Chapter 10

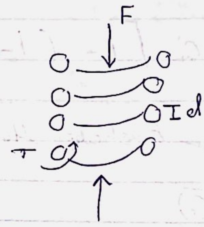
Mechanical springs

Wire Spring : → always compression forces

Helical springs:

$$\tau_{max} = \frac{Tr}{J} + \frac{F}{A}$$

$$= \frac{\frac{FD}{2} r}{J} + \frac{F}{A}$$



⊢ D ⊣ = mean diameter

$\tau = K_s \frac{8FD}{\pi d^3}$, K_s: shear correction factor } Not used

$K_s = \frac{2C+1}{2C}$

C: Spring index

With Curvature effect:

$$\tau_{max} = K_B \frac{8FD}{\pi d^3}$$

$$K_B = \frac{4C+2}{4C-3}$$

$C = \frac{D}{d}$

$D = OD - d$

$K = \frac{d^4 G}{8 D^3 N_a}$, N_a: Number of coils (Active)

K: Spring Constant or Spring rate

Spring types:
a) Plain end } right hand
b) closed end } اخر نص لفة لا تعد
c) ground end } left hand
d) Plain end

10.5 **Stability**

Critical deflection:

$$y_{cr} = L_o C_1' \left[1 - \left(1 - \frac{C_2'}{\lambda_{eff}^2} \right)^{\frac{1}{2}} \right]$$

$$C_1' = \frac{E}{2(E-G)}$$

E ← Elasticity Mod

G → Rigidity Modulus

$$C_2' = \frac{2\pi^2 (E-G)}{2G+E}$$

$$\lambda_{eff} = \frac{\alpha L_o}{D}$$

α → Tables

L_o → unstretched length

effective slinderness ratio

- stable if: $y < y_{cr}$ → $\frac{C_2'}{\lambda_{eff}^2} < 1$ → $L_o < \frac{\pi D}{\alpha}\left[\frac{2(E-G)}{2G+E}\right]^{1/2}$

For steel:- (No Buckling)

$L_o < 2.63 \frac{D}{\alpha}$

Scanned with CamScanner

Spring materials

- Springs materials are usually mixtures of different materials

How to find S_{ut}

$$S_{ut} = \frac{A}{d^{m}}$$

← Constant Not Area

A and m: from tables

S_{sy} = yield shear strength

= Maximum percent of tensile strength X S_{ut}

Notes for Solving:

ناخد العمود الأول دايماً في Table 10-6 لأنه بنتجاهل الـ concentration

ends are squared → N_a = total − 2 (from table 10-)

no. number → Table A-28 (you are Given the type)

D → mean effective diameter Not outside diameter

Get d :- D = outside − d

Then get K_b from C ($C = \frac{D}{d}$)

10.9 : fatigue loading

Zimmerli Data

peened ← يتعرض لتيار هواء بارد
unpeened ← يسدعل درجة حرارة الغرفة

shear endurance limit
→ Same as welding

or
→ Goodman line :

$$\frac{S_a}{S_e} + \frac{S_m}{S_{ut}} = 1$$ ← Remember

→ Gerber :

Note :
Wire Size: d / free length = L / N_a = active
D = out − d

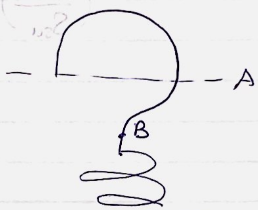
- If shear Torsion

$$n_f = \frac{1}{2}\left(\frac{0.67\,S_{ut}}{\tau_m}\right)\frac{\tau_a}{S_{se}}\left[-1 + \frac{\quad}{\quad}\right]$$ → Back to Table (6-7)

10.11 Extension Spring

* Different from compression spring
1- There is a hook
2- pitch = 0 or very small to store Max energy

$$\sigma_A = F\left((K)_A \frac{16D}{\pi d^3} + \frac{4}{\pi d^2}\right)$$



At Section A → $(K)_A = \frac{4C_1^2 - C_1 - 1}{4C_1(C_1-1)}$

$C_1 = \frac{2r_1}{d}$

→ $\tau_B = (K)_B \frac{8FD}{\pi d^3}$

At point B → $(K)_B = \frac{4C_2 - 1}{4C_2 - 4}$, $C_2 = \frac{2r_2}{d}$

In the Coils, I can use compression Spring equations

Static load not included (yielding)

endurance limit $S_e = S_e / 0.577$ → Distortion energy theory

10.12 helical coil Torsion Springs → Not included

$y = \frac{F - F_i}{(K)}$

Closed length $= 2(D-d) + (N_b+1)d$