NORTON 13.20

MIN LOAD = 30lb
MAX LOAD = 50lb
y_w = 1.25 in
PEENED CHROME VANADIUM
15% CLASH
250 rpm FORCING
INFINITE LIFE
"MINIMIZE PACKAGE SIZE"
SQUARED ENDS
FIND F.O.S. IN YIELD, FATIGUE AND SURGE

$$k = \frac{50-30\text{lb}}{1.25\text{ in}} = 16\text{lb/in}$$

USING SOLUTIONS MANUAL PARAMETERS, C = 10, d = 0.112 in ...

SPRING DIMENSIONS ARE

$d = 0.112$ in

$D = Cd = 10(0.112\text{in}) = 1.12$ in

$D_o = D + d = 1.232$ in

$$N_a = \frac{dG}{8C^3k} = \frac{0.112(11.7\times10^6)}{8(10)^3 16} = 10.25$$ (NEAREST 1/4 TURN

$L_s = d(N_a+2) = 0.112\text{in}(12.25) = 1.37$ in

$y_c = 0.15(1.25\text{in}) = .1875$ in

$y_w = 1.25$ in

$$y_i = \frac{30\text{lb}}{16\text{lb/in}} = 1.875\text{ in}$$

$L_f = 4.68$ in

NORTON 13,20 CONT'D

FIND F.O.S. IN YIELD

$$\tau_{max} = K_s \frac{8FC}{\pi d^2} = \left(1 + \frac{0.5}{10}\right) \frac{8(53\,lb)10}{\pi(.112in)^2} = 113\ kpsi$$

$$F_{max} = 161\,lb/in \times 3.3125in = 53\,lb$$

$$S_{ys} = 0.5\,S_{us} = 0.65(225\ kpsi) = 146\ kpsi$$

ASSUME SET

TABLE 13-16 & FIGURE 13-3

$$F.O.S._{yield} = \frac{146}{113} = 1.29$$

FIND F.O.S IN FATIGUE

$F_i = 30$, $F_{max} = 50$, $F_m = \frac{50+30}{2} = 40lb$, $F_a = \frac{50-30}{2} = 10lb$

$$\tau_i = k_s \frac{8F_iC}{\pi d^2} = \left(1 + \frac{0.5}{10}\right) \frac{8(30)10}{\pi(.112)^2} = 64\ kpsi$$

$$\tau_m = k_s \frac{8F_mC}{\pi d^2} = \left(1 + \frac{0.5}{10}\right) \frac{8(40)10}{\pi(.112)^2} = 85\ kpsi$$

$$\tau_a = k_w \frac{8F_aC}{\pi d^2} = 1.14 \frac{8(10)10}{\pi(.112)^2} = 23\ kpsi$$

$$k_w = \frac{4C-1}{4C-4} + \frac{0.615}{C} = \frac{39}{36} = 1.14$$

$$S_{es} = 0.707 \frac{S_{ew}S_{us}}{S_{us} - 0.707 S_{ew}} = 0.707 \frac{67.5(151)}{151 - 0.707(67.5)} = 69.8\ kpsi$$

$S_{ew} = 67.5\ kpsi$ (PREGNED, RUN 13.12)

$S_{us} = 0.67(S_{ut}) = 0.67(225) = 151\ kpsi$

$$F.O.S._{FATIGUE} = N_f = \frac{S_{es}(S_{us} - \tau_i)}{S_{es}(\tau_m - \tau_i) + S_{us}\tau_a} = \frac{69.8(151-64)}{69.8(85-64) + 151(23} = 1.23$$

NORTON 13,20 CONT'D

FIND F.O.S. IN SURGE

$$W_a = \frac{\pi^2 d^2 D N_c \gamma}{4} = \frac{\pi^2 (.112in)^2 1.12in (10.25) \cdot 285 \frac{lb}{in^3}}{4}$$

$$= 0.1011 lb$$

$$f = \frac{1}{2}\sqrt{\frac{kg}{w_a}} = \frac{1}{2}\sqrt{\frac{16\ lb/in\ (386\ in/sec^2)}{0.1011 lb}} = 123\ Hz$$

$$F.O.S.\ SURGE = \frac{123 Hz}{13\left(250 \frac{rev}{min} \div 60 \frac{sec}{min}\right)} = 2.27$$