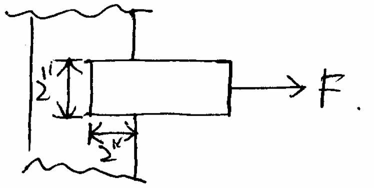
9-1

Find load F that cause shear stress in the weld of 20 kpsi.



Sol: using Eq. 9-3,

$$\tau = \frac{F}{2(0.707)hl}$$

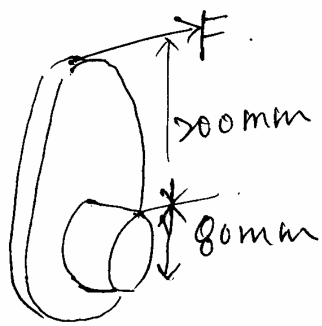
$$\Rightarrow \quad F = 2(0.707)\left(\tfrac{5}{16}\text{ in}\right)\left(20\times10^3\ \text{lb/in}^2\right)(2\text{ in})$$

$$= 17.K \text{ kip} \;//$$

9-10

given: permissible shear stress = 140 MPa.

Estimate load F that will cause this stress.



use table 9-2, $J_u = 2\pi r^3 = 2\pi(4)^3$
$= 402\ cm^3$

Eq 9-7, $J = 0.707\, h J_u$ ($h = 0.5$ cm)
$= 0.707(0.5\text{cm})(402\text{cm}^3)$
$= 142\ \text{cm}^4$.

Moment, $M = F(20+4)$
$= 24\,(\text{cm})\cdot F$

using Eq 9-6,

$$\tau'' = \frac{Mr}{J}$$

$$\Rightarrow \tau'' = \frac{24(cm) \cdot F \cdot r}{J}$$

$$F = \frac{(142\ cm^4)\left(140 \times 10^6 \frac{N}{m^2} \times \frac{m^2}{1 \times 10^4 cm^2}\right)}{(24\ cm)(4\ cm)}$$

$$= 41.4\ KN$$

9

10-3, given = 0.105 in diameter
music wire spring.

$D' = 1.225$ in, plain ground End,
$N = 12$.

(a) & (b)

Table 10-5, $m = 0.613$, $A = 186$ kpsi (music wire).

Eq 10-17, $S_{ut} = \frac{A}{d^m}$

$$= \frac{186 \text{ kpsi}}{(0.105)^{0.163}} = 269 \text{ kpsi}.$$

Eq 10-19, $S_{sy} = 0.45\,(269 \text{ kpsi}) = 121 \text{ kpsi}.$

$D = 1.225 \text{ in} - 0.105 \text{ in}$
$= 1.120$ in.

Eq 10-2 $\therefore\ C = D/d = 1.120/0.105 = 10.67.$

Eq 10-4: $K_s = \frac{2C+1}{2C} = \frac{2(10.67)+1}{2(10.67)} = 1.05$

Table 10-2: $N_a = 12 - 1 = 11$ coils.

$\therefore\ L_s = 0.105\,(12) = 1.26$ in.

Eq 10-3: $F_s = \frac{\pi d^3 S_{sy}}{8 K_s D}$

$$= \frac{\pi (0.105 \text{ in})^3 (121 \times 10^3 \text{ lb/in}^2)}{8(1.05)(1.120 \text{ in})}$$

$= 46.77$ lb // ———— (b)

To find k, (Table A-5)

$$k = \frac{d^4 G}{8 D^3 N} = \frac{(0.105)^4 (11.5)(10^6)}{8\,(1.12)^3\,(11)}$$

$$= 11.31 \text{ lb/in} \qquad \text{(c)}$$

From here, we can find the L_0,

$$L_0 = F_s/k + L_s = (46.77/11.31) + 1.26$$

$$= 5.40 \text{ in} \qquad \text{(a)}$$

Eq: 10-16, let $\alpha = 0.5$,

$$\frac{2.63 D}{\alpha} = \frac{2.63(1.12)}{0.5} = 5.89 \text{ in}$$

→ spring will not buckle if both ends are fixed.

(10.7) $d = 1.4$ mm O.D. = 12.19 mm

ends: squared & ground $L_s = 14.35$ mm

a) $D = 12.19 - 1.4 = 10.79$ mm

$$C = \frac{D}{d} = \frac{10.79}{1.4} = 7.707$$

Table 10-2: $N_t = \frac{L_s}{d} = \frac{14.35}{1.4} = 10.25$

$$N_a = N_t - 2 = 10.25 - 2 = 8.25$$

eq 10-4: $K_s = \frac{2C+1}{2C} = \frac{2(7.707)+1}{2(7.707)} = 1.065$

Table 10-5: $m = 0.163$ $A = 2060$ MPa

eq 10-17: $S_{ut} = \frac{A}{d^m} = \frac{2060}{(1.4)^{0.163}} = 1950$ MPa

eq. 10-19 $S_{sy} = 0.45\, S_{ut} = 0.45\,(1950) = 878$ MPa

$\tau_{MAX} = 0.9\,(878) = 790$ MPa

eq. 10-3: $\tau = K_s \frac{8FD}{\pi d^3} = (1.065)\frac{8(F)(10.79)}{\pi(1.4)^3} = 790$

$F = 74.1$ N

eq. 10-8: $y = \frac{8FD^3N}{d^4G}\left(1 + \frac{1}{2C^2}\right) \approx \frac{8FD^3N}{d^4G} = \frac{8(74.1)(10.79)^3(8.25)}{(1.4)^4(79.3)}$

$= 20.17$ mm

$L_o = L_s + y_s = 14.35 + 20.17 = 34.52$ mm

(10.14) $N_t = 14$ ends: squared & ground

$L_o = 1.25''$ outside diameter: $\frac{7}{16}''$

$d = 0.042''$ hard-drawn wire

$F_{MIN} = 1.5$ lb. $F_{MAX} = 3.5$ lb.

a) $D = \frac{7}{16} - 0.042 = 0.3955''$

Table 10-2: $L_s = d N_t = 0.042\,(14) = \underline{0.588''}$

$N_a = N_t - 2 = 14 - 2 = 12$

eq: 10-9: $K = \frac{d^4 G}{8 D^3 N} = \frac{(0.042)^4 (11.5)}{8(.3955)^3 (12)} = \underline{6.025 \frac{lb.}{in.}}$

$y_s = 1.25 - 0.588 = 0.662''$

$F_s = K y_s = (6.025)(0.662) = 3.99$ lb.

eq (10-2): $C = \frac{D}{d} = \frac{0.3955}{0.042} = 9.42$

(10-3): $\tau = K_s \frac{8FD}{\pi d^3} = \frac{2(9.42)+1}{2(9.42)} \cdot \frac{8\,(3.99)(0.3955)}{\pi\,(0.042)^3} = \underline{57.1 \text{ kpsi}}$

$K_s = \frac{2C+1}{2C}$

b) $K_B = \frac{4C+2}{4C-3} = \frac{4(9.42)+2}{4(9.42)-3} = 1.144$

$F_m = \frac{3.5+1.5}{2} = 2.5$ $F_a = \frac{3.5-1.5}{2} = 1$

$\tau_a = K_B \frac{8F_a D}{\pi d^3} = 1.144 \frac{8\,(1)(0.3955)}{\pi\,(0.042)^3} = 15.55$ kpsi

$\tau_m = K_s \frac{8F_m D}{\pi d^3} = 1.053 \frac{8\,(2.5)(0.3955)}{\pi\,(0.042)^3} = 35.79$ kpsi

Table 10-5: $A = 137$ kpsi $m = 0.201$

$$S_{ut} = \frac{137}{(0.042)^{0.201}} = 259 \text{ kpsi}$$

$$S_{su} = 0.67(259) = 174 \text{ kpsi}$$

$$S_{se} = 45 \text{ kpsi}$$

$$\frac{1}{n} = \frac{\tau_a}{S_{se}} + \frac{\tau_m}{S_{su}} = \frac{15.55}{45} + \frac{35.79}{174} = 0.55$$

$$n = 1.81$$

(10.16) $d = 3.0\text{ mm}$ music wire

ends: squared & ground

$N_t = 9$ $OD = 28\text{ mm}$ $L_0 = 60\text{ mm}$

a) $C = \frac{28-3}{3} = 8.33$ $D = 28 - 3 = 25$

$N_a = 9 - 2 = 7$

$$K = \frac{d^4 G}{8 D^3 N} = \frac{3^4 (79.3)}{8 (25)^3 (7)} = 7.34 \frac{N}{mm}$$

b) $F: 0 \leftrightarrow 60N$

$F_a = \frac{60+0}{2} = 30N$ $F_m = \frac{60-0}{2} = 30N$

$$K_B = \frac{4(8.33)+2}{4(8.33)-3} = 1.165$$

$$K_s = \frac{2(8.33)+1}{2(8.33)} = 1.06$$

$$\tau_A = 1.165 \frac{8(30)(25)}{\pi (3)^3} = 82.4\ MPa$$

$$\tau_m = 1.06 \frac{8(30)(25)}{\pi (3)^3} = 75.0\ MPa$$

Table 10-5: $A = 2060\ MPa$ $m = 0.163$

$S_{ut} = \frac{2060}{3^{.163}} = 1722\ MPa$ $S_{su} = .67(1722) = 1154\ MPa$

$S_{sa} = 310\ MPa$ $\frac{1}{n} = \frac{82.4}{310} + \frac{75}{1154} = 0.33$ $n = 3.02$