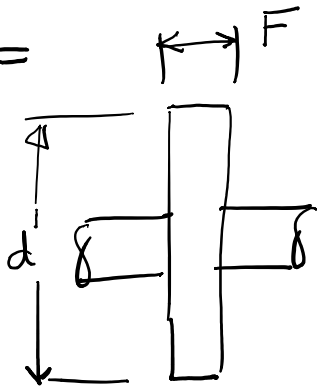
3-9-22

$$K_m = 1 + C_{mc}\left(C_{PF}\,C_{Pm} + C_{ma}\,C_e\right)$$

$C_{mc} \equiv$ Crown effect

$C_{mc} = 1$ (not Crowned)

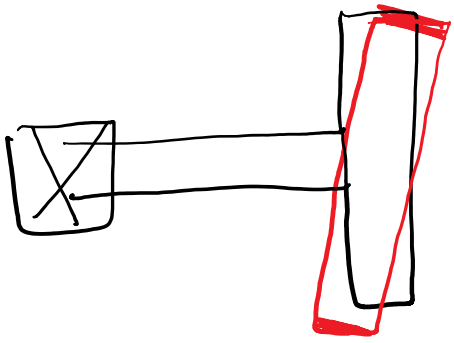
$$C_{PF} = \frac{F}{10d} - 0.375 + 0.0125\,F$$

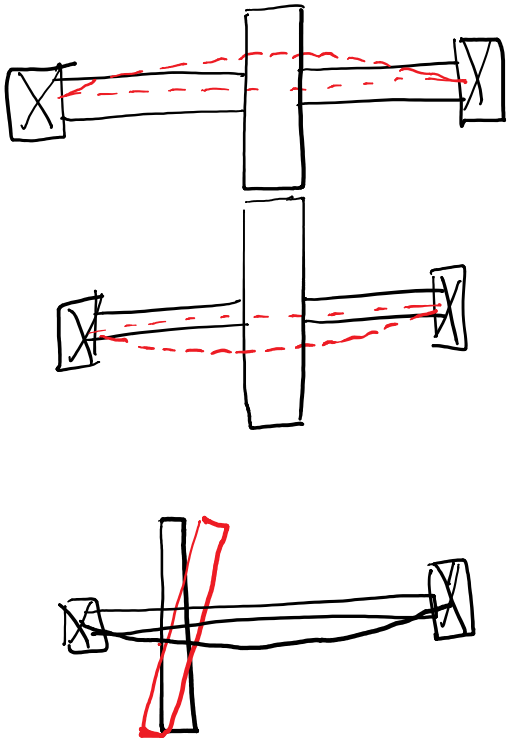


$$= \frac{2}{10\,(2.667)} - 0.375 + 0.0125\,(2)$$

$$C_{PF} = 0.0625$$

$C_{Pm} \equiv$ No info given





$$C_{Pm} = 1$$

$C_e \equiv$ Post Process lapping

no info given

$C_e = 1$

$C_{ma} \equiv$ Precision & rigidity of gear box

$\equiv$ Precision rigid gear box

$C_{ma} = 0.1$

$$\Rightarrow K_m = 1 + 1\left(0.0625 * 1.0 + 0.1(1)\right)$$

$K_m = 1.16$

Geometry Factor J

For $N_p = 16$ and $N_G = 48$

$J = 0.27$

$$\sigma = W^t K_o K_v K_s \frac{P_d}{F J} K_m K_B$$

$$= 788\,(1)(1.2)(1)\frac{6}{2\,(0.27)}(1.16)(1.3)$$

$\sigma = 15844$ psi

Strength in fatigue (fatigue limit)

$$S_b = \frac{Y_N}{K_T K_R} S_t$$

$S_t = 28260$ psi (Fig 14-2)

$K_R = 0.85$ for 90% (Table 14-10)

$Y_N = 0.928$ (Fig 14-14) for 100 Million cycles

-0.0323

$Y_N = 1.6831\ N$

$N = 100,000,000$ cycles

$K_T = 1$

$$\Rightarrow S_b = \frac{0.928}{(1)(0.85)}(28260)$$

$$\Rightarrow S_b = 30853 \text{ psi}$$

Factor of Safety against eventual bolt breakage

$$n = \frac{S_b}{\sigma} = \frac{30853}{15844} = 1.95$$

Surface Fatigue Failure Analysis
(Not included in final exam)

$$n_{surface} = \frac{\text{Contact strength in fatigue} = S_c}{\text{Contact stress} = \sigma_c}$$

$$\sigma_c = C_p \sqrt{W^t K_o K_v K_s \frac{K_m}{d F} \cdot \frac{C_f}{I}}$$

K_m: Same

C_p: $2300\ \sqrt{psi}$ (Steels)

W^t: Same; K_o: Same; K_v: Same; K_s: Same; d: Same; F: Same; C_f: Same; I: Same

$$S_{ce} = \frac{Z_N C_H}{K_R K_T} S_c$$

S_{ce}: Contact endurance limit (Compare to σ_c)

C_H = Hardness ratio factor

$C_H = 1$ for pinion

$C_H > 1$ for gear

C_f = Surface Condition factor
(Surface roughness / surface lay / Residual Stress)

$C_f = 1$

$$\sigma_c = 2300 \sqrt{788\,(1)(1.2)(1)\frac{1.16}{(2.667)(2)} \cdot \frac{1}{\quad}}$$

Where I is geometry factor

$$I = \frac{\cos\phi \sin\phi}{2 m_N} \cdot \frac{m_G}{m_G + 1}$$

m_G = gear ratio

$m_N = 1$ for spur gears

$$I = \frac{\cos(20)\sin(20)}{2(1)} \cdot \frac{3}{3+1} = 0.12$$

$$\Rightarrow \sigma_c = 95212.4 \text{ Psi}$$

strength

$$S_{ce} = \frac{Z_N \, C_H}{K_R \, K_T} S_c$$

$S_c \equiv$ Contact stress number (Fig 14-5, Grade 1)

$S_c = 322 \; H_B + 29100 \quad Psi$

$S_c = 93500 \quad Psi$ (Contact stress number)

$K_T = 1 \quad C_H = 1 \quad Z_N = 0.88$ (Fig 14-15)

$K_R = 0.85$ for 90 %.

$$S_{ce} = \frac{0.88\,(1)}{0.85\,(1)} \, 93500 \quad Psi$$

$$S_{ce} = 96800 \quad Psi$$

$$\Rightarrow \quad n_{\text{surface-damage}} = \frac{96800}{95212} \cong 1$$