7.5, 7.7, 7.9, 7.11

7.5) USE TABLE 7.13

$S_{UT} = .495(H_B) = .495(490) = 242.6$ kpsi

WE CAN USE EQ 7-4 SINCE $S_{UT} > 212$ kpsi

$S_e' = 107$ kpsi

FROM TABLE 7.5

$a = 1.34$ kpsi $\quad b = -.086 \quad C = .120$

SOLVE FOR THE SURFACE FACTOR USING EQ 7-9:

$k_a = 1.34(242.6)^{(-.086)} = .8356$

SOLVE FOR SIZE FACTOR BY USING EQ 7-10: $d = 3/16$ in $= .1875$ in

$k_b = \left(\frac{d}{0.3}\right)^{(-.107)} = .879\, d^{(-.107)} = 1.051$

SINCE THE BEAM IS IN BENDING AND SINCE TEMP IS NOT GIVEN $k_c = 1$ and $k_d = 1$ (ASSUME AT RT).

$\therefore \quad S_e = k_a k_b S_e'$

$= (.8356)(1.051)(107) = \boxed{93.97 \text{ kpsi}}$

7.7) $S_e' = (0.506)(710) = 359.3$ MPa

From TABLE 7-5:

$a = 4.45 \quad b = -.265 \quad C = .058$

$k_a = 4.45\,(710)^{(-.265)} = .7812$

$k_b = \left(\frac{d}{7.62}\right)^{-.107} = \left(\frac{32}{7.62}\right)^{-.107} = .858$

OTHER FACTORS = 1 SO,

$S_e = (.7812)(.858)(359.3) = \boxed{240.8 \text{ MPa}}$

7.9) TABLE E-20 GIVES: $S_{UT} = 440$ MPa, $S_y' = 370$ MPa

(WHY NOT S_{SE} S_N)

$S_e' = (.506)(440) = 222.64$ MPa

From TABLE 7-5:

$k_a = 4.45\,(440)^{-.265} = .807$

$k_b = 1$ (AXIAL LOADING)

CONDITIONS:

$\left(\sigma_a \le \frac{S_e}{n}\right) \Rightarrow$ FATIGUE FAILURE

$\left(\sigma_a \le \frac{S_y}{n}\right) \Rightarrow$ YIELDING

USE EQUATION 7-21 and TABLE 7-7:

$k_c = 1.43\,S_{UT}^{(-.0778)}$; $a = 1.43 \Rightarrow$ MPa $\quad b = -.078$

$= 1.43\,(440)^{(-.0778)} = .890$

$S_e = (.890)(.887)(222.64) = 175.7$ MPa

From TABLE E-15-1: $\frac{d}{w} = \frac{12\text{ mm}}{60\text{ mm}} = .2 \;\therefore\; k_t = 2.5$

USE EQ 7-27 and TABLE 7-12:

$k_f = \frac{k_t}{1 + \left(\frac{2}{\sqrt{r}}\right)\left(\frac{k_t - 1}{k_t}\right)\sqrt{a}}$; $\frac{2.5}{1 + \left(\frac{2}{\sqrt{6}}\right)\left(\frac{2.5-1}{2.5}\right)\left(\frac{174}{440}\right)} = 2.09$

$\sigma_a = k_f \sigma_{a,0} = k_f \frac{F_A}{A} = \frac{S_e}{n} \quad A = 10\,(60 - 12) = 480\text{ mm}^2$

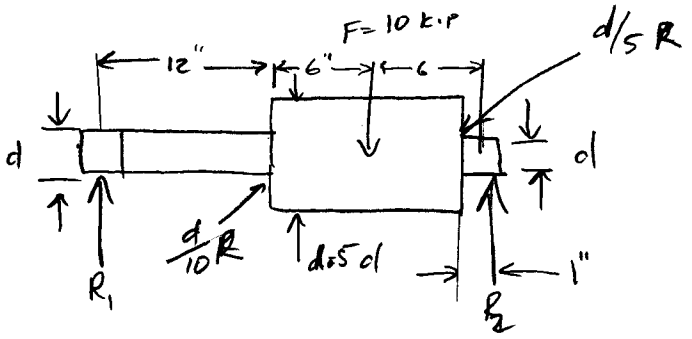
$\frac{F_A}{A} = \frac{S_y}{n} \rightarrow \frac{2.09\,F_A}{480\text{ mm}^2} = \frac{175.7}{1.8}$

$F_A = \frac{370}{1.8}\,480 = 98.7$ kN

$F_A = 22.4$ kN (IF designing for Fatigue Failure)

$F_A = 98.7$ kN (IF designing for yielding)

7.11)



MATERIAL : 1095 STEEL ∴ $S_{UT} = 120$ $S_y' = 66$ kpsi

DESIGN FACTOR : $n = 1.6$

LIFE : 3 min or $3(1150) = 3450$ REVOLUTIONS

FUNCTION : CARRY 10,000 lb LOAD

$Se' = .506(120) = 60.7$ kpsi

$k_a = 2.67(120)^{-.265} = .751$

$\sigma = \frac{Mc}{I}$ $c = \frac{d}{2}$ $I = \pi \frac{d^4}{64}$

$\Sigma F = 0$: $R_1 = F - R_2$ $\Sigma M = 0$: $-10(18) + R_2(24) = 0$

$R_1 = 10 - 7.5$ $R_2 = 7.5$ kip

$R_1 = 2.5$ kip

$M_{(CRIT.)} = 2.5(1000)12 = 30000$ in·lb

$\frac{D}{d} = \frac{1.5d}{d} = 1.5$ $\frac{r}{d} = \frac{\frac{d}{10}}{d} = \frac{1}{10}$ ∴ k_t * WE WILL USE 1.68 FOR k_t

WE CAN ESTIMATE f FROM TABLE ON PAGE 373

∴ $f = .82$

USE A DETERMINISTIC APPROACH AND EXAMINE VALUES OF d:

TRIAL 1 $d = 2.00$ in

$k_b = \left(\frac{d}{0.30}\right)^{-.107} = .816$

$Se = (.75^1)(.816)(60.7) = 37.2$ kpsi

$a = \frac{(.82)^2(120)^2}{37.2} = 260.1$ (7-5)

$b = -\frac{1}{3}\log\left(\frac{.82(120)}{37.2}\right) = -.1408$ (7-6)

$S_f = 260.1\,(3450)^{-.1408} = 82.6$ kpsi

$\sigma_0 = \frac{Mc}{I} = \frac{30}{.09817 d^3} = \frac{305.6}{d^3} = \frac{305.6}{2^3} = 38.2$ kpsi

$r = \frac{d}{10} = .2$ $\therefore$ $k_f \frac{1.68}{1 + \frac{2}{\sqrt{.2}}\left(\frac{1.68-1}{1.68}\right)\left(\frac{4}{120}\right)} = 1.584$

TABLE 7-13:

$k_3 = 1 + [1.584 - 1][-.18 + .43(10^{-2})120 - .45(10^{-5})120^2]$

$= 1.158$

$k_N = k_{3450} = \frac{1.158^2}{1.584}(3450)^{(-1/3)\,1.09\left(\frac{1.158}{1.584}\right)} = 1.224$

$\sigma_a = \sigma_0 k_N = 38.2\,(1.224) = 46.8$

$\sigma_a = \frac{(S_f)_{3450}}{f}$ $\quad f = \frac{82.6}{46.8} = 1.77 \neq 1.6$

KEEP PLUGGING IN VALUES FOR d AND SOLVING:

d	f	
2.00	1.77	
1.90	1.51	
1.92	1.56	
1.94	1.605	← close enough

$\therefore$ $d = 1.94$ in or 2.00 in

$D = 3$ in

$r = 2/10 = .20$ in