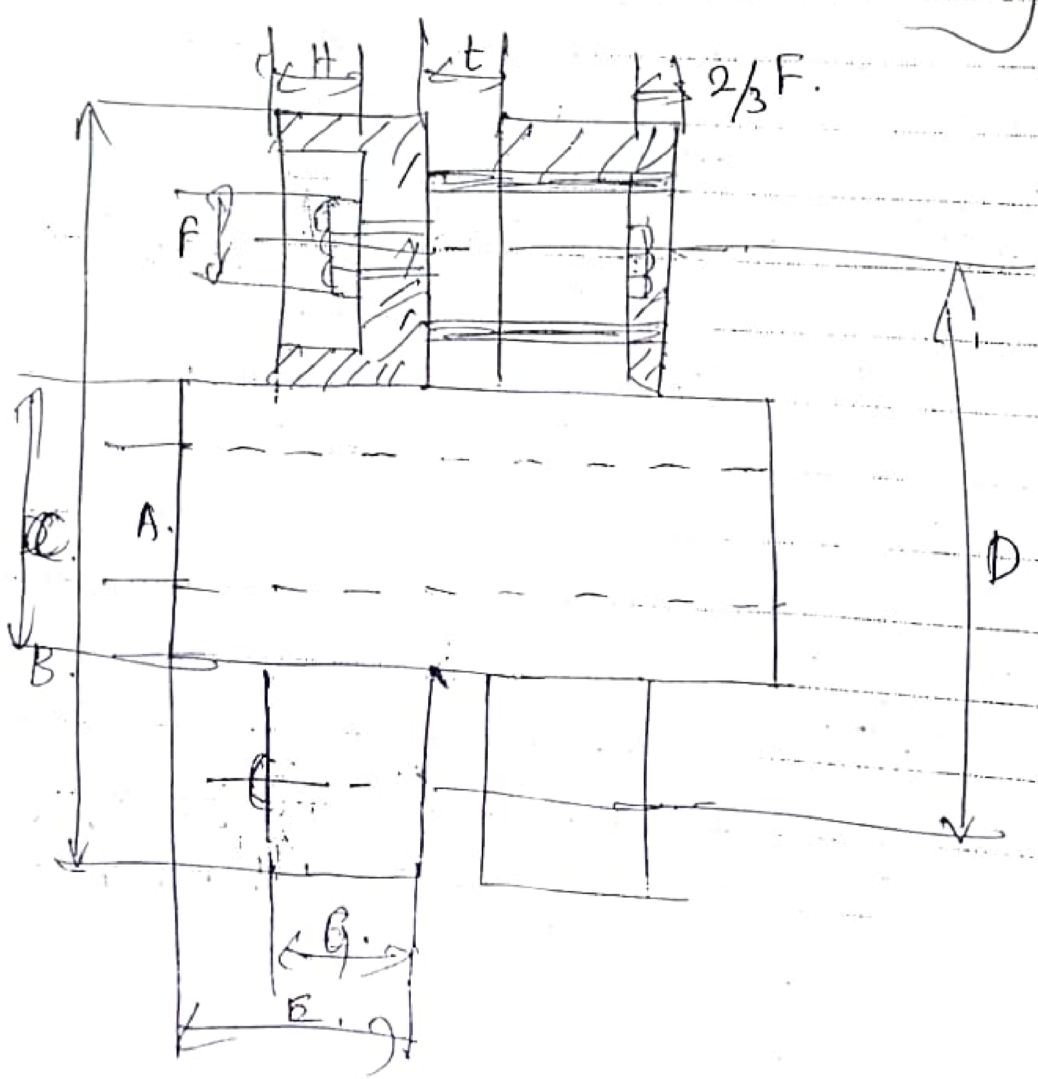
Design of Bushed pin type flexible coupling:

With reference to P.S.G. D.B, 7.106;

A → Diameter of shaft.
B → OD of flange.
C → ∅ of hub.
D → pitch ⓒle ∅ of bolts on flange.
E → length of Hub.
F → Diameter of bolts.
G → Length of bush in flange.
H → protective layer thickness.
n → No of bolts.
db → Diameter of bush.
t → clearance.



1. Design a bushed pin type of flange coupling to connect a pump shaft to a motor shaft transmitting 30kw at 900 rpm. The overall torque is 15% greater than mean torque. The material allowable properties are as follows:

Crushing stress for shaft & key = 80Mpa.
Shear stress for shaft & key = 40Mpa.
Shear stress of coupling = 18Mpa.
Bearing pressure for rubber bush = 0.8 Mpa.
Material of the pin is same as shaft & key.

Given:

Power (P) = 30 kw
Speed (N) = 900 rpm.
$T_{max}$ = 1.15 $T_{mean}$.
$\sigma_{cs}$, & $\sigma_{ck}$ = 80Mpa.
$\tau_s$ & $\tau_k$ = 40Mpa.
$\tau_{coupling}$ = 18Mpa.
Bearing pressure for rubber bush = $P_{bo}$ = 0.8 Mpa.

(i) Design of flexible coupling:

To find dia of shaft.

$$T = \frac{P \times 60}{2\pi N}$$

$$= \frac{60 \times 30 \times 10^3}{2 \times \pi \times 900}$$

$\boxed{T_{mean} = 318.3 \text{ N.m.}}$ $\boxed{T_{max} = \cancel{477.46}\ 366.05 \text{ N.m}}$

We know,

$$T = \frac{\pi}{16} \times \tau_s \times d^3$$

$$d^3 = \frac{477.46 \times 10^3 \times 16}{40\pi}, \quad \boxed{d = 39.32} \simeq 40\text{m}$$

35.98

From PSG D.B 7.109, For 30 – 45mm diameter (A

Specifications are:

B → OD of flange = 132 mm.
C → Dia of hub = 55 mm.
D → pitch cle dia of bolt = 90mm.
E → Length of hub = 40mm.
F → Diameter of bolt = 12mm.
G → Length of bush in flange = 30mm.
H → protective layer thickness = 15mm.
n → No of bolts = 4.
$d_b$ → Diameter of bush = 25mm.
t → clearance = 4mm.

ii)

## Design of key:

For $\phi$ 40mm. $w = 10mm$.
$t = 8mm$.

Length of key = Length of Hub $= \frac{40mm}{2} = 20mm$.

Check for Shearing:

$$T = l \times w \times \tau_k \times d/2.$$

$$477.46 \times 10^3 = 20 \times 10 \times \tau_k \times \frac{40}{2}.$$

$\tau_k = 119.36$ Mpa $>$ given. 40Mpa. So design is not Safe.

Let width w may be Increased. So,

$$477.46 \times 10^3 = 20 \times w \times 40 \times 20.$$

$\boxed{W = 29.84mm.}$ for Safe design.

check for crushing:

$$T = l \times t/2 \times \sigma_{ck} \times d/2.$$

$$477.46 \times 10^3 = 20 \times 8/2 \times \sigma_{ck} \times 40/2.$$

$\sigma_{ck} = 298.4$ Mpa $>$ given 80Mpa, So, thickness may be increased.

$$\frac{T \times 2 \times 2}{l \times \sigma_{ck} \times d} = t$$

$$\frac{477.46 \times 10^3 \times 2 \times 2}{20 \times 80 \times 40} = \boxed{t = 29.84 \text{ mm.}}$$ for de

iii) Check for bolt:

Bearing load acting on the pin, W,

$$T_{max} = W \times n \times \frac{D}{2} \quad D \rightarrow \text{pitch circle } \phi \text{ of bo}$$

$$\frac{477.46 \times 10^3}{4 \times \frac{90}{2}} = W$$

$\therefore$ Bearing load on pin $\boxed{W = 2652.55 \text{ N.}}$

To find Max. principal Stress:

$$\frac{\sigma_b}{2} + \frac{1}{2}\sqrt{(\sigma_b)^2 + 4\tau^2}$$

Bending Stress; $\sigma_b = \frac{M}{Z}$ $M \rightarrow$ Bending moment, $Z \rightarrow$ section mod,

Bending moment $M = W \times \left[\frac{G}{2} + t\right]$ (2 bushes)

$G \rightarrow$ length of

$$M = 2652.55 \left[\frac{30}{2} + 4\right]$$

$$\boxed{M = 50398.45 \text{ N.mm}}$$

$$Z = \frac{\pi}{32} (r)^3$$

$$Z = \frac{\pi}{32} (12)^3 \qquad \boxed{Z = 1357.16 \, mm^3}$$

Bending stress $\sigma_b = \frac{50398.45}{1357.16}$

$$\boxed{\sigma_b = 37.13 \, N/mm^2}$$

Direct Stress : $(\tau) = \frac{W}{A}$

$$= \frac{2652.55}{\frac{\pi}{4} \times (r)^2} = \frac{2652.55}{\frac{\pi}{4} (12)^2}$$

$$\boxed{\tau_{direct} = 23.45 \, N/mm^2}$$

$\therefore$ Max. Principal Stress $= \frac{\sigma_b}{2} + \frac{1}{2}\sqrt{(\sigma_b)^2 + 4\tau^2}$

$$= \frac{37.13}{2} + \frac{1}{2}\sqrt{(37.13)^2 + 4(23.45)^2}$$

$$\boxed{\text{Max principal stress} = 48.47 \, N/mm^2}$$

(iv) Design of bush:

a) Length of bush $L = G + t - \frac{2}{3} \times F$.

$L = 30 + 4 - (2/3 \times 12.)$.

Length of bush $\boxed{L = 26\,mm.}$

To ~~find~~ check bearing stress of bush;

$$\sigma_{bc} = \frac{W}{d_b \times L}.$$

$$\sigma_{bc} = \frac{2652.55}{25 \times 26}.$$

$$\boxed{\sigma_{bc} = 4.08\ Mpa > \text{given } 0.8\ Mpa}$$

For safe design.

diameter of bush $d_b$ may be modified

$$0.8 = \frac{2652.55}{d_b \times 26}.$$

$\boxed{d_b = \text{dia of bush} = 127.56\,mm}$ For safe des

Design of Hub:

$$T_{max} = \frac{\pi}{16} \times \tau_c \times \left(\frac{c^4 - A^4}{c}\right)$$

$$\overset{366.05}{\boxed{477.46}} \times 10^3 = \frac{\pi}{16} \times \tau_c \times \left[\frac{55^4 - 40^4}{55}\right]$$

$$\tau_c = \underset{15.5}{\boxed{20.29}}\ \text{Mpa} \cancel{>} < \text{given } 18\ \text{Mpa} = \text{design is } \cancel{\text{not}}\ \text{safe.}$$

Design of flange:

$$T_{max} = \frac{\pi c^2}{2} \times \tau_{f(c)} \times G.$$

$$366.05 \times 10^3 = \frac{\pi \times 55^2}{2} \times \tau_R \times 30.$$

$$\tau_{f(c)} = 2.56\ \text{Mpa} < \text{given } 18\ \text{Mpa Safe.}$$