Question #80180

A plane element is subject to the stresses σ_x = 60 MPa, σ_y = -60 MPa, and τ_{xy} = 0. Determine analytically the maximum shearing stress existing in the element. What is the direction of the planes on which the maximum shearing stresses occur?

Answer:

The maximum shearing stress is given by:

$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}, \quad (1)$$

The plane on which the maximum sharing stresses occurs is perpendicular to plane *xy* and is rotated counter-clockwise from *x* on angle, which is given by:

$$\tan 2\theta_{max} = -\frac{\sigma_x - \sigma_y}{2\tau_{xy}}, \quad (2)$$

Substitute into (1) and (2):

$$\tau_{max} = \sqrt{\left(\frac{60 + 60}{2}\right)^2 + 0} = 60 \text{ MPa},$$

$$\tan 2\theta_{max} = -\frac{60 + 60}{0} = -\infty,$$

$$\theta_{max} = \frac{1}{2}\tan^{-1}(-\infty) = \frac{90°}{2} = 45°.$$