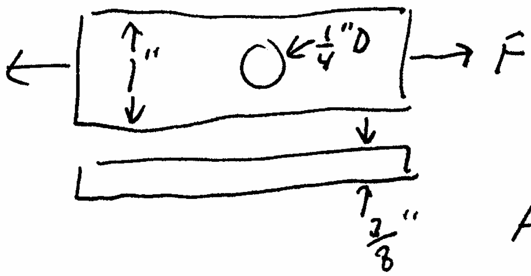
7.20 Cold-drawn AISI 1018 steel

$S_{ut} = 64$ kpsi
$S_{yt} = 54$ kpsi

$F: 800 \leftrightarrow 3000$ lb.



$A_{min} = \left(\frac{3}{8}\right)\left(1-\frac{1}{4}\right) = 0.281$

$$\sigma_{max} = \frac{F_{max}}{A_{min}} = \frac{3000}{0.281} = 10.67 \text{ kpsi}$$

yielding: $n = \frac{54}{10.67} = \boxed{5.06}$

$S_e' = 0.504\,(64) = 32.3$

$k_a = 2.7\,(64)^{-.265} = 0.897 \qquad k_b = 1 \qquad k_c = 0.923$

$\frac{d}{w} = \frac{.25}{.375} = 0.77 \rightarrow K_t = 2.08 \qquad q = 0.78$

$K_f = 1 + 0.78\,(2.08-1) = 1.84$

$k_e = \frac{1}{K_f} = \frac{1}{1.84} = 0.54$

$S_e = (.897)(1)(.923)(.54)(32.3) = 14.44$

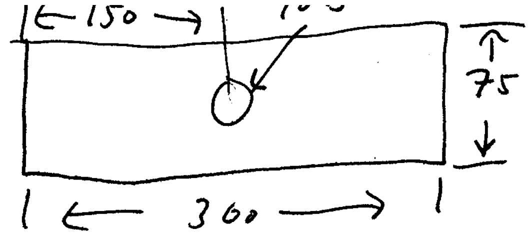
$$\sigma_a = \frac{\sigma_{max}-\sigma_{min}}{2} = \frac{F_{max}-F_{min}}{2A} = \frac{3000-800}{2(.281)} = 3.91 \text{ kpsi}$$

$$\sigma_m = \frac{F_{max}+F_{min}}{2A} = \frac{3000+800}{2(.281)} = 6.76 \text{ kpsi}$$

Goodman:

$$\frac{\sigma_A}{S_e} + \frac{\sigma_m}{S_{ut}} = \frac{1}{n} = \frac{3.91}{14.44} + \frac{6.76}{64} = 0.376 \qquad \boxed{n = 2.66}$$

(7.23)

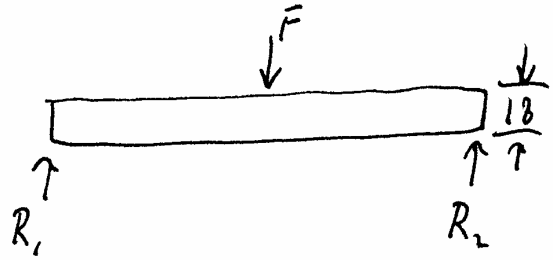


$S_{ut} = 1400$ MPa

$S_{yt} = 950$ MPa

F: 9.3 kN ⟷ 10.67 kN

Find: n



$S_e' = 0.504(1400) = 706$

$K_a = 272(1400)^{-.995} = 0.201$

$K_b = \left(\dfrac{d_e}{7.62}\right)^{-0.1133}$ $\quad d_e = 0.808hb^{1/2} = .808(75 \cdot 18)^{1/2} = 29.7$

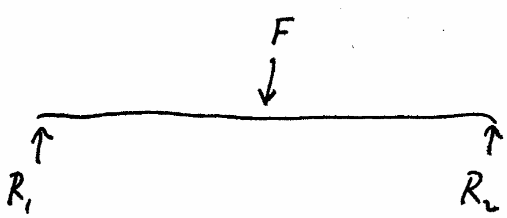
$K_b = \left(\dfrac{29.7}{7.62}\right)^{-0.1133} = 0.857$

Fig. A-15-2 $\quad d = 10,\ w = 75,\ h = 18 \rightarrow K_t = 2.2$ $\quad K_f = 1 + 0.95(2.2-1) = 2.14$

$K_e = \dfrac{1}{2.14} = 0.467$

Fig 5-16 $\quad r = 5,\ S_{ut} = 1.4\,GPa \rightarrow q = 0.95$

$S_e = (.201)(.857)(.467)(706) = 56.79$ MPa



$R_1 = R_2 = \dfrac{F}{2}$ $\quad M = \dfrac{F}{2}(150) = 75F$

$\sigma = \dfrac{Mc}{I}$ $\quad I = \dfrac{bh^3}{12} = \dfrac{(.075 - .01)(.018)^3}{12}$

$= 3.159 \times 10^{-8}$

$\dfrac{c}{I} = \dfrac{0.009}{3.159 \times 10^{-8}} = 0.285 \times 10^{-6}$

$\sigma = (0.285)(75)\,F(kN)$ — unit will be MPa

$$\sigma_{MIN} = (0.285)(75)(9.36) = 200 \text{ MPa}$$

$$\sigma_{MAX} = (.285)(75)(10.67) = 228 \text{ MPa}$$

Alternating: $\sigma_A = \dfrac{228-200}{2} = 14$

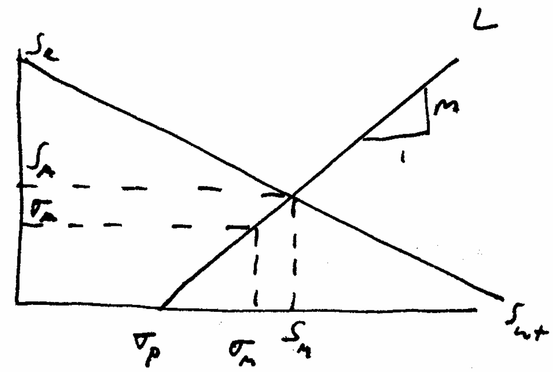
MEAN: $\sigma_m = \dfrac{228+200}{2} = 214$

yielding: $n = \dfrac{S_y}{\sigma_{max}} = \dfrac{950}{228} = \boxed{4.167}$

Goodman: $\dfrac{1}{n} = \dfrac{\sigma_a}{S_e} + \dfrac{\sigma_m}{S_{ut}} = \dfrac{14}{56.79} + \dfrac{214}{950} = 0.472$

$$n = \boxed{2.12}$$

OR



$n = \dfrac{S_a}{\sigma_a} = \dfrac{S_m - \sigma_p}{\sigma_m - \sigma_p}$

$m = \dfrac{\sigma_a}{\sigma_m - \sigma_p}$

Goodman: $S_m = S_{ut}\left(1 - \dfrac{S_a}{S_e}\right)$

Load: $m = \dfrac{S_a}{S_m - \sigma_p}$

So $S_a = m(S_m - \sigma_p) = m S_{ut}\left(1 - \dfrac{S_a}{S_e}\right) = m\sigma_p$

$= m(S_{ut} - \sigma_p) - \dfrac{m S_a S_{ut}}{S_e}$

$\longrightarrow S_a + \dfrac{m S_a S_{ut}}{S_e} = m(S_{ut} - \sigma_p)$

$S_a = \dfrac{m(S_{ut} - \sigma_p)}{1 + \dfrac{m S_{ut}}{S_e}}$

$m = \dfrac{14}{214-200} = 1$

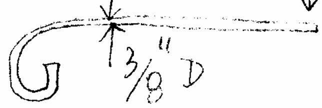
$S_a = \dfrac{1(950-200)}{1 + \dfrac{1(950)}{56.79}} = 42.3$

$n = \dfrac{42.3}{14} = \boxed{3.02}$

7-24/ Given:

$F_{max} = 30\,lb$ → hot-rolled finish

$\downarrow F_{min} = 15\,lb$ → no stress concentration



380 Bhn.

wanted: what number of load application is likely to cause fail

solution:

Eq 5-20, $S_{ut} = 0.45 H_B = 0.45(380) = 171$ kpsi

Eq 7-4, $S_e' = 0.504 S_{ut}$
$= 0.504(171) = 86.2$ kpsi

Table 7-4, $a = 14.4$, $b = -0.718$

$K_a = 14.4(171)^{-0.718} = 0.359$

Eq 7-18, $d_e = 0.37 D$
$= 0.37(0.375)$
$= 0.139$

} Effective size of round corresponding to a non-rotat. solid or hollow round.

Eq 7-15, $K_b = (0.139/0.3)^{-0.1133}$
$= 1.09$

$K_c = K_d = K_e = 1$,

So, $S_e = K_a K_b K_c K_d K_e S_e'$
$= (1.09)(0.139)(86.2\text{ kpsi})$
$= 33.7$ kpsi

we need to find σ_m & σ_a

The maximum moment cause by the force is

$$M_{max} = 30lb(16in)$$
$$= 480 \ lbin$$

$$I = \frac{1}{4}\pi r^4$$
$$= \frac{1}{4}\pi(3/16in)^4 = 9.7\times10^{-4} \ in^4$$

$$M_{min} = 15lb(16in)$$
$$= 240 \ lbin$$

$$\sigma_{max} = \frac{MC}{I} = \frac{480lbin(3/16in)}{9.7\times10^{-4} \ in^4}$$
$$= 92.714 \ Kpsi$$

$$\sigma_{min} = \frac{MC}{I} = \frac{240lbin(3/16in)}{9.7\times10^{-4} \ in^4}$$
$$= 46.357 \ Kpsi$$

$$\sigma_m = \frac{\sigma_{max}+\sigma_{min}}{2} = \frac{92.714+46.357}{2} = 69.53 \ Kpsi$$

$$\sigma_a = \frac{\sigma_{max}-\sigma_{min}}{2} = \frac{92.714-46.357}{2} = 23.18 \ Kpsi$$

using modify Goodman relation to find the Sf,

, use Eq 7-35 & let $S_f = S_e$.

$$\frac{\sigma_a}{S_f} + \frac{\sigma_m}{S_{ut}} = 1$$

$$\Rightarrow S_f = \frac{\sigma_a}{1-\frac{\sigma_m}{S_{ut}}} = \frac{23.2}{1-\frac{69.5}{171}} = 39.2 \ Kpsi$$

using Eq 7-6, 7-7 to find No. of cycles of life.

$$a = \frac{(0.9S_{ut})^2}{S_e}$$
$$= \frac{(0.9\times171)^2}{33.7} = 703$$

$$b = -\frac{1}{3}\log\frac{0.9S_{ut}}{S_e} = -\frac{1}{3}\log\left[\frac{0.9\times171}{33.7}\right] = -0.220$$

Eq 7-7, $N = \left(\frac{\sigma a}{a}\right)^{1/b}$ σa can be replace by Sf,

$$N = \left(\frac{39.3}{703}\right)^{1/-0.22}$$

$= 494$ K cycles //

7-26, Given 1018 CD steel.

$S_{ut} = 64$ Kpsi $\quad S_{yt} = 54$ Kpsi

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

$= 0.504(64) = 32.3$ Kpsi

using table 7-4, $a = 2.7$, $b = -0.265$

$K_a = 2.7(64)^{-0.265}$

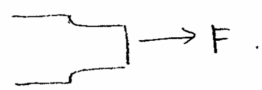
$= 0.897$

$K_b = 1$, $K_c = 0.923$ (axial load)

so, $S_e = (0.897)(0.923)(32.3)$

$= 26.7$ Kpsi

Check to see if the steel will yield.

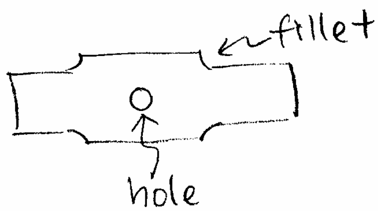


$\sigma = \frac{F_{max}}{A} = \frac{-16}{2.5(0.5)} = -12.8$ Kpsi

$n_{static/yield} = \frac{-S_y}{\sigma} = \frac{-54}{-12.8} = 4.22$

SF > 1, so will not yied cause by the max F.

Now check 2 places where failures are more likely to occur. The "fillet" & "hole" are the two places.



At the fillet.

using Fig A-15-5, $D = 3.75$, $d = 2.5$

$D/d = 3.75/2.5 = 1.5 \quad r/d = 0.25/2.5$

$r/d = 0.1$, $K_t = 2.1$ (Approx)

usig Fig 5-16, $q \simeq 0.78$

Eq 5-26 $K_f = 1 + 0.78(2.1 - 1) = 1.86$

$$\sigma_{max} = \frac{4\ \text{kpsi}}{0.5(2.5)} = 3.2\ \text{kpsi}$$

$$\sigma_{min} = \frac{-16\ \text{kpsi}}{0.5(2.5)} = -12.8\ \text{kpsi}$$

$$\sigma_a = K_f \left| \frac{\sigma_{max} - \sigma_{min}}{2} \right|$$

$$= 1.86 \left[\frac{3.2 - (-12.8)}{2} \right] = 14.88\ \text{kpsi}$$

$$\therefore \boxed{n_{fillet} = \frac{S_e}{\sigma_a} = \frac{26.7}{14.88} = 1.80}$$

At the hole

$$d/w = 0.75/3.75 = 0.20$$

From Fig A-15-1,

$K_t = 2.5$ also $q \cong 0.78$

Eq 5-26, $K_f = 1 + 0.78(2.5 - 1)$
$= 2.17$

$$\sigma_{max} = \frac{4}{0.5(3.75 - 0.75)} = 2.67\ \text{kpsi}$$

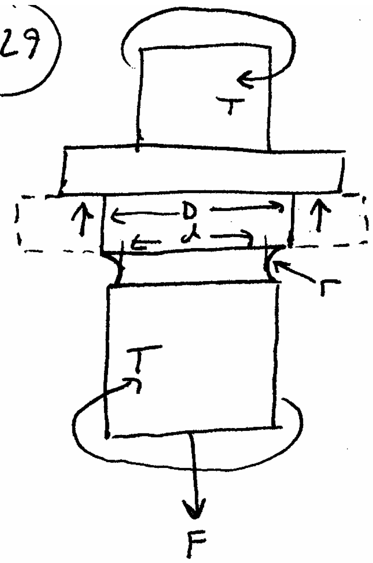
$$\sigma_{min} = \frac{-16}{0.5(3.75 - 0.75)} = -10.67\ \text{kpsi}$$

$$\sigma_a = 2.17 \left| \frac{2.67 - (-10.67)}{2} \right| = 14.47\ \text{kpsi}$$

$$\therefore \boxed{n_{Hole} = \frac{26.7}{14.47} = 1.85}$$

Since $n_{fillet} < n_{Hole}$, failure would likely occur at the fillet.

(7.29)



$S_{ut} = 148$ kpsi

$S_{yt} = 112$ kpsi

$F: \quad 2 \leftrightarrow 15$ kip

$T: \quad -300 \leftrightarrow 3000$ lb·in

$d = 1.25''$

$D = 1.75''$

$r = \frac{1}{8}''$

$$\sigma = \frac{F}{A} = \frac{F}{\pi\left(\frac{d}{2}\right)^2} = \frac{15}{\pi\left(\frac{1.25}{2}\right)^2} = 12.2 \text{ kpsi}$$

$$\tau = \frac{Tr}{J} = \frac{Tr}{\frac{\pi d^4}{32}} = \frac{(3)\left(\frac{1.25}{2}\right)}{\frac{\pi\,(1.25)^4}{32}} = 7.82 \text{ kpsi}$$

$$\sigma' = \sqrt{12.2^2 + 3\,(7.82)^2} = 18.2$$

$$n = \frac{112}{18.2} = \boxed{6.15}$$

$S_e' = 0.504\,(148) = 74.6$ $\qquad S_e = (0.876)(0.851)(74.6) = 55.6$ kpsi

$K_a = 1.34\,(148)^{-.085} = 0.876$

$K_b = \left(\frac{1.25}{.3}\right)^{-.1133} = 0.851$

Fig. A-15-8 $\quad \frac{D}{d} = \frac{1.75}{1.25} = 1.4$ $\qquad$ Fig. 5-17 $q = 0.99$

$K_t = 1.42$

$\frac{r}{d} = \frac{.125}{1.25} = 0.1$

Torsion — $K_{fT} = 1. + 0.99(1.42-1) = 1.42$

Fig. A-15-7 $\quad K_t = 1.88$ $\qquad$ Fig 5-16 $\quad q = 0.9$

Axial — $K_{fA} = 1 + 0.9(1.88-1) = 1.79$

$$\sigma_{MIN} = \frac{2}{\pi \left(\frac{1.25}{2}\right)^2} = 1.63 \qquad \sigma_{MAX} = 12.2$$

$$\tau_{MIN} = \frac{(-0.3)\left(\frac{1.25}{2}\right)}{\frac{(\pi)(1.25^4)}{32}} = -0.782 \qquad \tau_{MAX} = 7.82$$

$$\cancel{\sigma_m = \frac{12.2+1.63}{2} = 6.92 \qquad \sigma_A = \frac{12.2-1.63}{2} =}$$

$$\sigma_a = 1.79 \quad \frac{12.2-1.63}{2} = 9.46 \qquad \sigma_m = \frac{12.2+1.63}{2} = 6.92$$

$$\tau_a = 1.42 \quad \frac{7.82-(-.782)}{2} = 6.11 \qquad \tau_m = \frac{7.82+(-.782)}{2} = 3.52$$

$$\sigma_a' = \sqrt{9.46^2 + 3(6.11)^2} = 14.195$$

$$\sigma_m' = \sqrt{6.92^2 + 3(3.52)^2} = 9.22$$

$$\frac{1}{n} = \frac{14.195}{55.6} + \frac{9.22}{148} = 0.318 \qquad n = \boxed{3.15}$$