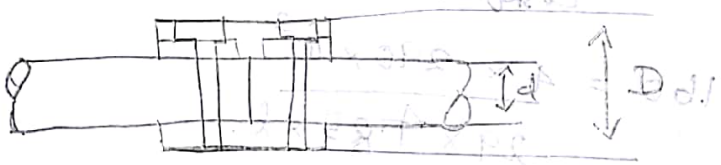
Design the clamp coupling to connect two plain carbon steel to transmit 30 kW at 500 rpm. The CI muff halves are clamped by 4 alloy steel bolts, The key uses the same material as that of shaft. Maximum torque transmitted is 20% greater than average torque material properties Allowable crushing stress & for plane carbon steel shafts & keys are 155 N/mm². Allowable cast iron muff is 150 N/mm². Allowable tensile stress for alloy steel bolt is 130 N/mm². Allowable shear stress for plain carbon steel shaft & key is 55 N/mm².



P = 30 kW

N = 500 rpm

Design of the shaft

$$T_{max} = \frac{16 T_{max}}{\pi d^3}$$

$$T_{max} = 1.20\, T_{mean}$$

$$T_{mean} = \frac{60 \times 30 \times 10^3}{2\pi \times 500}$$

$$= \frac{1145.91}{2}$$

$$= 572.95 \times 10^3 \text{ N·mm}$$

$T_{max} = 687 \times 10^3$ N·mm

Step: 2

Design of Sleeve.

Shear stress of shaft = 55 N/mm².

$$55 = \frac{16 \times 687 \times 10^3}{\pi d^3}$$

$$d^3 = \frac{16 \times 687 \times 10^3}{\pi \times 55}$$

$$d = 40 \text{ mm}$$

Design of Sleeve.

$D = 2d$

$D = 80$ mm.

$L = 3.5 \times 40$

$= 140$ mm.

$K = d/D$

$\therefore 40/80 = 0.5$

$$T = \frac{16 T_{max}}{\pi D^3 (1 - K^4)}$$

$$= \frac{16 \times 687 \times 10^3}{\pi \times 80^3 (1 - 0.5^4)}$$

$$= \frac{10992000}{1507964.4}$$

$= 7.2$ N/mm² < 150 N/mm²

Design is safe

Design of keys.

i) Sunk key [rectangular cross section]

$w = d/4$

$= 10\ mm$

$h = \frac{2}{3} w$

$= 6.66\ mm$

Length of key $l = 1.75\ d$.

$l = l/2$

$= \frac{140}{2}$

$l = 70\ mm$.

$l = 1.75 \times 40$

$= 70\ mm$

$\sigma_c = \frac{4 T_{max}}{d h l}$

$155 = \frac{4 \times 687 \times 10^3}{40 \times 6.66 \times l}$

$l = \frac{4 \times 687 \times 10^3}{40 \times 6.66 \times 155}$

$l = 66.55$

$l = 70\ mm$.

$$d_c = \sqrt{\frac{16\, T_{max}}{\pi^2 \mu N d \sigma_t}}$$ → no. of bolts

$$= \sqrt{\frac{16 \times 687 \times 10^3}{\pi^2 \times 0.3 \times 4 \times 40 \times 130}}$$

$d_c = 13.35$ mm.

$$d_s = \frac{d_c}{0.84}$$

$= 16$ mm

$$\tau = \frac{2\, T_{max}}{d w l}$$

$$\frac{\sigma_c}{2} = \frac{2 \times 687 \times 10^3}{40 \times 10 \times l}$$

$$l = \frac{2 \times 687 \times 10^3}{40 \times 10 \times 77.5}$$

$= 44.32$ mm.