Formula Sheet

Stresses
$$\sigma = \frac{P}{A} \qquad \sigma = \frac{M \cdot c}{I} \qquad \tau = \frac{T \cdot c}{J}$$
 Unsymmetric bending
$$\sigma = \frac{P}{A} + \frac{-M_z y}{I_z} + \frac{-M_y z}{I_y} \qquad \tan \phi = \frac{I_z}{I_y} \tan \theta$$
 Shear stress
$$\tau = \frac{VQ}{R} \qquad q = \tau \cdot t = \frac{VQ}{I}$$
 Thin-walled pressure vessel:
$$\sigma_1 = \frac{P^r}{A} \qquad \sigma_2 = \frac{P^r}{A}$$

Stress Transformation

$$\begin{split} \sigma_{x'} &= \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta & \tan 2\theta_y = \frac{2 \cdot \tau_{xy}}{(\sigma_x - \sigma_y)} \\ \tau_{x'y'} &= -\frac{\sigma_x - \sigma_y}{2} \sin 2\theta + \tau_{xy} \cos 2\theta & \tan 2\theta_z = -\frac{(\sigma_x - \sigma_y)}{2 \cdot \tau_{xy}} \\ \tau_{\text{max}} &= \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} & \sigma_{\text{mig}} &= \frac{\sigma_x + \sigma_y}{2} \\ \sigma_{12} &= \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \end{split}$$

Beam Design:
$$S_{\text{min}} = \frac{|M|_{\text{met}}}{\sigma_{\text{eff}}}$$
 $r_{\text{m}} = \frac{V_{\text{max}}}{A_{\text{sob}}}$, where $A_{\text{sob}} = d \cdot t_{\text{sob}}$

Vield Criteria

Von Mises (Distortion Energy):
$$\sigma_a^2 - \sigma_a \sigma_b + \sigma_b^2 < \sigma_T^2$$

Tresca (Maximal Shear Stress):
$$|\sigma_a| < \sigma_T$$
 and $|\sigma_b| < \sigma_T$
or $|\sigma_a - \sigma_b| < \sigma_T$

Strain Gauge Transformation
$$\varepsilon(\theta) = \varepsilon_e \cos^2 \theta + \varepsilon_p \sin^2 \theta + \gamma_{ep} \sin \theta \cos \theta$$

Generalized Hook's Law

$$\begin{split} \varepsilon_{x} &= \frac{1}{B} \left[\sigma_{x} - \nu (\sigma_{y} + \sigma_{z}) \right] & \gamma_{yz} = \frac{1}{G} \tau_{yz}, \quad \gamma_{zz} = \frac{1}{G} \tau_{zz}, \quad \gamma_{zz} = \frac{1}{G} \tau_{zz}, \\ \varepsilon_{y} &= \frac{1}{B} \left[\sigma_{y} - \nu (\sigma_{x} + \sigma_{z}) \right] & G = \frac{B}{2(1 + \nu)} \\ \varepsilon_{z} &= \frac{1}{B} \left[\sigma_{z} - \nu (\sigma_{x} + \sigma_{y}) \right] & \text{Plane Stress:} \quad \sigma_{x} = \frac{B}{(1 - \nu^{2})} \left[\varepsilon_{x} + \nu \varepsilon_{y} \right] \end{split}$$

Mechanical Engineering Formulas Cheat Sheet

Navy Feroz

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