxed{(\sigma_{x_1} - \sigma_{aver})^2 + \tau_{x_1, y_1}^2 = R^2}$$

Equation of a Circle



$$C = \sigma_{aver} = \frac{\sigma_x + \sigma_y}{2}$$

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

$$\sigma_1 = C + R$$

$$\sigma_2 = C - R$$

$$\tau_{max} = R$$

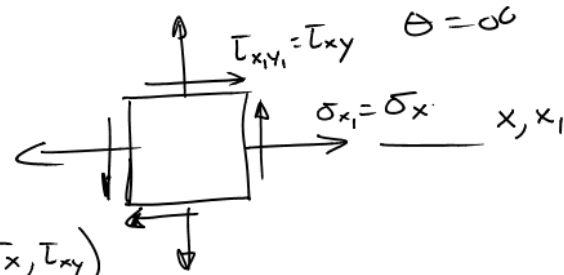
Any point on the circle represents the stresses at an angle

$\theta = 0^\circ$

$$\sigma_{x_1} = \sigma_x$$

$$\tau_{x_1, y_1} = \tau_{xy}$$

$$\theta = 0^\circ (\text{Point A}) = (\sigma_x, \tau_{xy})$$



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$$\theta = 90^\circ$$

$$\sigma_{x_1} = \sigma_y$$

$$\tau_{x_1 y_1} = -\tau_{xy}$$

$$\theta = 90^\circ (\text{Point B}) = (\sigma_y, -\tau_{xy})$$

