Term Test #2 - Fall 2018

PROBLEM #1:

a) From Table 10.3, for a major diameter of 1.25",

The number of threads per inch is 5.

Single thread ⇒ lead $L = p$ - pitch ⇒ $L = p = 1/5 = \underline{\underline{0.2''}}$ ∴

mean diameter $d_m = d - p/2 = 1.25 - 0.2/2 = \underline{\underline{1.15''}}$ ∴

b) $\tan\lambda = \frac{L}{\pi d_m} = \frac{0.2}{1.15\pi} \Rightarrow \lambda \cong 3.17^\circ$

$\tan\alpha_n = \tan\alpha \times \tan\lambda = \tan(45^\circ) \times \tan(3.17^\circ) \Rightarrow \alpha_n \cong 14.48^\circ$

Torque required to lift the load W:

$$T_{lift} = \frac{W d_m}{2} \frac{f\pi d_m + L\cos\alpha_n}{\pi d_m \cos\alpha_n - fL} + \frac{W f_c d_c}{2}$$

$$= \frac{1000 \times 1.15}{2} \cdot \frac{\pi \times 0.15 \times 1.15 + 0.2\cos(14.48^\circ)}{\pi \times 1.15 \times \cos(14.48^\circ)} + \frac{1000 \times 0.15 \times 1.75}{2}$$

$= \underline{253.2}$ lbf-in ∴

$$T_{lower} = \frac{W d_m}{2} \frac{f\pi d_m - L\cos\alpha_n}{\pi d_m \cos\alpha_n + fL} + \frac{W f_c d_c}{2} = \underline{188} \text{ lbf-in} ∴$$

c) efficiency $e = \frac{WL}{2\pi T_{lift}} = \frac{1000 \times 0.2}{2\pi \times 253.2} = 0.125 = 12.5\%$

d) The screw is self-locked if: $f \geqslant \frac{L\cos\alpha_n}{\pi d_m} = \frac{0.2 \times \cos(14.48^\circ)}{\pi \times 1.15} = 0.0536$

So it is self-locked as $\underline{f = 0.15 > 0.0536}$

∴

PROBLEM #2:

spring constant $K = 200$ N/cm ; $F_{min} = 250$ N ; $F_{max} = 500$ N

Excitation frequency $f = 1000$ rpm , spring index $C = 8$

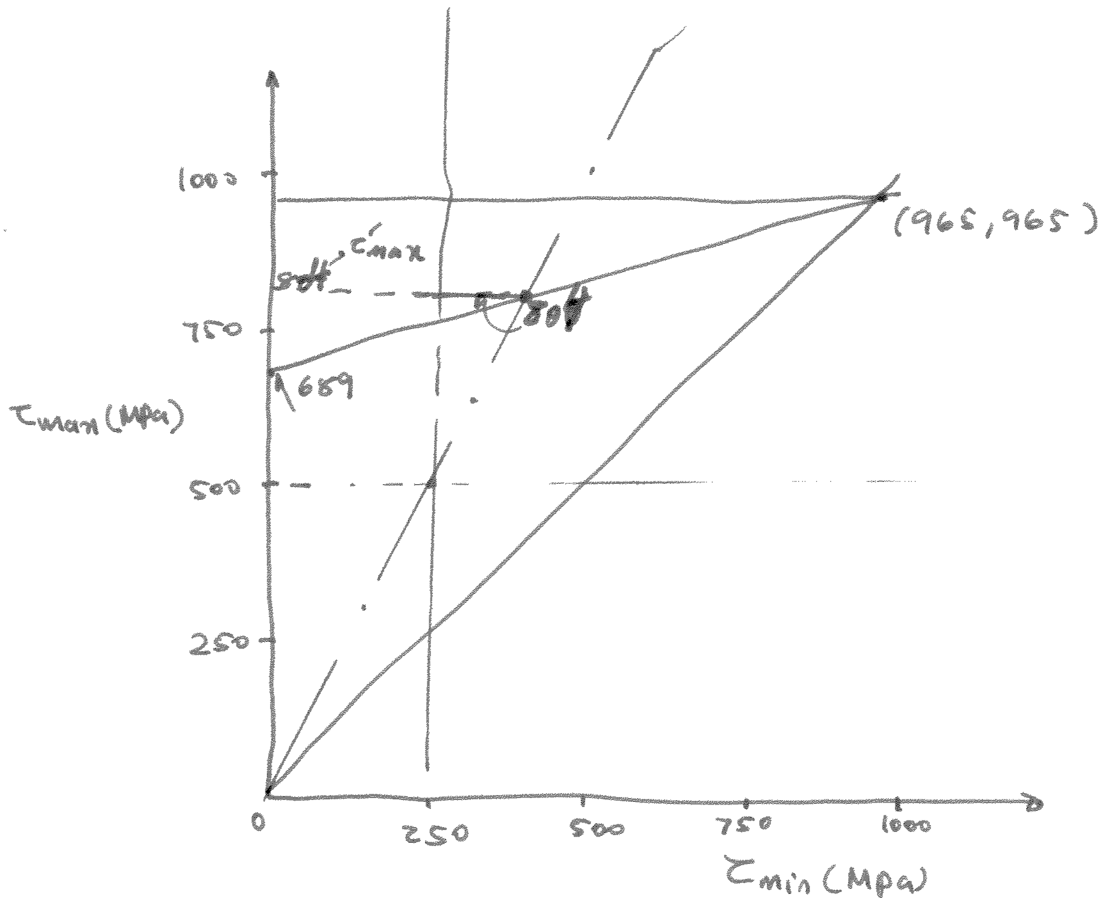
$SF = 1.5$ against fatigue , density $\rho = 7700$ kg/m^3 .

Shear modulus $G = 79000$ Mpa, HCS steel A232 , Shot-peened
No preset

a) wire diameter?

$$\frac{\tau_{max}}{\tau_{min}} = \frac{F_{max}}{F_{min}} = \frac{500}{250} = 2 \quad , \quad SF = \frac{\tau'_{max}}{\tau_{max}} = \frac{804}{\tau_{max}} \Rightarrow \tau_{max} = \frac{804}{1.5} \cong 536 \text{ Mpa}$$

A line of this slope is drawn on Figure below, giving an intersection of $\tau'_{max} = 804$ Mpa



$$K_W = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

$C = 8 \Rightarrow CK_W \cong 9.5$

$$\tau_{max} = \frac{8F_{max}}{\pi d^2}(CK_W) = \frac{8 \times 500}{\pi d^2} \times 9.5 \quad , \quad \tau_{max} = 536 \Rightarrow d^2 = \frac{8 \times 500 \times 9.5}{\pi(536)}$$

$\Rightarrow d \cong 4.75$ mm $\therefore$

b) mean diameter $D = c\,d = 8 \times 4.75 = \underline{38}$ mm $\therefore$

c) $K = \dfrac{dG}{8 N_a C^3}$ $\Rightarrow$ $\underset{\text{Number of active coils}}{N_a} = \dfrac{dG}{8 K C^3} = \dfrac{4.75 \times 79000}{8 \times \underset{N/mm}{20} \times 8^3} \simeq \underline{4.5} \therefore$

ends are squared and grounded $\Rightarrow$ $\underset{\text{total number of coil}}{N_t} = N_a + 2 = 4.5 + 2 = \overline{6.5}$

(d) Free Length $L_f = L_s + \underbrace{\dfrac{F_{max}}{K}}_{\delta_w} + \delta_{clash} = L_s + \delta_{shut}$

$\delta_{shut} = \dfrac{F_{shut}}{K}$ for 10% clash allowance $F_{shut} = 1.1 \times F_{max}$

$\Rightarrow$ $F_{shut} = 1.1 \times 500 = 550$ N , $\delta_{shut} = \dfrac{550}{20\,N/mm} = 27.5^{mm} \therefore$

shut height length $L_s = N_t\,d = 6.5 \times 4.75 = 30.875^{mm} \therefore$

$\Rightarrow$ $L_f = 30.875 + 27.5 = \underline{58.375}$ mm $\therefore$

e) No preset $\xrightarrow{\text{eq. 12.9}}$ $\tau_s \leq 0.45\, S_{ut} = 0.45 \times 1523 \simeq 685.35$

$S_{ut} = A d^b = \underset{MPa}{1909.9} (\underset{m}{4.75})^{-0.1453} \simeq 1523$ MPa or From Fig. 12.7

~~Also~~

$\tau_s = \dfrac{8F_s}{\pi d^2}\, C K_s$ $\Rightarrow$ $K_s = 1 + \dfrac{0.5}{C}$, $C = 8$

$C K_s = 8.5$

$\Rightarrow \tau_s = \dfrac{8 \times 550}{\pi \times 4.75^2} \times 8.5$ $\Rightarrow$ $SF = \dfrac{685.35}{527.63} \simeq \underline{1.3} \therefore$

$= 527.63$ MPa

f: $\frac{L_f}{D} = \frac{58.375}{38} = 1.536$ ✓, $\frac{\delta_{shut}}{L_f} = \frac{27.5}{58.375} = 0.468$ ✓

From Fig 12.10 ⟹ stable with respect to both end conditions
No buckling will occur ✓

g) $f_n = \frac{353000\, d}{N_a D^2} = \frac{353000 \times 4.75}{4.5 \times 38^2} \simeq 258\ Hz$

excitation freq f = 1000 rpm = $\frac{1000}{60} \simeq 16.7\ Hz$

$\frac{f_n}{f} = \frac{258}{16.7} = 15.4 > 13$ OK

No surging will occur