



•1-33. The bar has a cross-sectional area A and is subjected to the axial load P . Determine the average normal and average shear stresses acting over the shaded section, which is oriented at θ from the horizontal. Plot the variation of these stresses as a function of θ ($0 \leq \theta \leq 90^\circ$).

Equations of Equilibrium:

$$\downarrow + \Sigma F_x = 0; \quad V - P \cos \theta = 0 \quad V = P \cos \theta$$

$$\nearrow + \Sigma F_y = 0; \quad N - P \sin \theta = 0 \quad N = P \sin \theta$$

Average Normal Stress and Shear Stress: Area at θ plane, $A' = \frac{A}{\sin \theta}$.

$$\sigma = \frac{N}{A'} = \frac{P \sin \theta}{\frac{A}{\sin \theta}} = \frac{P}{A} \sin^2 \theta$$

$$\begin{aligned} \tau_{\text{avg}} &= \frac{V}{A'} = \frac{P \cos \theta}{\frac{A}{\sin \theta}} \\ &= \frac{P}{A} \sin \theta \cos \theta = \frac{P}{2A} \sin 2\theta \end{aligned}$$

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$$P \quad 15 \text{ N} \quad \theta \quad \text{deg} \quad A \quad 100 \text{ mm}$$

$$\sigma(\theta) = \frac{P \sin \theta}{A \sin \theta} \quad \theta = (30 \text{ deg}) \quad \theta \quad 90 \text{ deg}, 85 \text{ deg} \dots 0 \text{ deg}$$

$$\theta = \square$$

