ET 200, Prof. Dupen Final Exam Equation Sheet Fall 2014

Chapter 1-5 formulas

$$\sigma = \frac{P}{A}$$

$$\varepsilon = \frac{\Delta L}{L} = \frac{\delta}{L}$$

$$E = \frac{\sigma}{\varepsilon}$$

$$\delta = \frac{PL}{AE}$$

$$\tau = \frac{P}{A}$$

$$\gamma = \frac{\delta}{L}$$

$$G = \frac{\tau}{\gamma}$$

$$\nu = \frac{-\varepsilon_{transverse}}{\varepsilon_{long}}$$

$$\varepsilon_x = \frac{1}{E}(\sigma_x - \nu\sigma_y - \nu\sigma_z)$$

$$\varepsilon_y = \frac{1}{E}(\sigma_y - \nu\sigma_x - \nu\sigma_z)$$

$$\varepsilon_z = \frac{1}{E}(\sigma_z - \nu\sigma_x - \nu\sigma_y)$$

$$\delta = \alpha L(\Delta T)$$

$$\sigma_{thermal} = -\alpha E(\Delta T)$$

$$\sigma_{hoop} = \frac{p\,d_i}{2t}\ ,\quad \sigma_{long} = \frac{p\,d_i}{4t}$$

$$P_S = n A_B \tau_{allowable} N$$

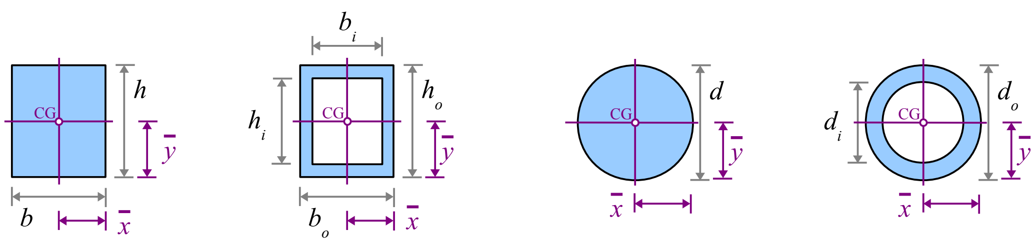
$$P_P = d\,t\,\sigma_{P-allowable} N$$

$$P_G = b\,t\,\sigma_{G-allowable}$$

$$P_N = (b\,t - N_F d_H t)\,\sigma_{N-allowable}$$

$$\text{Joint efficiency} = \frac{P_{min.}}{P_G}$$

Chapter 6-10 formulas



$$\bar{x} = \frac{b}{2}\ ,\quad \bar{y} = \frac{h}{2}$$

$$A = b\,h$$

$$I_x = \frac{b\,h^3}{12}$$

$$I_y = \frac{h\,b^3}{12}$$

$$\bar{x} = \frac{b_o}{2}\ ,\quad \bar{y} = \frac{h_o}{2}$$

$$A = b_o h_o - b_i h_i$$

$$I_x = \frac{b_o h_o^3 - b_i h_i^3}{12}$$

$$\bar{x} = \bar{y} = \frac{d}{2}$$

$$A = \frac{\pi d^2}{4}$$

$$I_x = I_y = \frac{\pi d^4}{64}$$

$$J = \frac{\pi d^4}{32}$$

$$\bar{x} = \bar{y} = \frac{d_o}{2}$$

$$A = \frac{\pi(d_o^2 - d_i^2)}{4}$$

$$I_x = I_y = \frac{\pi(d_o^4 - d_i^4)}{64}$$

$$J = \frac{\pi(d_o^4 - d_i^4)}{32}$$

$$I_x = \sum_1^n a_i y_i^2$$

$$I_y = \sum_1^n a_i x_i^2$$

$$I = I_o + ad^2$$

$$\circlearrowleft + \sum M_A = 0\ ,\quad \uparrow + \sum F_y = 0$$

$$\tau = \frac{Tc}{J}$$

$$\tau = K\frac{Tc}{J}$$

$$\theta = \frac{TL}{JG}$$

$$\theta = \frac{\tau L}{G c}$$

$$\sigma = \frac{Mc}{I_x}$$

$$\sigma = \frac{M}{S_x}$$

$$M_{allowable} = \frac{\sigma_{allowable} I_x}{c}$$

$$M_{allowable} = \sigma_{allowable} S_x$$

$$\tau = \frac{V\,Q}{I\,t}$$

$$Q = \bar{y}\,A'$$

$$\tau = \frac{V}{d\,t_w}$$

$$\tau_{allowable} = 0.4\,\sigma_{YS}$$

$$R = \frac{E\,I}{M}$$

$$\sigma = \frac{E\,c}{R}$$

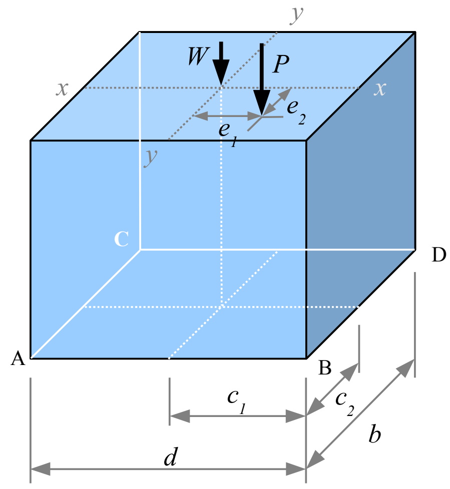
$$\sigma = \frac{M}{Z_x}$$

$$M_{allowable} = 0.6\,\sigma_{YS} Z_x$$

Chapter 11–15 formulas

$$Z_{required} = \frac{1.67\,M}{\sigma_{YS}} \qquad V_{applied} \le 0.4\,\sigma_{YS}\,d\,t_w$$

$$S_{required} = \frac{M}{\sigma_{allowable\ bending}} \qquad V_{applied} < \frac{2\,A\,\tau_{allowable}}{3}$$



$$\sigma = \frac{-W}{A} - \frac{P}{A} \pm \frac{P\,e_1 c_1}{I_y} \pm \frac{P\,e_2 c_2}{I_x} \qquad W = mg$$

$$I_x = \frac{d\,b^3}{12} \qquad I_y = \frac{b\,d^3}{12} \qquad \rho = \frac{m}{V} \qquad \gamma = \frac{W}{V}$$

$$P_{cr} = \frac{\pi^2 E\,I}{(KL)^2\,\text{F.S.}} \qquad \sigma_{cr} = \frac{\pi^2 E}{(KL/r_G)^2\,\text{F.S.}} \qquad r_G = \sqrt{\frac{I}{A}}$$

Structural Steel Columns

If $\frac{KL}{r_G} > 200$ then the column is too slender for safe use.

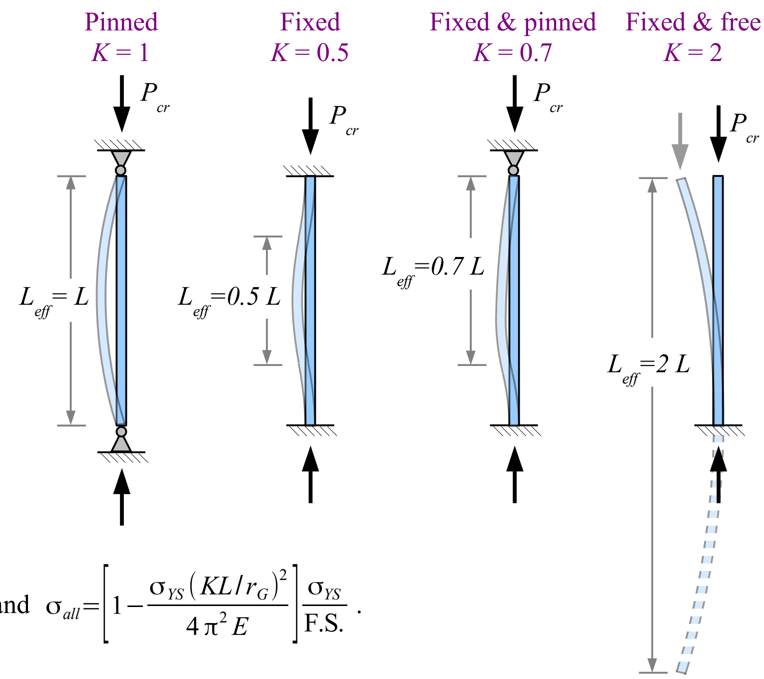
If $\frac{KL}{r_G} > 4.71\sqrt{\frac{E}{\sigma_{YS}}}$ then $P_{all} = 0.525\,\sigma_{cr}\,A$

If $\frac{KL}{r_G} < 4.71\sqrt{\frac{E}{\sigma_{YS}}}$ then $P_{all} = \frac{0.658^{(\sigma_{YS}/\sigma_{cr})}\,\sigma_{YS}\,A}{1.67}$

Steel Machine Columns

If $\frac{KL}{r_G} \ge \sqrt{\frac{2\pi^2 E}{\sigma_{YS}}}$ then the column is slender, and

the allowable stress is $\sigma_{all} = \frac{\pi^2 E}{(KL/r_G)^2\,\text{F.S.}}$.



If $\frac{KL}{r_G} < \sqrt{\frac{2\pi^2 E}{\sigma_{YS}}}$ then the column is intermediate, and $\sigma_{all} = \left[1 - \frac{\sigma_{YS}\,(KL/r_G)^2}{4\pi^2 E}\right]\frac{\sigma_{YS}}{\text{F.S.}}$.

Calculate $P_{all} = \sigma_{all}\,A$

$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2}$$

$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tan 2\theta = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2}$$

Units

Giga, G-, 10^9	1 ft. = 12 inches
Mega, M-, 10^6	180 degrees = π radians
kilo, k-, 10^3	Pa = N/m^2
centi, c-, 10^{-2}	1 kip = 1000 lb.
milli, m-, 10^{-3}	$\text{N} = \frac{\text{kg m}}{\text{s}^2}$