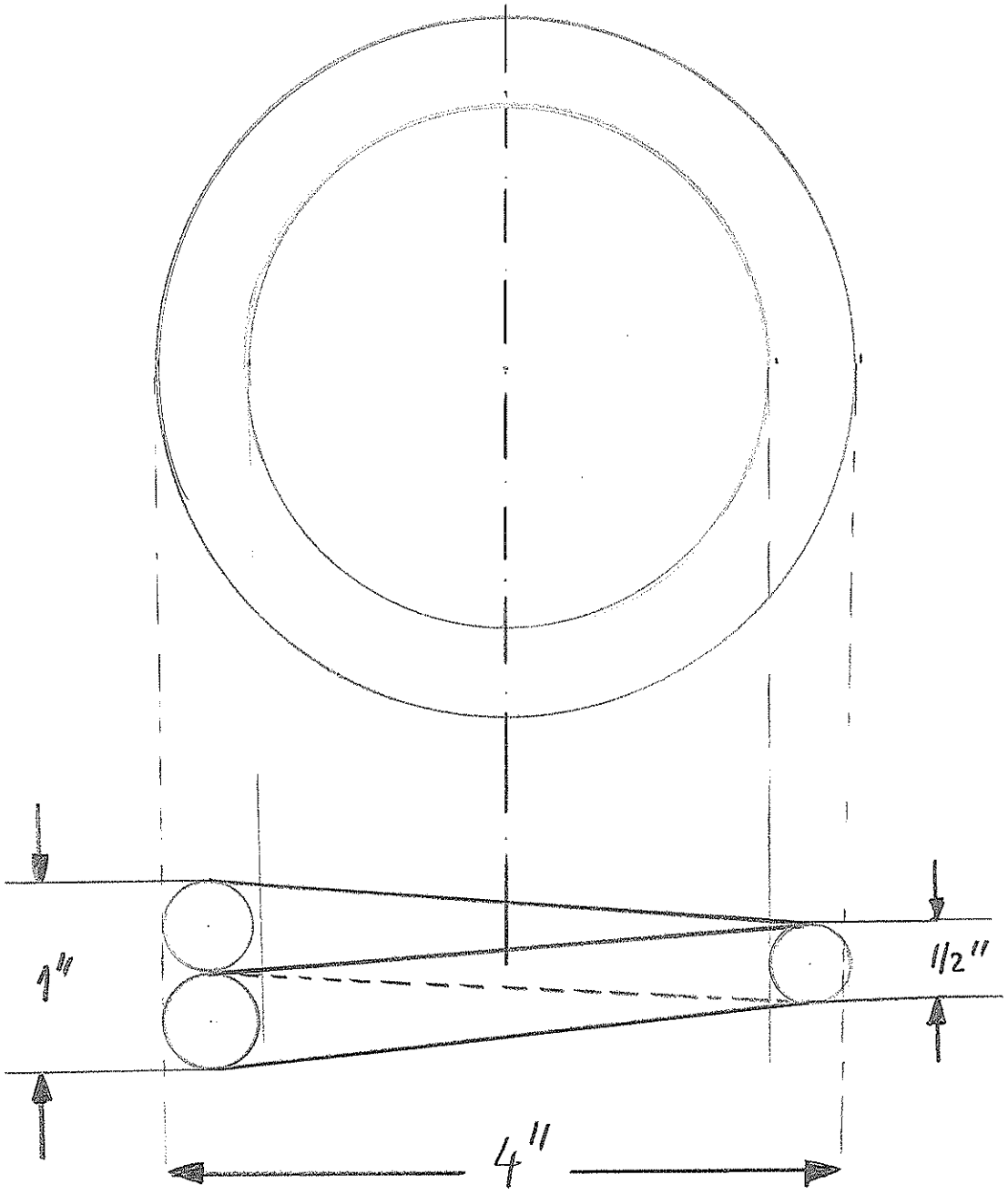
ME 325 – Homework #7
Due: Wed., Apr. 22, 2009

1. Problem 10-1
2. Problem 10-5
3. Problem 10-7
4. Problem 10-14

① Problem 10-1



② Problem 10-5

(a) $N_t = 12\frac{1}{2}$ $\quad D = 46.6\ mm$ $\quad C = \frac{46.6}{3.4} = 13.7$

Table 10-2: $N_a = 11\frac{1}{2}$ $\quad p = \frac{120}{12.5} = 9.6\ mm$

$L_s = 3.4 \cdot (12.5) = 42.5\ mm$

(b) $K = \frac{d^4 G}{8D^3 N} = 1140\ \frac{N}{m}$

(c) $F = 1140\ (120 - 42.5) \cdot 10^{-3} = 88.4\ N$

(d) $K_s = \frac{2 \cdot 13.7 + 1}{2 \cdot 13.7} = 1.036$

$\tau = K_s \frac{8FD}{\pi d^3} = 276\ MPa$

(3) Problem 10-7

Table 10-2:

$$N_t = \frac{L_s}{d} = \frac{14.35}{1.40} = 10.25$$

$$D = 12.19 - 1.40 = 10.79 \text{ mm}$$

$$C = \frac{10.79}{1.40} = 7.707$$

$$N_a = 10.25 - 2 = 8.25 \text{ coils}$$

$$K_s = \frac{2\cdot(7.707)+1}{2(7.707)} = 1.065$$

$$m = 0.163 \quad A = 2060 \text{ MPa} \Rightarrow S_{ut} = \frac{A}{d^m} = \frac{2060}{(1.40)^{0.163}} = 1950 \text{ MPa}$$

$$S_{ys} = 0.45(1950) = 878 \text{ MPa}$$

$$\tau_{max} = 0.9\, S_{ys} = 0.9\cdot 878 = 790 \text{ MPa}$$

$$F = \frac{\pi d^3 \tau_{max}}{8 K_s D} = \frac{\pi\cdot(1.4)^3\cdot 790}{8\cdot 1.065\cdot 10.79} = 74.1 \text{ N}$$

$$k = \frac{d^4 G}{8 D^3 N} = \frac{(1.4)^4\cdot 79.3}{8\cdot(10.79)^3\cdot 8.25} = 3674 \frac{N}{m}$$

$$y_s = \frac{F}{k} = \frac{74.1\cdot 10^3}{3674} = 20.17 \text{ mm}$$

$$L_o = L_s + y_s = 14.35 + 20.17 = 34.5 \text{ mm}$$

(4) Problem 10-14

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

$L_s = d N_t = 0.042(14) = 0.588$ in

$N_a = 14 - 2 = 12$ coils

$$k = \frac{d^4 G}{8 D^3 N} = \frac{(0.042)^4 \cdot 11.5 \cdot 10^6}{8 \cdot (0.3955)^3 \cdot 12} = 6.025 \ \frac{lb}{in}$$

$y_s = 1.25 - 0.588 = 0.662$ in

$F_s = k y_s = 6.025 (0.662) = 3.99$ lb

$$C = \frac{0.3955}{0.042} = 9.42$$

$$\tau_s = 1.053 \cdot \frac{8 \cdot (3.99)(0.3955)}{\pi (0.042)^3} \cdot 10^3 = 57.1 \text{ Kpsi}$$

(b)

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

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

$$\tau_a = K_B \cdot \frac{8 F_a D}{\pi d^3} = 1.144 \cdot \frac{8 \cdot (1) \cdot (0.3955) \cdot 10^{-3}}{\pi \cdot (0.042)^3} = 15.55 \text{ Ksi}$$

$$\tau_m = K_s \cdot \frac{8 F_m D}{\pi d^3} = 1.053 \cdot \frac{8 \cdot (2.5) \cdot (0.3955) \cdot 10^{-3}}{\pi (0.042)^3} = 35.79 \text{ Ksi}$$

$$A = 137\ \text{Ksi} \qquad m = 0.201 \Rightarrow S_{ut} = \frac{137}{(0.042)^{0.201}} = 259\ \text{Ksi}$$

$$S_{Su} = 0.67(S_{ut}) = 0.67 \cdot (259) = 174\ \text{Ksi}$$

Equation 10-31 :

$$\frac{\sigma_a}{S_{se}} + \frac{\sigma_m}{S_{Su}} = \frac{1}{n} \Rightarrow n = \frac{S_{se} \cdot S_{Su}}{\sigma_a S_{Su} + \sigma_m S_{se}}$$

$$n = \frac{45 \cdot 174}{15.55 \cdot (174) + 35.79 \cdot (45)} = 1.813$$