ET 200 – Proposed equation sheet for Exam 3 Fall 2014

Chapter 1–5 formulas

$\sigma=\frac{P}{A}$ $\nu=\frac{-\varepsilon_{transverse}}{\varepsilon_{long}}$ $P_S=n\,A_B\,\tau_{allowable}\,N$

$\varepsilon=\frac{\Delta L}{L}=\frac{\delta}{L}$ $\varepsilon_x=\frac{1}{E}(\sigma_x-\nu\sigma_y-\nu\sigma_z)$ $P_P=d\,t\,\sigma_{P-allowable}\,N$

$E=\frac{\sigma}{\varepsilon}$ $\varepsilon_y=\frac{1}{E}(\sigma_y-\nu\sigma_x-\nu\sigma_z)$ $P_G=b\,t\,\sigma_{G-allowable}$

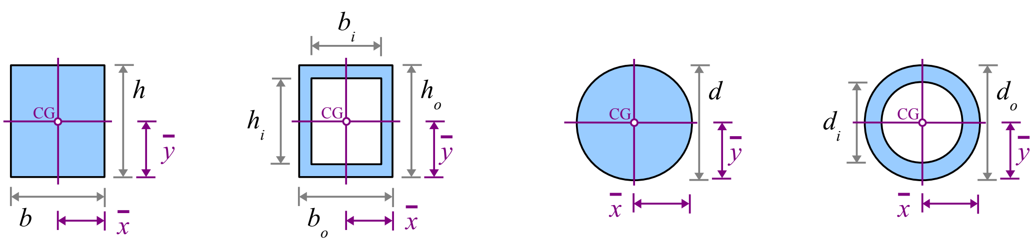
$\delta=\frac{PL}{AE}$ $\varepsilon_z=\frac{1}{E}(\sigma_z-\nu\sigma_x-\nu\sigma_y)$ $P_N=(b\,t-N_F\,d_H\,t)\,\sigma_{N-allowable}$

$\tau=\frac{P}{A}$ $\delta=\alpha\,L(\Delta T)$ $\text{Joint efficiency}=\frac{P_{min.}}{P_G}$

$\gamma=\frac{\delta}{L}$ $\sigma_{thermal}=-\alpha\,E(\Delta T)$ $\sigma=K\,\sigma_{net}$

$G=\frac{\tau}{\gamma}$ $\sigma_{hoop}=\frac{p\,d_i}{2t}$, $\sigma_{long}=\frac{p\,d_i}{4t}$

Chapter 6–10 formulas



$\bar{x}=\frac{b}{2}$, $\bar{y}=\frac{h}{2}$
$A=b\,h$
$I_x=\frac{b\,h^3}{12}$
$I_y=\frac{h\,b^3}{12}$

$\bar{x}=\frac{b_o}{2}$, $\bar{y}=\frac{h_o}{2}$
$A=b_o\,h_o-b_i\,h_i$
$I_x=\frac{b_o h_o^3-b_i\,h_i^3}{12}$

$\bar{x}=\bar{y}=\frac{d}{2}$
$A=\frac{\pi\,d^2}{4}$
$I_x=I_y=\frac{\pi\,d^4}{64}$
$J=\frac{\pi\,d^4}{32}$

$\bar{x}=\bar{y}=\frac{d_o}{2}$
$A=\frac{\pi(d_o^2-d_i^2)}{4}$
$I_x=I_y=\frac{\pi(d_o^4-d_i^4)}{64}$
$J=\frac{\pi(d_o^4-d_i^4)}{32}$

$I_x=\sum_1^n a_i\,y_i^2$ $I_y=\sum_1^n a_i\,x_i^2$ $I=I_o+ad^2$ ↶+ $\sum M_A=0$, ↑+ $\sum F_y=0$

$\tau=\frac{Tc}{J}$ $\tau=K\frac{Tc}{J}$ $\theta=\frac{TL}{JG}$ $\theta=\frac{\tau\,L}{G\,c}$

$\sigma=\frac{Mc}{I_x}$ $\sigma=\frac{M}{S_x}$ $M_{allowable}=\frac{\sigma_{allowable}\,I_x}{c}$ $M_{allowable}=\sigma_{allowable}\,S_x$

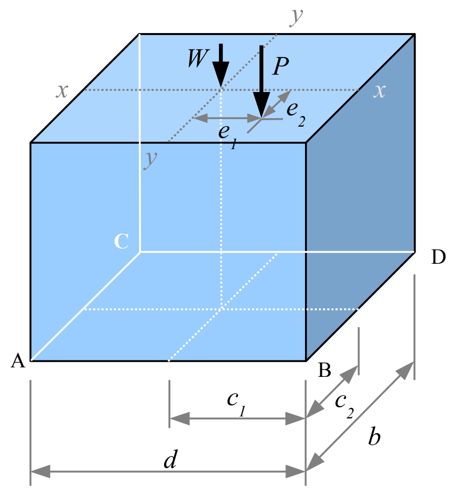
$\tau=\frac{V\,Q}{I\,t}$ $Q=\bar{y}\,A'$ $\tau=\frac{V}{d\,t_w}$ $\tau_{allowable}=0.4\,\sigma_{YS}$

$R=\frac{E\,I}{M}$ $\sigma=\frac{E\,c}{R}$ $\sigma=\frac{M}{Z_x}$ $M_{allowable}=0.6\,\sigma_{YS}\,Z_x$

Chapter 11-14 formulas

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

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



$$\sigma=\frac{-W}{A}-\frac{P}{A}\pm\frac{P\,e_1c_1}{I_y}\pm\frac{P\,e_2c_2}{I_x} \qquad W=mg$$

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

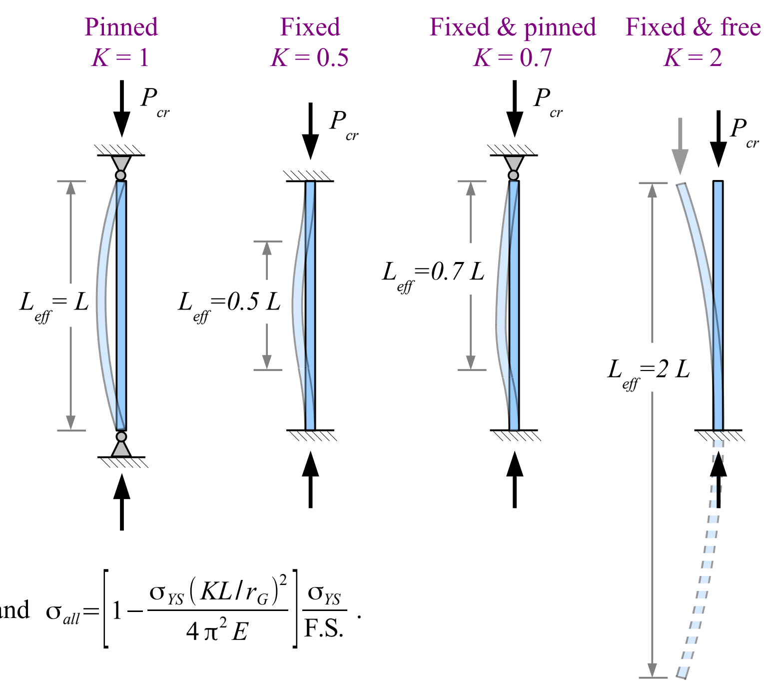
$$P_{cr}=\frac{\pi^2 EI}{(KL)^2\,\text{F.S.}} \qquad \sigma_{cr}=\frac{\pi^2 E}{(KL/r_G)^2\,\text{F.S.}}$$

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

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}	$N=\frac{\text{kg m}}{\text{s}^2}$

Exam III problem topics

Beam design

Combined stresses

Statically indeterminate beams

Columns (all varieties)