

USEFUL EQUATIONS

$$\sigma_{avg} = \frac{F_N}{A}$$

$$\tau_{avg} = \frac{V}{A}$$

Generalized Hooke's Law

$$\varepsilon_x = \left(\frac{1}{E}\right) [\sigma_x - \nu(\sigma_y + \sigma_z)] + \alpha \Delta T$$

$$\varepsilon_y = \left(\frac{1}{E}\right) [\sigma_y - \nu(\sigma_x + \sigma_z)] + \alpha \Delta T$$

$$\varepsilon_z = \left(\frac{1}{E}\right) [\sigma_z - \nu(\sigma_x + \sigma_y)] + \alpha \Delta T$$

$$\gamma_{xy} = \left(\frac{1}{G}\right) \tau_{xy}$$

$$\gamma_{xz} = \left(\frac{1}{G}\right) \tau_{xz}$$

$$\gamma_{yz} = \left(\frac{1}{G}\right) \tau_{yz}$$

$$G = \frac{E}{2(1+\nu)}$$

Axial Deformations

$$e_{AB} = u_B - u_A$$

$$e = \int_0^L \frac{F(x)}{E(x)A(x)} dx + \int_0^L \alpha \Delta T dx$$

$$e = \frac{FL}{EA} + \alpha \Delta T L$$

$$e = u \cos(\theta) + v \sin(\theta)$$

Torsional Deformations

$$\phi_{AB} = \phi_B - \phi_A$$

$$\phi = \int_0^L \frac{T(x)}{G(x)I_p(x)} dx$$

$$\phi = \frac{TL}{GI_p}$$

$$\gamma = \rho \frac{d\phi}{dx}$$

$$\tau = G\rho \frac{d\phi}{dx}$$

$$\gamma = \frac{T\rho}{I_p}$$

$$\text{with } I_p = \int_A \rho^2 dA$$

$$I_p = \frac{\pi r^4}{2} \text{ (solid)}$$

$$I_p = \frac{\pi}{2} (r_o^4 - r_i^4) \text{ (hollow)}$$

Flexural and Shear Stress

$$\sigma(x, y) = -\frac{Ey}{\rho} = -\frac{M_{zz}y}{I_{zz}}$$

$$I_{zz} = \frac{bh^3}{12} \text{ (rectangle)}$$

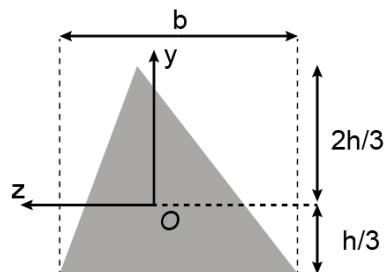
$$I_{zz} = \frac{\pi}{4} R^4 \text{ (circle)}$$

$$\tau(x, y) = \frac{VQ}{I_{zz}t} = \frac{VA^*y^*}{I_{zz}t}$$

$$I_{zz} = \frac{bh^3}{36} \text{ (triangle)}$$

$$I_{zz} = (\frac{\pi}{8} - \frac{8}{9\pi})R^4 \text{ (semi-circle)}$$

$$\tau_{max} = \frac{3V}{2A} \text{ (rectangle)}$$



$$\tau_{max} = \frac{4V}{3A} \text{ (circle)}$$

