9A Solutions

6.96

Inside radius $= r = 2.5\,m - 0.01\,m = 2.49\,m$

Eq. (6.36): $\sigma_1 = \frac{pr}{2t} = \frac{(400\times10^3\,Pa)(2.49\,m)}{2(0.01\,m)} = 49.8\,MPa$

Eq. (6.37): $\tau_{max} = \frac{\sigma_1}{2} = \frac{1}{2}(49.8\,MPa) = 24.9\,MPa$

6.110

$t = 0.25\,in.,\quad r = 6\,in. - 0.25\,in. = 5.75\,in.$

For annular cross section

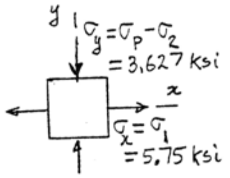
$A = \pi(c_2^2 - c_1^2) = \pi(6^2 - 5.75^2) = 9.2284\,in^2$

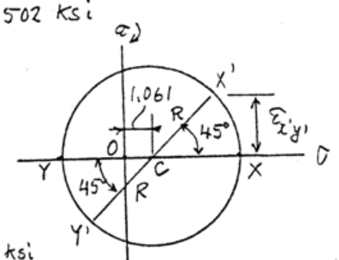
Stresses due to inside pressure $p = 250\,psi$:

$\sigma_1 = \frac{pr}{t} = \frac{(250\,psi)(5.75\,in.)}{0.25\,in} = 5.75\,ksi,\quad \sigma_2 = \frac{1}{2}\sigma_1 = 2.875\,ksi$

Stresses due to axial force $P = 60\,kips$:

$\sigma_P = \frac{P}{A} = \frac{60\,kips}{9.2284\,in^2} = 6.502\,ksi$

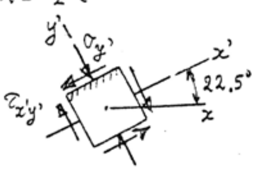




$\sigma_{ave} = \frac{1}{2}(5.75 - 3.627) = 1.061\,ksi$

$R = \frac{1}{2}(5.75 + 3.627) = 4.689\,ksi$

$R = 4.689\,ksi$



(a) $\sigma_{y'} = \sigma_{ave} - R\cos 45° = 1.061 - 4.689\cos 45°$

$\sigma_{y'} = -2.25\,ksi$

(b) $\tau_{x'y'} = R\sin 45° = 4.689\sin 45° = 3.32\,KSi$

6.102

$t = 0.1875\,in.,\quad r = (12.5\,ft)(12\,in./ft) - 0.1875\,in$
$= 150\,in. - 0.1875\,in. = 149.81\,in.$

$\sigma_1 = \frac{\sigma_U}{F.S.} = \frac{60\,ksi}{4.00} = 15.00\,ksi = 15\times10^3\,psi$

From Eq. (6.30): $p = \frac{\sigma_1 t}{r} = \frac{(15\times10^3\,psi)(0.1875\,in)}{149.81\,in.} = 18.774\,psi$

$= (18.774\,psi)\frac{144\,in^2}{1\,ft^2} = 2.703\times10^3\,lb/ft^2$

$p = \gamma h:\quad h = \frac{p}{\gamma} = \frac{2.703\times10^3\,lb/ft^2}{62.4\,lb/ft^3} = 43.3\,ft$

6.103

From Prob. 6.102: $t = 0.1875\,in.,\ r = 149.81\,in.$

For $h = 48\,ft$: $p = \gamma h = (62.4\,lb/ft^3)(48\,ft) = 2.9952\times10^3\,lb/ft^2$

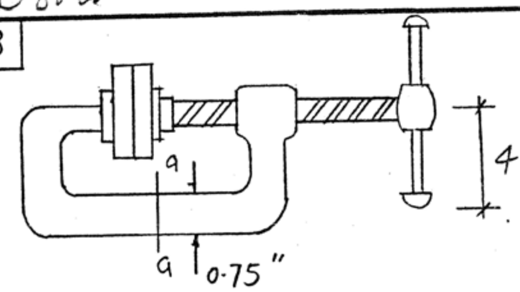
$= (2.9952\times10^3\,lb/ft^2)\frac{1\,ft^2}{144\,in^2} = 20.80\,psi$

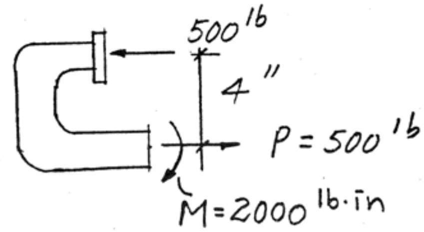
Eq. (6.30): $\sigma_1 = \frac{pr}{t} = \frac{(20.80\,psi)(149.81\,in.)}{0.1875\,in.} = 16.62\,ksi$

Eq. (6.34): $\tau_{max} = \frac{1}{2}\sigma_1 = \frac{pr}{2t} = \frac{1}{2}(16.62\,ksi) = 8.31\,ksi$

9B Soln

8-8





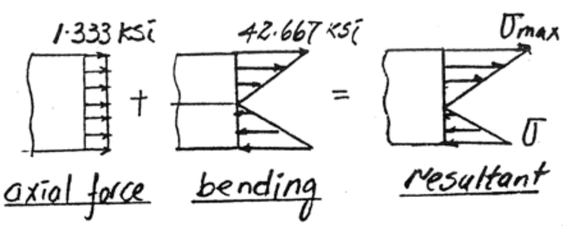
σ Due to axial force

$$\sigma = \frac{P}{A} = \frac{500}{(0.75)(0.5)} = 1.333\,KSi.$$

σ Due to bending

$$\sigma = \frac{Mc}{I} = \frac{2000(0.375)}{\frac{1}{12}(0.5)(0.75^3)}$$

$$= 42.666\,KSi$$



$\sigma_{max} = 1.333 + 42.666 = \underline{\underline{44.0}}\,KSi$

8-18

Prob 8-12 on Next Page

$I_y = \frac{1}{12}(4.5)(3)^3 = 10.125\,m^4$

$I_x = \frac{1}{12}(3)(4.5)^3 = 22.78125\,m^4$

$M_x = -800(0.5) = -400\,KN.m$

$M_y = 800(0.25) = 200\,KN.m$

$\sigma = \frac{P}{A} - \frac{M_y x}{I_y} + \frac{M_x y}{I_x}$

$\sigma_A = \frac{-800(10^3)}{4.5(3)} - \frac{200(10^3)(-1.5)}{10.125} + \frac{-400(10^3)(-2.25)}{22.78125}$

$= \underline{\underline{9.88\,KPa}}$

$\sigma_B = \frac{-800(10^3)}{4.5(3)} - \frac{200(10^3)(1.5)}{10.125} + \frac{-400(10^3)(-2.25)}{22.78125}$

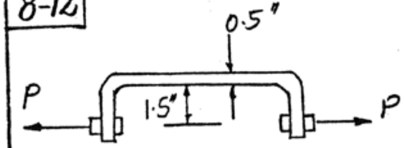
$= \underline{\underline{-49.4\,KPa}}.$

$\sigma_C = \frac{-800(10^3)}{4.5(3)} - \frac{200(10^3)(1.5)}{10.125} + \frac{-400(10^3)(2.25)}{22.78125}$

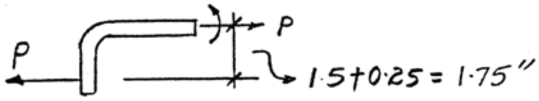
$= \underline{\underline{-128\,KPa}}.$

9B Sol. continued

8-12



$M = P(1.75)$



σ due to axial load

$$\sigma_a = \frac{P}{A} = \frac{P}{0.5(0.75)} = 2.6667P$$

σ due to bending

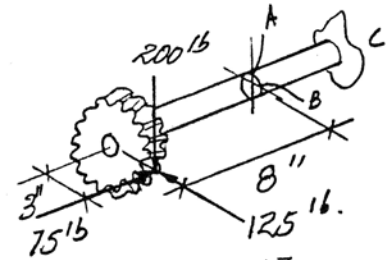
$$\sigma_b = \frac{Mc}{I} = \frac{1.75P(0.25)}{\frac{1}{12}(0.75)(0.5^3)} = 56P$$

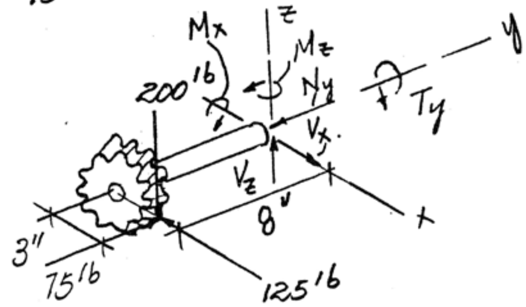
$$\sigma_{max} = \sigma_{allow} = \sigma_a + \sigma_b$$

$$24(10^3) = 2.6667P + 56P$$

$$P = \underline{\underline{409}}\text{ lb}$$

8-31





$\Sigma F_x = 0;\quad V_x - 125 = 0\quad V_x = 125\text{ lb}$

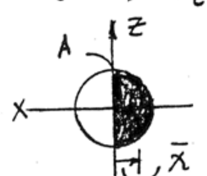
$\Sigma F_y = 0,\quad 75 - N_y = 0\quad N_y = 75\text{ lb.}$

$\Sigma F_z = 0;\quad V_z - 200 = 0\quad V_z = 200\text{ lb.}$

$\Sigma M_x = 0;\quad 200(8) - M_x = 0\quad M_x = 1600\text{ lb-in}$

$\Sigma M_y = 0;\quad 200(3) - T_y = 0\quad T_y = 600\text{ lb-in}$

$\Sigma M_z = 0;\quad M_z + 75(3) - 125(8) = 0\quad M_z = 775\text{ lb-in}$



$A = \pi(0.5)^2 = 0.7854\text{ in}^2$

$J = \frac{\pi}{2}(0.5)^4 = 0.098175\text{ in}^4$

$I = \frac{\pi}{4}(0.5)^4 = 0.049087\text{ in}^4$

$(Q_A)_x = 0$

$(Q_A)_z = \frac{4(0.5)}{3\pi}(\frac{1}{2})(\pi)(0.5^2) = 0.08333\text{ in}^3$

8-32

From prob 8-31

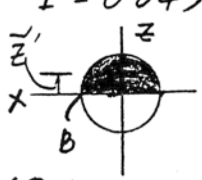
$V_x = 125\text{ lb}\quad N_y = 75\text{ lb}\quad V_z = 200\text{ lb}$

$M_x = 1600\text{ lb-in}\quad T_y = 600\text{ lb-in}$

$M_z = 775\text{ lb-in}$

$A = 0.7854\text{ in}^2\quad J = 0.098175\text{ in}^4$

$I = 0.049087\text{ in}^4$



$(Q_B)_z = 0$

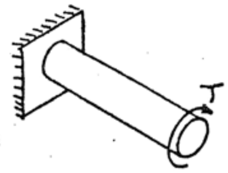
$(Q_B)_x = \frac{4(0.5)}{3\pi}(\frac{1}{2})(\pi)(0.5^2) = 0.08333\text{ in}^3$

$$(\sigma_B)_y = \frac{-N_y}{A} + \frac{M_z c}{I}$$

$$= \frac{-75}{0.7854} + \frac{775(0.5)}{0.049087} = \underline{\underline{7.80\text{ ksi}}}$$

Solutions
3 of Six problems from problem set #10
to help with exam #2

10-57



$$\sigma_x = -\frac{P}{A} = -\frac{P}{\pi c^2} = -\frac{P}{\pi(3)^2} = -0.3183P$$

$$\tau_{xy} = \frac{Tc}{J} = \frac{Tc}{\pi c^4/2} = \frac{2T}{\pi c^3} = \frac{2(9000\pi)(12)}{\pi(3)^3} = 8000 \text{ psi}$$

Maximum-shear-stress: $\tau_f = \frac{1}{2}\left(\frac{\sigma_f}{FS}\right) = \frac{1}{2}\left(\frac{60}{2.5}\right) = 12 \text{ ksi}$

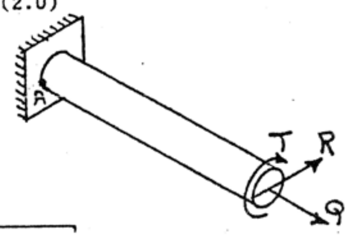
$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \sqrt{\left(\frac{-0.3183P}{2}\right)^2 + (8000)^2} = 12{,}000 \text{ psi}$$

$P = 56{,}200 \text{ lb} = 56.2 \text{ kip}$ Ans.

10-65*

$A = \pi(2)^2 = 4\pi \text{ in.}^2$ $\quad I = \frac{\pi}{4}(2)^4 = 4\pi \text{ in.}^4$

$J = \frac{\pi}{2}(2)^4 = 8\pi \text{ in.}^4$ $\quad \tau_{max} = \frac{1}{2}\frac{\sigma_y}{FS} = \frac{48}{2(2.0)} = 12 \text{ ksi}$



$$\sigma_x = \frac{Q}{A} + \frac{Mc}{I} = \frac{8R}{4\pi} + \frac{R(24)(2)}{4\pi} = 4.4563R$$

$$\tau_{xy} = \frac{Tc}{J} = \frac{R(20)(2)}{8\pi} = 1.5915R$$

$$\sigma_{p1,p3} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= \frac{4.4563R + 0}{2} \pm \sqrt{\left(\frac{4.4563R - 0}{2}\right)^2 + (1.5915R)^2} = 2.228R \pm 2.738R$$

$\sigma_{p1} = 2.228R + 2.738R = 4.966R \text{ ksi} \cong 4.97R \text{ ksi (T)}$ $\quad \sigma_{p2} = \sigma_z = 0$

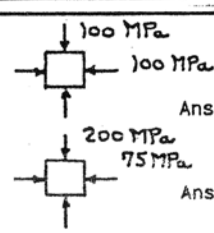
$\sigma_{p3} = 2.228R - 2.738R = -0.510R \text{ ksi} = 0.510R \text{ ksi (C)}$

(a) Maximum-Shear-Stress:

$$\tau_{max} = \frac{1}{2}(\sigma_{p1} - \sigma_{p3}) = \frac{1}{2}(4.966R + 0.510R) = 2.738R = 12 \text{ ksi}$$

$R = \frac{12}{5.476} = 4.383 \text{ kip} \cong 4.38 \text{ kip}$ Ans.

10-72*



(a) $\frac{\sigma_{p1}}{\sigma_{ut}} - \frac{\sigma_{p3}}{\sigma_{uc}} = \frac{100}{152} - \frac{-100}{572} = 0.8327 \le 1$ (Safe) Ans.

(b) $\frac{\sigma_{p1}}{\sigma_{ut}} - \frac{\sigma_{p3}}{\sigma_{uc}} = \frac{75}{152} - \frac{-200}{572} = 0.8431 \le 1$ (Safe) Ans.