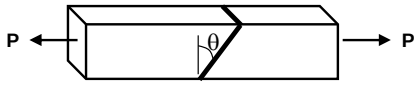
Clarkson University
ES222, Strength of Materials
Exam I – Formula Sheet

Axial Loading

Normal Stress: $\sigma = \frac{P}{A}$ Splice joint: $\tau_{ave} = \frac{F}{A}$ Single shear: $\tau_{ave} = \frac{F}{A}$

Double shear: $\tau_{ave} = \frac{F}{2A}$ Bearing stress: $\sigma_b = \frac{P}{td}$

$$\sigma = \frac{P}{A_o}\cos^2\theta, \quad \tau = \frac{P}{A_o}\sin\theta\cos\theta$$



Factor of Safety = F.S. = $\frac{\text{ultimate load}}{\text{allowable load}}$

Stress and Strain – Axial Loading

Normal strain: $\varepsilon = \frac{\delta}{L}$ Normal stress: $\sigma = E\varepsilon$ Shear stress: $\tau = G\gamma$

Elongation: $\delta = \frac{PL}{AE}$ Rods in series: $\delta = \sum_i \frac{P_i L_i}{A_i E_i}$

Thermal elongation: $\delta_T = \alpha(\Delta T)L$ Thermal strain: $\varepsilon_T = \alpha(\Delta T)$

Poisson's ratio: $\nu = -\frac{\text{lateral strain}}{\text{axial strain}}$

Generalized Hooke's Law:

$$\varepsilon_x = \frac{\sigma_x}{E} - \frac{\nu\sigma_y}{E} - \frac{\nu\sigma_z}{E}$$

$$\varepsilon_y = -\frac{\nu\sigma_x}{E} + \frac{\sigma_y}{E} - \frac{\nu\sigma_z}{E}$$

$$\varepsilon_z = -\frac{\nu\sigma_x}{E} - \frac{\nu\sigma_y}{E} + \frac{\sigma_z}{E}$$

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

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

Units: k = 10^3 Pa = N/m^2
M = 10^6 psi = lb/in^2
G = 10^9 ksi = 10^3 lb/in^2 kips = 10^3 lbs