

CLASS Problem 10-15

Part 3

Extension Spring

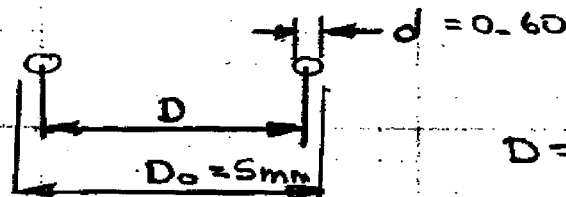
$d = 0.60 \text{ mm}$ Music Wire

$D_o = 5 \text{ mm}$

$P_o = 1.0 \text{ N}$

$P_{\max} = 6.0 \text{ N}$

$N_{\text{fatigue}} = \text{F.S. for Fatigue} = ?$



$D = D_o - d$

$D = 4.4 \text{ mm}$

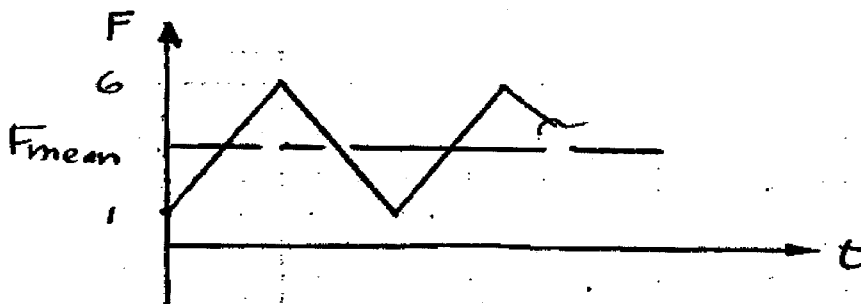
For Fatigue, we need $F_{\max}$, $F_{\min}$

$F_{\min} = 1.0 \text{ N}$

$F_{\max} = 6.0 \text{ N}$

$F_{\text{mean}} = 3.5 \text{ N}$

$F_{\text{alt}} = 2.5 \text{ N}$



$C = \frac{4.4}{0.6} = 7.3 = C$

$\sigma_{\text{net}} = 2400 \text{ MPa}$

For Fatigue, we need τ_{mean} and τ_{alt} plus the Wahl factor (Fatigue)

$$K_w = \frac{4C-1}{4C-4} + \frac{0.615}{C} = \frac{[(4)(7.3)-1]}{[(4)(7.3)-4]} + \frac{0.615}{7.3}$$

$$K_w = 1.2 \quad K_s = 1 + \frac{S}{C} = 1.07 = K_s$$

$$\tau = \frac{8FDK_s}{\pi d^3} = \frac{8FC}{\pi d^2} K_s \quad \left\{ \begin{array}{l} \tau = \frac{(8)(1)(7.3)(1.07)}{(\pi)(.6)^2} \\ \tau = 55 \text{ MPa} \end{array} \right.$$

$$\tau_m = \frac{8F_m C (K_s)}{\pi d^2}$$

$$\tau_m = \frac{(8)(3.5)(7.3)(1.07)}{(\pi)(.6)^2} =$$

$$193 \text{ MPa} = \tau_m$$

$$\tau_a = \frac{(8)(F_a)(7.3)(1.2)}{(\pi)(.6)^2}$$

$$= \frac{(8)(2.5)(7.3)(1.2)}{(\pi)(.6)^2} = 155 \text{ MPa} = \tau_a$$

$$\tau_{su} = 0.67 \sigma_{uet}$$

$$\tau_{su} = 1600 \text{ MPa} = S_{su}$$

Assume an unpeened spring

φ 8 436

$$S_{se} = 310 \text{ MPa}$$

$$\text{Eqn 10-31, Pg 437} : \frac{\tau_a}{S_{se}} + \frac{\tau_m}{S_{su}} = \frac{1}{n}$$

$$\frac{193}{310} + \frac{193}{1600} = \frac{1}{n} = 0.63$$

$$n = 1.6$$

choose unpeened
because limit

$$N_{ss} = \frac{S_{es} (S_{us} - \tau_u)}{S_{es} (\tau_m - \tau_u) + S_{us} \tau_u}$$

$$S_{es} = 0.707 \frac{S_{ew} S_{us}}{S_{us} - 0.707 S_{ew}}$$

unpeened

$$S_{ew} = 310 \text{ MPa}$$

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Pg 20 of notes

$$S_{us} = 0.707 \sigma_{ult}$$

$$S_{us} = 1600 \text{ MPa}$$

A228 d = 0.6

$$\sigma_{ult} = 2400 \text{ MPa}$$

Sew = S_{ew}

$$S_{es} = 0.707 \frac{(310)(1600)}{(1600) - (0.707)(310)}$$

$$S_{es} = 254$$

$$N_{ss} = \frac{254(1600 - 55)}{254(193 - 55) + (1600)(155)}$$

$$N_{ss} = 1.3$$

Satigue

$$N_{fs, yield} = \frac{\tau_{yp}}{\tau_{max}}$$

$$\tau_{yp} = 0.45 \sigma_{ult}$$

$$\tau_{yp} = 1080 \text{ MPa}$$

$$\tau_{max} = \frac{(8)(6)(7.3)(1.07)}{(\pi)(0.6)^2} = 330 \text{ MPa} = \tau_{max}$$

$$F_{S, yield} = 3.3 \sim \text{yield}$$

Ps 4.14

Peened Kugelgestrahlet

$$S_{ew} = 465 \text{ MPa}$$

$$S_{es} = 0.707 \frac{(465)(1600)}{(1600) - (0.707)(465)}$$

$$S_{es} = 414 \text{ MPa}$$

$$N_{ss} = \frac{414 (1600 - 55)}{414 (193 - 55) + (1600)(155)}$$

$$N_{ss} = 2.10$$