

USEFUL EQUATIONS

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

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

Generalized Hooke's Law

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

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

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

$$\gamma_{xy} = \frac{1}{G} \tau_{xy} \quad \gamma_{xz} = \frac{1}{G} \tau_{xz} \quad \gamma_{yz} = \frac{1}{G} \tau_{yz}$$

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

$$\sigma_x = \frac{E}{(1+\nu)(1-2\nu)} [(1-\nu)\epsilon_x + \nu(\epsilon_y + \epsilon_z) - (1+\nu)\alpha \Delta T]$$

$$\sigma_y = \frac{E}{(1+\nu)(1-2\nu)} [(1-\nu)\epsilon_y + \nu(\epsilon_x + \epsilon_z) - (1+\nu)\alpha \Delta T]$$

$$\sigma_z = \frac{E}{(1+\nu)(1-2\nu)} [(1-\nu)\epsilon_z + \nu(\epsilon_x + \epsilon_y) - (1+\nu)\alpha \Delta T]$$

Axial Deformations

$$e_{AB} = u_B - u_A \qquad e = \int_0^L \frac{F}{AE} dx + \int_0^L \alpha \Delta T dx, \qquad e = \frac{FL}{AE} + \alpha \Delta T L$$

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

Torsional Deformations

$$\phi_{AB} = \phi_B - \phi_A \qquad \phi = \int_0^L \frac{T(x)}{G(x) I_p(x)} dx \qquad \phi = \frac{TL}{G I_p}$$

$$\gamma = \rho \frac{d\phi}{dx} \qquad \tau = G \rho \frac{d\phi}{dx} \qquad \gamma = \frac{\rho T}{G I_p} \qquad \tau = \frac{\rho T}{I_p}$$

$$\text{with} \quad I_p = \int_A \rho^2 dA, \quad I_p = \frac{\pi r^4}{2} \text{ (solid)}, \quad I_p = \frac{\pi}{2} (r_o^4 - r_i^4) \text{ (hollow)}$$