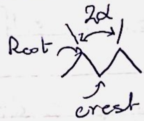
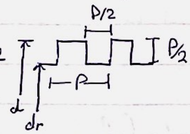
Chapter 8: Screws

Types:-

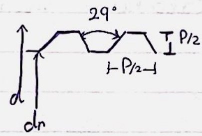
- Minor Diameter : المسافة بين قاع وقاع آخر
- Major Diameter :
- Pitch Diameter : Average



Threads :→ Square



→ Acme



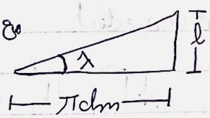
d: major diameter

Power Screws

λ : lead angle

l = lead = np

مع كل لفة πdm
تتحرك مسافة
l



$$P_{raising} = P_R = \frac{F(\sin\lambda + f\cos\lambda)}{\cos\lambda - f\sin\lambda}$$

where $\lambda = \frac{l}{\pi dm}$

$$P_{Lowering} = P_L = \frac{F(f\cos\lambda - \sin\lambda)}{\cos\lambda + f\sin\lambda}$$

dm: mean diameter

Torque needed :- for square thread (No angle)

$$T_R = P_R \times \frac{dm}{2} = \frac{Fdm}{2}\left(\frac{L + \pi f dm}{\pi dm - fL}\right)$$

$$T_L = P_L \times \frac{dm}{2} = \frac{Fdm}{2}\left(\frac{\pi f dm - L}{\pi dm + fL}\right)$$

$T_L > 0 \rightarrow$ self locking
$T_L < 0 \rightarrow$ overhauling   السيارة تنزل لحالها

Condition of self locking $= \pi f d_m > l$

- Efficiency of power screw

$e = \frac{T_o}{T_R} = \frac{Fl}{2\pi T_R}$ ~ calculated from formula

$= \frac{T_o}{T_L} = \frac{Fl}{2\pi T_L}$

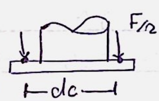
- For Acme thread

$$T_R = \frac{F d_m}{2}\left(\frac{l + \pi f d_m \sec\alpha}{\pi d_m - f l \sec\alpha}\right) \qquad \alpha = \frac{29}{2} = 14.5°$$

- If the force → axial → collar is needed

→ Required Torque

$T_c = \frac{F f_c d_c}{2}$ (Add to T_R or T_L) d_c ↘



material of collar ≠ material of screw

Table 8-6: we take starting → worst case

Stresses on Power Screw

1- Shear stress from torque:

$\tau = \frac{16T}{\pi d_r^3}$

2- Axial stress

$\sigma = \frac{F}{A} = \frac{4F}{\pi d_r^2}$ d_r: minor diameter / Always Comp

$$\left(\frac{F}{A}\right)_{crit} = S_y - \left(\frac{S_y}{2\pi}\frac{l}{K}\right)^2 \frac{1}{CE}$$

3- Bearing stress
= Normal stress

$$\sigma_B = \frac{-2F}{\pi d_m n_t p}$$ ~ pitch

n_t: number of threads (engaged)

Thread:
Single $l = p$
Double $l = 2p$

4- Bending Stress

$$\sigma = \frac{6F}{\pi d_r n_t p}$$

5- Transverse shear stress

$$\tau = \frac{3F}{\pi d_r n_t p}$$

Note:
Von misses stress

$$\sigma' = \left(\sigma_x^2 + \dots + 3\tau_{xy}^2\right)^{\frac{1}{2}}$$

8.3: Threaded Joints & 8.4

Washer thickness t → Table A-33/32
Nut thickness H → Table A-31
Material squeezed l

Fastner stifness :-

$$K = \frac{A_d A_t E}{A_d l_t + A_t l_d}$$

$l_t = l - l_d$
$l_d = L - L_T$ ~ equation
$A_d = \frac{\pi d^2}{4}$
A_t → Table 8-1 or 8-2

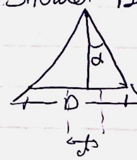
L_T : L thread
L : total

$L > l + H$

8.5 Member Stifness

$$K = \frac{0.5774 \pi E d}{\ln \frac{(1.55t + D - d)(D + d)}{(1.55t + D + d)(D - d)}}$$

D should be found



you divide member into parts

$$\frac{1}{K_m} = \frac{1}{K_1} + \frac{1}{K_2} + \text{------}$$

8.6 : Bolt strength
8.7 : Tension Joints

$P_m = P_b \frac{K_m}{K_b}$

P_m: portion of force taken by membe
P_b : portion of force taken by bolt

But $P = P_b + P_m$

$C = \frac{K_b}{K_b + K_m}$

$P_m = (1 - C)P$

$F_b = CP + F_i$, $F_m < 0$
$F_m = (1 - C)P - F_i$, $F_m < 0$

Torque required to produce a given preload

$T = K F_i d$
from tables (Torque factor)

Note
preload stress $= \frac{F_i}{A_t}$ ← threaded area

8.9 factor of safety (Static and Tension)
Yielding factor of safety
$n_p = \frac{S_p A_t}{CP + F_i}$

S_p: proof stress (Tables)
A_t : tables
C , calculated
: F_i

$n_L = \frac{S_p A_t - F_i}{CP}$
load factor of safety

Scanned with CamScanner

$$n_o = \frac{P_o}{P} = \frac{F_i}{P(1-c)}$$

proof load

$$F_i = \begin{cases} 0.75 F_p & \text{nonpermenant connection} \\ 0.9 F_p & \text{permenant connection} \end{cases}$$

$$F_p = A_t S_p$$

8.9 : static factor of safety (in Tension with Preload)

1- yielding FOS against static stress

$$n_p = \frac{S_p A_t}{CP + F_i} = \frac{S_p}{\sigma_b}$$

2- load FOS against static stress
I can calculate P that Gives n = 1

$$\frac{C n_L P + F_i}{A_t} = S_p \rightarrow n_L = \frac{S_p A_t - F_i}{CP}$$

3- FOS against joint separation (ءىلاً)

$$n_o = \frac{P_o}{P} = \frac{F_i}{P(1-C)}$$

Scanned with CamScanner

To obtain F_i :-

$$F_i = \begin{cases} 0.75 F_p, & \text{reused fasteners} \\ 0.9 F_p, & \text{permenant connections} \end{cases}$$

Where $F_p = A_t S_p$

threaded area ↙ ↳ proof strength

P: Separating force, Given →

A_t: table

k_b, k_m :

If we want factor of safety of each bolt we use

$$n_L = \frac{S_p A_t - F_i}{C(P_{total}/N)}$$

↑ number of bolts ← تقريبا للأكبر

8.11 : Fatigue loading of tension Joints

$F_{b\,min} = C P_{min} + F_i$

$F_{b\,max} = C P_{max} + F_i$

$$\sigma_m = \frac{C(P_{max} + P_{min})}{2 A_t} + \frac{F_i}{A_t}$$

yield

$$n_p = \frac{S_p}{\sigma_m + \sigma_a}$$

Gerber : $n_f = \frac{1}{2\sigma_a S_e}\left[S_{ut}\sqrt{S_{ut}^2 + 4S_e(S_e + \sigma_i)} - S_{ut}^2 - 2\sigma_i S_e\right.$

Goodman:

$$n_f = \frac{S_e (S_{ut} - \sigma_i)}{\sigma_a (S_{ut} + S_e)}$$

How to find S_e: → Table 8–17

static

8.12: Bolted and Riveted joints loaded in shear

→ permenant

In case of shear stress: Bolted, Riveted, treated

Same

Example

Shear force → Primary: load
→ secondary: from Moment

$$F_B = \sqrt{(F''_{Bx})^2 + (F''_{By} + F'_B)^2}$$

Proof is used in Tension Not Shear

We need yield shear stress