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Question:
A power screw on a machine has single start square thread with a non rotating bronze nut. Axial force on the screw is 15 kN. Allowable stresses for screw material in compression and shear are 85 MPa and 37 MPa respectively. Allowable bearing pressure for the screw nut pair is 5 MPa. Find (i) Core diameter of screw (ii) Length of the nut (iii) Efficiency of power screw in coefficient of friction between screw and nut is 0.12. (iv) Shear stresses in the threads of screw and nut.

Answer:

Design of power Screw:

Given Data:

W =15 KN =15 X 10^3 N, σ_{cnut} =85 N/mm^2, τ_{nut} =37 N/mm^2

P_b= 5 N/mm^2, μ =0.14

Design of Screw:

1) Core Diameter of screw :

Consider the screw under pure compression to find diameter of screw

$\sigma c = \frac{W}{\frac{\pi}{4}X(dc)^2}$, $85 = \frac{15\,x(10)^3}{\frac{\pi}{4}X(dc)^2}$ d_C = 14.99 say 15 mm

Do =Dc /0.84 = 15/0.84 = 17.86 Say 18 mm

D = (do + dc)/2 = (15 +18) /2 = 16.5 mm

P= do- dc = 18-15 = 3 mm

ii)Length of Nut :

The bearing pressure between the thread

$Pb = \frac{w}{\frac{\pi}{4}X(do^2-dc^2)\,n}$, $5 = \frac{15\,x(10)^3}{\frac{\pi}{4}X(18^2-15^2)\,n}$,

n= 38.60 i.e = 40 contacts

Height of Nut: h=n x p =40 x 3 =120 mm

Helix angle $\alpha = tan^{-1}\frac{\text{Lead}}{\pi x 16.5}$ = 3.31°

$\emptyset = tan^{-1}\mu$ $= tan^{-1}x\ 0.12$ = 6.84°

Torque required lifting the load

T_1= W. tan ($\alpha + \emptyset$) $\frac{d}{2}$

T_1= 15x 10^3 tan (3.31+6.84) $\frac{16.5}{2}$ = 22159.13 N.mm

As collar friction is Neglecting, T_2=0

Total Torque required to lift the load = T_1= 22159.13 N.mm

III) Efficiency of power screw :

$$\tilde{n} = \frac{W.\tan(\alpha)\frac{d}{2}}{T}$$

$\frac{=(15x10^3 tan\,(3.31\,)16.5/2)}{22159.13}$ = 0.323 = 32 %

IV)Shear stresses in threads of screw & nut :

Shear stress induced in the screw thread

$\tau = \frac{W}{\pi X(dc)Xtn}$ as t= p /2

$\tau = \frac{50\ X\ 10^3}{\pi X(15)X1.5\ X\ 40}$ =5.30 N/mm^2

Shear stress induced in the Nut thread

$\tau = \frac{W}{\pi X(do)Xtn}$ as t = p /2

$\tau = \frac{50\ X\ 10^3}{\pi X(18)X1.5\ X\ 40}$ =4.42 N/mm^2 .