9.20 NORTON

$M_m = \frac{900+100}{2} = 500$ in-lb

$M_a = \frac{900-100}{2} = 400$ in-lb

$T_m = \frac{1500-300}{2} = 600$ in-lb

$T_a = \frac{1500+300}{2} = 900$ in-lb

SINCE BENDING MOMENTS AND TORQUES ARE GIVEN, THERE IS NO NEED FOR A FREE BODY DIAGRAM OR CALCULATION OF REACTION FORCES.

NEED ENDURANCE LIMIT

$S_e = \frac{1}{2} S_{ut} C_{LOAD} C_{SIZE} C_{SURF} C_{TEMP} C_{RELIAB}$ EQN 6.6 pg 376

$C_{LOAD} = 1$ EQN 6-7a

$C_{SIZE} = 0.869\, d^{-0.097}$ EQN 6-7b

$= 0.869$ GUESS 1 in dia

$C_{SURF} = 0.66$ FIGURE 6-26 pg 378

$C_{TEMP} = 1$ EQN 6-7f

$C_{RELIAB} = 0.814$ TABLE 6-4 ASSUME 99% RELIABILITY

$S_e = \frac{1}{2}(180)1(.869).66(1).814 = 42.0$ kpsi

NEED K_f & K_{fs}

$k_t = k_{ts} = 2.5$ $r = 0.02$ in

$q = 0.85$ FOR BENDING

$q = 0.88$ FOR TORSIONAL LOADING

} FIG 6-36 pg 392

$K_f = 1 + q(k_t - 1) = 1 + 0.85(2.5-1) = 2.28$

$K_{fs} = 1 + q(k_{ts} - 1) = 1 + 0.88(2.5-1) = 2.32$

9.20 NORTON (CONT'D)

USE GENERAL SHAFT EQN: (NEGLECT BENDING SHEAR)

$$d = \left\{ \frac{32 N_f}{\pi} \left[\frac{\sqrt{(K_f M_a)^2 + \frac{3}{4}(K_{fs} T_a)^2}}{S_e} + \frac{\sqrt{(K_t M_m)^2 + \frac{3}{4}(K_{ts} T_m)^2}}{S_{ut}} \right] \right\}^{1/3} \quad \text{EQN 9.8}$$

$$d = \left\{ \frac{32(1.5)}{\pi} \left[\frac{\sqrt{(2.28(400))^2 + \frac{3}{4}(2.32(900))^2}}{42{,}000} + \frac{\sqrt{(2.5(500))^2 + \frac{3}{4}(2.5(600))^2}}{180{,}000} \right] \right\}^{1/3}$$

$= 0.96$ in

LOOKS LIKE THE GUESS OF 1 in FOR THE SIZE CORRECTION IS SATISFACTORY. RE-ITERATION USING 0.96 IN TO CALCULATE THE SIZE CORRECTION WILL NOT CHANGE THESE CALCULATIONS BECAUSE ONLY TWO SIGNIFICANT DIGITS WERE USED IN S_e ANYWAY.