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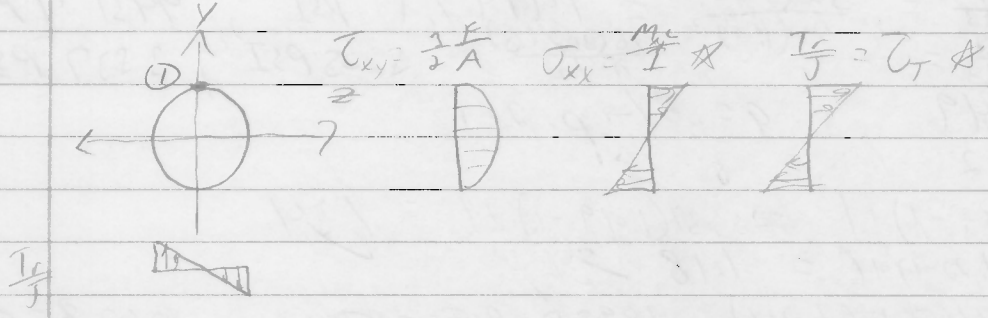
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Test 1

5-10-04

1.  $S_y = 50 \times 10^3 \text{ PSI}$   $l = 8''$ ,  $d = 1.2''$ ,  $a = 6''$ ,  $h = 2''$ ,  $t = .4''$   
 $F = 800 \text{ lb}$



$M_{xy} = 6400 \text{ in-lb}$   
 $M_{zy} = 4800 \text{ in-lb} = T$

$\tau_{xy} = \frac{F}{A} = \frac{800}{\pi(0.6)^2} = 1061 \text{ PSI}$   
 $\tau_T = \frac{4800(0.6)}{\frac{\pi(1.2)^4}{32}} = 14147 \text{ PSI}$

$\sigma_{xy} = \frac{M_{xy}r}{I} = \frac{(6400 \text{ in-lb})(0.6 \text{ in})}{\frac{\pi(1.2)^4}{64}} = 37726 \text{ PSI}$

$R = \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \tau_{xy}^2} = \sqrt{\left(\frac{37726 - 0}{2}\right)^2 + (14147)^2} = 23,578.6$

$\sigma_{11} = \frac{\sigma_{xx} + \sigma_{yy}}{2} + R = \frac{37726}{2} + 23,578.6 = 42441.6 \text{ PSI}$   
 $\sigma_{22} = \frac{\sigma_{xx} + \sigma_{yy}}{2} - R = \frac{37726}{2} - 23,578.6 = -4715.6 \text{ PSI}$

$\sigma_{eq} = \sqrt{\frac{1}{2} [(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2]}$   
 $= \sqrt{\frac{1}{2} [(42441.6 + 4715.6)^2 + (-4715.6)^2 + (-42441.6)^2]} = 44985 \text{ PSI}$

Factor of safety =  $\frac{S_y}{\sigma_{eq}} = \frac{50,000}{44,985} = 1.11$

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2)  $S_f = 16 \text{ ksi}$ ,  $S_u = 70 \text{ ksi}$   $r_n = 0.25''$   $F = 200, 300 \text{ lbf}$   
 $D = \infty$   $r/d = \frac{.25}{1.2} = .21$   $D/d = \infty \approx 6$   $M = 300 \cdot 8 = 2400 \text{ in-lb}$   
 $M_{max} = 1600 \text{ in-lb}$

$\sigma_{comb} = \frac{32 M}{\pi d^3} = \frac{32(2400)}{\pi(1.2)^3} = 14147.1 \text{ PSI}$ ,  $9431.4 \text{ PSI}$   
 $\sigma_{max} = \frac{32 M}{\pi d^3} = \frac{32(1600)}{\pi(1.2)^3} = 5305 \text{ PSI}$ ,  $3537 \text{ PSI}$

p. 214  $K_{Tb} = 1.49$   $q = .81 \rightarrow p. 221$   
 $K_{Tf} = 1.22$

$K_{f_{ax}} = q(K_T - 1) + 1 = .81(1.49 - 1) + 1 = 1.34$   
 $K_{Tf} = .81(1.22 - 1) + 1 = 1.18$

$\sigma_{actb} = (14147.1)(1.34) = 18957 \text{ PSI} = \sigma_{x_{max}}$ ,  $12638 = \sigma_{y_{min}}$   
 $\sigma_{actf} = (5305)(1.18) = 6260 \text{ PSI} = \sigma_{x_{y_{max}}}$ ,  $4174 = \sigma_{y_{min}}$

$\sigma_{max} = \frac{\sigma_x}{2} + \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + \tau_{xy}^2} = \frac{18957}{2} + \sqrt{\left(\frac{18957}{2}\right)^2 + 6260^2} = 20838 \text{ PSI}$

$\sigma_{min} = \frac{18957}{2} - \sqrt{\left(\frac{18957}{2}\right)^2 + 6260^2} = -1881 \text{ PSI}$

$\tau_{3_{max}} = 0 = \tau_{y_{min}}$

$\sigma_{min} = \frac{12638}{2} + \sqrt{\left(\frac{12638}{2}\right)^2 + \left(\frac{4174}{2}\right)^2} = 12974 \text{ PSI}$

$\tau_{3_{min}} = -336 \text{ PSI}$

$\sigma_{im} = \frac{20838 + 12974}{2} = 16906 \text{ PSI}$

$\sigma_{ia} = \frac{20838 - 12974}{2} = 3932 \text{ PSI}$

$\sigma_{im} = \frac{-1881 + 336}{2} = -772 \text{ PSI}$

$\sigma_{ia} = -1108.5 \text{ PSI}$

$\sigma_{eq} = \sqrt{\frac{1}{2}[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2]}$

$\sigma_{eq} = 4589 \text{ PSI}$

$\sigma_{em} = 17304 \text{ PSI}$

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$\sigma_{eq-CR} = \frac{4589}{1 - (17304/100000)} = 6096 \text{ PSI}$

$N = \frac{16000}{6096} = 2.62$

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3.  $E_1 = E_2 = 10.3 \times 10^6 \text{ PSI}$      $G = 3.9 \times 10^6 \text{ PSI}$      $\nu = 0.3$   
 $M_1 = 4800 \text{ in-lb}$      $M_2 = 6400 \text{ in-lb}$      $P = 800 \text{ lb}$      $a = 6$      $l = 8$

a.  $\delta_p = \int_0^a \frac{m_1 (dx/p)}{E_1 I_1} dx + \int_0^l \frac{m_2 (dx/p)}{E_2 I_2} dx + \int_0^l \frac{T (dx/p)}{G J_1}$

$$\delta_p = \left[ \frac{Pa^3}{3E_1 I_1} \right] + \left[ \frac{Pl^3}{3E_2 I_2} \right] + \left[ \frac{Pa^2 l}{G J_1} \right] \quad J = I_1$$

$$I_1 = \frac{27}{12} = 1.33 \text{ in}^4$$

$$I_2 = \frac{\pi (2)^4}{64} = .787 \text{ in}^4$$

$$J = 1.57 \text{ in}^4$$

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$$\delta_p = .064 \text{ in}$$

b.  $a = \sqrt{\frac{2P \left[ \frac{1-\nu_1^2}{E_1} \right] + \left[ \frac{1-\nu_2^2}{E_2} \right]}{\pi L \left( \frac{1}{d_1} + \frac{1}{d_2} \right)}}$

~~2~~ (x)