7-1, Given ANSI 1020 Hot-rolled steel.

From table A-20, $S_{ut} = 55$ kpsi

Eq. 7-4.

$$S_e' = \begin{cases} 0.504\, S_{ut} & S_{ut} \le 200 \text{ kpsi} \\ 100 \text{ kpsi} & S_{ut} > 200 \text{ kpsi} \\ 700 \text{ MPa} & S_{ut} > 1400 \text{ MPa} \end{cases}$$

$$S_e' = 0.504 \cdot S_{ut}$$
$$= 27.7 \text{ kpsi}$$

Eq. 7-6, $a = \dfrac{(0.9\, S_{ut})^2}{S_e'}$ → can use S_e or S_e',

$$= \frac{(0.9 \times 55)^2}{27.7} = 88.46$$

$$b = -\frac{1}{3} \log \frac{0.9\, S_{ut}}{S_e}$$
$$= -\frac{1}{3} \log \left[\frac{0.9 \times 55}{27.7}\right] = -0.084.$$

To find fatigue strength,

Eq 7-5, $S_f = a N^b$ $N = 12500$ cycle.

$$= 88.46 (12500)^{-0.084}$$
$$= 40.05 \text{ kpsi} \quad //.$$

Estimate life (N) for given $S_f = 36$ kpsi,

Eq 7-5, $N = \left(\dfrac{S_f}{a}\right)^{1/b}$

$$= \left(\frac{36}{88.46}\right)^{1/-0.084}$$
$$= 44.5 \times 10^3 \text{ cycle} \quad //.$$

7-5, Brinell Hardness : 490 Bhn.

Eq 5-20, $S_{ut} = 0.45\ H_B$

$= 0.45(490) = 220.5$ kpsi.

need to find S_e'

Eq 7-4, $\boxed{S_e' = 100 \text{ kpsi}}$ (since $S_{ut} > 200$ kpsi)

the rod was ground, table 7-4,

$\boxed{a = 1.34,\ b = -0.085}$

(surface factor) $k_a = 1.34(220.5)^{-0.085} = \boxed{0.847}$

since $d = \frac{3}{16}$ in & use for "rotating bending"

(size factor) Eq 7-15, $k_b = \left(\frac{d}{0.3}\right)^{-0.1133}$

$= \left(\frac{0.1875}{0.3}\right)^{-0.1133}$

$\boxed{k_b = 1.055}$

$k_c = 1,\ k_d = 1,\ k_e = 1$

$\therefore\ S_e = 0.847(1.055)(100)$

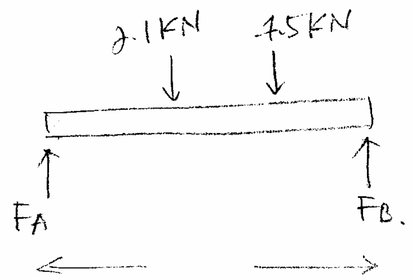
$\boxed{= 89.4 \text{ kpsi}}$ //

7-11. Given $F_1 = 2.1\,KN$, $F_2 = 4.5\,KN$ machined finish

$S_{ut} = 610\,MPa$. $S_{yt} = 490\,MPa$.

wanted : Estimate factor of safety

solution :



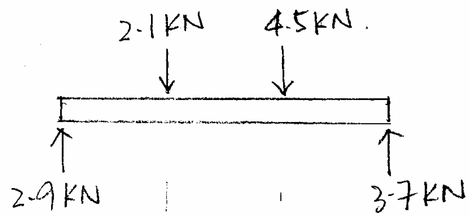
$+\uparrow \Sigma F_y = 0$,

$F_A + F_B = 2.1\,KN + 4.5\,KN$

$= 6.6\,KN$

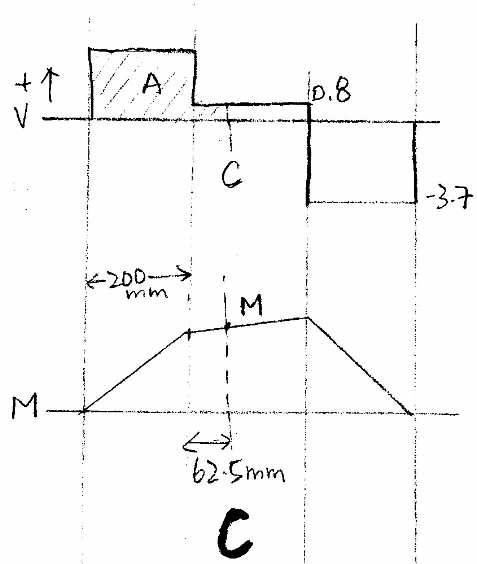
$+\circlearrowright \Sigma M_A = 0$,

$F_B(600) = 2.1\,KN(200) + 4.5\,KN(400)$



$F_B = 3.7\,KN$ //

$F_A = 6.6\,KN - 3.7\,KN = 2.9\,KN$,



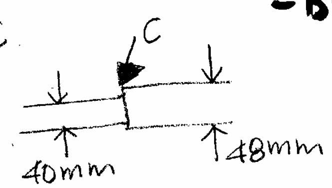
* Then draw the shear & moment diagram.

→ The most dangerous section is at the fillet joining the 40 mm & 48mm section on C.

- BIGGER DIA + STRESS CONCENT.

- M is ONLY A LITTLE SMALER THAN MAX M (C)

* B/cos of stress concentration.



At this point moment M is equal to the area shown in shear diagram.

$M = 2.9(200) + 0.8(62.5)$

$= 630\,Nm$

Eq-7-4, $S_e' = 0.504\,S_{ut}$

$= 0.504(610)$

$= 307\,MPa$.

From table 7-4, machined finish,

$a = 4.51$, $b = -0.265$

$\therefore K_a = 4.51(610)^{-0.265} = 0.824$

Size factor K_b,

Eq 7-15, $K_b = \left(\frac{d}{7.62}\right)^{-0.1133} = 0.829$

K_c, K_d, $= 1$

and $K_e = 1/K_f$,

Now we need to use Table A-15-9 (See Example 7-3 on pg290)

$D/d = 48/40 = 1.2$ $r/d = 1.6/40 = 0.04$

use table A-15-9, $K_t \simeq 2.0$ (approx)

Now use Figure 5-16, $r = 1.6$ mm , $S_{ut} = 610$ MPa,

found $q \simeq 0.8$

$\therefore K_f = 1 + q(K_t - 1)$

$= 1 + 0.8(2-1)$

$= 1.80$,

$\therefore S_e = K_a K_b K_c K_d K_e S_e'$

$= (0.824)(0.829)(1/1.8)(307 \text{ MPa})$

$= 116.51$ MPa

The section modulus,

$$I/c = \frac{\pi d^3}{32}$$

$$= \frac{\pi (4\ cm)^3}{32} = 6.28\ cm^3$$

$$\sigma = \frac{M}{I/c} = \frac{630\ Nm}{6.28 cm^3 \times m^3/1\times10^6 cm^3}$$

$$= 100.3\ MPa,$$

$$\therefore\ n = \frac{116.51\ MPa}{100.3\ MPa} = 1.16\ //$$

Note : The stress on that point is 100.3 MPa, and the yield strength is 490 MPa,

So the part will not yield with this stress but will have a limited life cycle.

cal: $n = \frac{S_y}{\sigma} = 490/100 = 4.9 > 1.0$ (will not yield).

(THIS CORRESPONDS TO EITHER MSST OR DET)

$d = 1.25''$

Hot-Rolled Steel

$S_{ut} = 60$ Kpsi

$0.125''$ hole

Alternating Torque $= 2000$ in-lb.

$S_y = 45$ Kpsi

Find: (1) n for infinite life

(2) n for yielding

(3) n for 20×10^3 cycles

(1) $n = \dfrac{S_e}{\sigma_a}$ $\quad S_e' = 0.504(60) = 30.24$ Kpsi

$S_e = K_a K_b K_c K_d K_e S_e'$

$K_a = a S_{ut}^{\,b} = 14.4(60)^{-0.718} = 0.76$

$K_b = \left(\dfrac{1.25}{0.3}\right)^{-0.1133} = 0.85$

$K_c = 0.577$

$K_d = 1$

$K_e = \dfrac{1}{K_f}$ from A-15-10 $\dfrac{d}{D} = \dfrac{.125}{1.25} = 0.1$ @ A $K_t = 3.3$

FIG. 5-16 $q = 0.7$

eq. 5-26 $K_f = 1 + 0.7(3.3-1) = 2.61$

$K_e = 0.38$

$S_e = (0.76)(0.85)(0.577)(1)(0.38)\,30.24 = 4.28$ Kpsi

$\sigma_a = \tau_{max} = \dfrac{Tr}{J} = \dfrac{(2000)\left(\frac{1.25}{2}\right)}{\frac{\pi(1.25)^4}{32}} = 5.215$ Kpsi

$n = \dfrac{4.28}{5.215} = \underline{0.8}$

(2) $n = \frac{S_y}{\sigma} = \frac{45}{5.215} = 8.63$

(3) $N = 20{,}000$ cycles

$n = \frac{S_f}{\sigma_a} \qquad S_f = a N^b$

$$a = \frac{(0.9\, S_{ut})^2}{S_e} = \frac{(0.9 \cdot 60)^2}{4.28} = 681.31$$

$$b = -\frac{1}{3} \log \frac{0.9\, S_{ut}}{S_e} = -\frac{1}{3} \log \frac{0.9 \cdot 60}{4.28} = -0.37$$

$S_f = 17.46$

$$n = \frac{17.46}{5.215} = \underline{3.35}$$