نام درس: طراحی اجزا ۱، طراحی اجزا
رشته تحصیلی /کد درس : مکانیکها حرارت وسیالات–جامدات–ساخت وتولید- مهندسی هوافضا – مهندسی پزشکی گرایش بیومکانیک- مهندسی راه آهن جریه۱۳۱۵۰۲۶ - مهندسی مدیریت اجرایی۱۳۱۱۰۱۲-مهندسی خودرو۱۳۱۵۲۴۴-

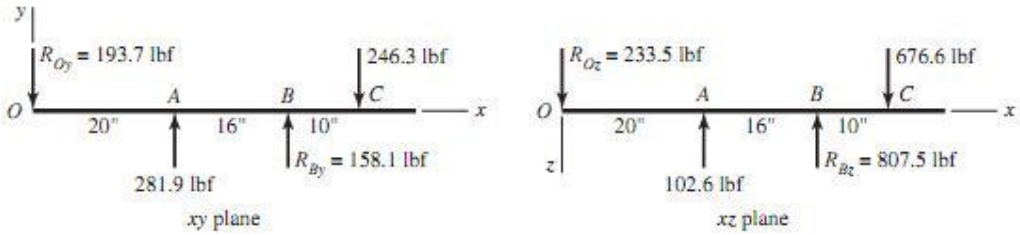
بارم نمره هرسوال۲/۸۰ می باشد.

۱ -

$$(F_A)_t = 300\cos 20 = 281.9\ \text{lbf}, \quad (F_A)_r = 300\sin 20 = 102.6\ \text{lbf}$$

$$T = 281.9(12) = 3383\ \text{lbf}\cdot\text{in}, \quad (F_C)_t = \frac{3383}{5} = 676.6\ \text{lbf}$$

$$(F_C)_r = 676.6\tan 20 = 246.3\ \text{lbf}$$



$$M_A = 20\sqrt{193.7^2 + 233.5^2} = 6068\ \text{lbf}\cdot\text{in}$$

$$M_B = 10\sqrt{246.3^2 + 676.6^2} = 7200\ \text{lbf}\cdot\text{in} \quad \text{(maximum)}$$

$$\sigma_x = \frac{32(7200)}{\pi d^3} = \frac{73\,340}{d^3}$$

$$\tau_{xy} = \frac{16(3383)}{\pi d^3} = \frac{17\,230}{d^3}$$

$$\sigma' = \left(\sigma_x^2 + 3\tau_{xy}^2\right)^{1/2} = \frac{S_y}{n}$$

$$\left[\left(\frac{73\,340}{d^3}\right)^2 + 3\left(\frac{17\,230}{d^3}\right)^2\right]^{1/2} = \frac{79\,180}{d^3} = \frac{60\,000}{3.5}$$

$$d = 1.665\ \text{in} \quad \text{so use a standard diameter size of } 1.75\ \text{in} \quad \textit{Ans.}$$

۲ – صفحه ۲۳۰

-۳

Members: Table A-20, $S_y = 320$ MPa
Bolts: Table 8-11, ISO class 5.8, $S_y = 420$ MPa, $S_{sy} = 0.577(420) = 242.3$ MPa

Shear of bolts,

$$A_s = \pi(20^2)/4 = 314.2 \text{ mm}^2$$

$$\tau_s = \frac{90(10^3)}{3(314.2)} = 95.48 \text{ MPa}$$

$$n = \frac{S_{sy}}{\tau_s} = \frac{242.3}{95.48} = 2.54 \quad \textit{Ans.}$$

Bearing on bolt,

$$A_b = 3(20)15 = 900 \text{ mm}^2$$

$$\sigma_b = -\frac{90(10^3)}{900} = -100 \text{ MPa}$$

$$n = \frac{S_y}{|\sigma_b|} = \frac{420}{100} = 4.2 \quad \textit{Ans.}$$

Bearing on members,

$$n = \frac{S_y}{|\sigma_b|} = \frac{320}{100} = 3.2 \quad \textit{Ans.}$$

Tension on members,

$$\sigma_t = \frac{F}{A} = \frac{90(10^3)}{15[190 - 3(20)]} = 46.15 \text{ MPa}$$

$$n = \frac{S_y}{\sigma_t} = \frac{320}{46.15} = 6.93 \quad \textit{Ans.}$$

Primary shear: $\tau' = 0$ (why?)

Secondary shear:

Table 9-1: $J_u = 2\pi r^3 = 2\pi(1.5)^3 = 21.21 \text{ in}^3$

$$J = 0.707\, h\, J_u = 0.707(1/4)(21.21) = 3.749 \text{ in}^4$$

2 welds: $\tau'' = \dfrac{Mr}{2J} = \dfrac{8F(1.5)}{2(3.749)} = 1.600F$

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Table 9-1: $J_u = 2\pi r^3 = 2\pi(1.5)^3 = 21.21 \text{ in}^3$

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Given: $N_b = 84$ coils, $F_i = 16$ lbf, OQ&T steel, OD = 1.5 in, $d = 0.162$ in.

$$D = \text{OD} - d = 1.5 - 0.162 = 1.338 \text{ in}$$

(a) Eq. (10-39):

$$L_0 = 2(D - d) + (N_b + 1)d$$
$$= 2(1.338 - 0.162) + (84 + 1)(0.162) = 16.12 \text{ in} \quad \textit{Ans.}$$

or $$2d + L_0 = 2(0.162) + 16.12 = 16.45 \text{ in overall}$$

(b)
$$C = \frac{D}{d} = \frac{1.338}{0.162} = 8.26$$

$$K_B = \frac{4C + 2}{4C - 3} = \frac{4(8.26) + 2}{4(8.26) - 3} = 1.166$$

$$\tau_i = K_B\left[\frac{8F_iD}{\pi d^3}\right] = 1.166\frac{8(16)(1.338)}{\pi(0.162)^3} = 14\,950 \text{ psi} \quad \textit{Ans.}$$

(c) From Table 10-5 use: $G = 11.4(10^6)$ psi and $E = 28.5(10^6)$ psi

$$N_a = N_b + \frac{G}{E} = 84 + \frac{11.4}{28.5} = 84.4 \text{ turns}$$

$$k = \frac{d^4G}{8D^3N_a} = \frac{(0.162)^4(11.4)(10^6)}{8(1.338)^3(84.4)} = 4.855 \text{ lbf/in} \quad \textit{Ans.}$$

(d) Table 10-4: $A = 147$ psi · in^m, $m = 0.187$

$$S_{ut} = \frac{147}{(0.162)^{0.187}} = 207.1 \text{ kpsi}$$
$$S_y = 0.75(207.1) = 155.3 \text{ kpsi}$$
$$S_{sy} = 0.50(207.1) = 103.5 \text{ kpsi}$$

Body

$$F = \frac{\pi d^3 S_{sy}}{\pi K_B D}$$
$$= \frac{\pi(0.162)^3(103.5)(10^3)}{8(1.166)(1.338)} = 110.8 \text{ lbf}$$

Torsional stress on hook point B

$$C_2 = \frac{2r_2}{d} = \frac{2(0.25 + 0.162/2)}{0.162} = 4.086$$
$$(K)_B = \frac{4C_2 - 1}{4C_2 - 4} = \frac{4(4.086) - 1}{4(4.086) - 4} = 1.243$$
$$F = \frac{\pi(0.162)^3(103.5)(10^3)}{8(1.243)(1.338)} = 103.9 \text{ lbf}$$

Normal stress on hook point A

$$C_1 = \frac{2r_1}{d} = \frac{1.338}{0.162} = 8.26$$
$$(K)_A = \frac{4C_1^2 - C_1 - 1}{4C_1(C_1 - 1)} = \frac{4(8.26)^2 - 8.26 - 1}{4(8.26)(8.26 - 1)} = 1.099$$
$$S_{yt} = \sigma = F\left[\frac{16(K)_AD}{\pi d^3} + \frac{4}{\pi d^2}\right]$$
$$F = \frac{155.3(10^3)}{[16(1.099)(1.338)]/[\pi(0.162)^3] + \{4/[\pi(0.162)^2]\}} = 85.8 \text{ lbf}$$
$$= \min(110.8,\ 103.9,\ 85.8) = 85.8 \text{ lbf} \quad \textit{Ans.}$$

(e) Eq. (10-48):

$$y = \frac{F - F_i}{k} = \frac{85.8 - 16}{4.855} = 14.4 \text{ in} \quad \textit{Ans.}$$