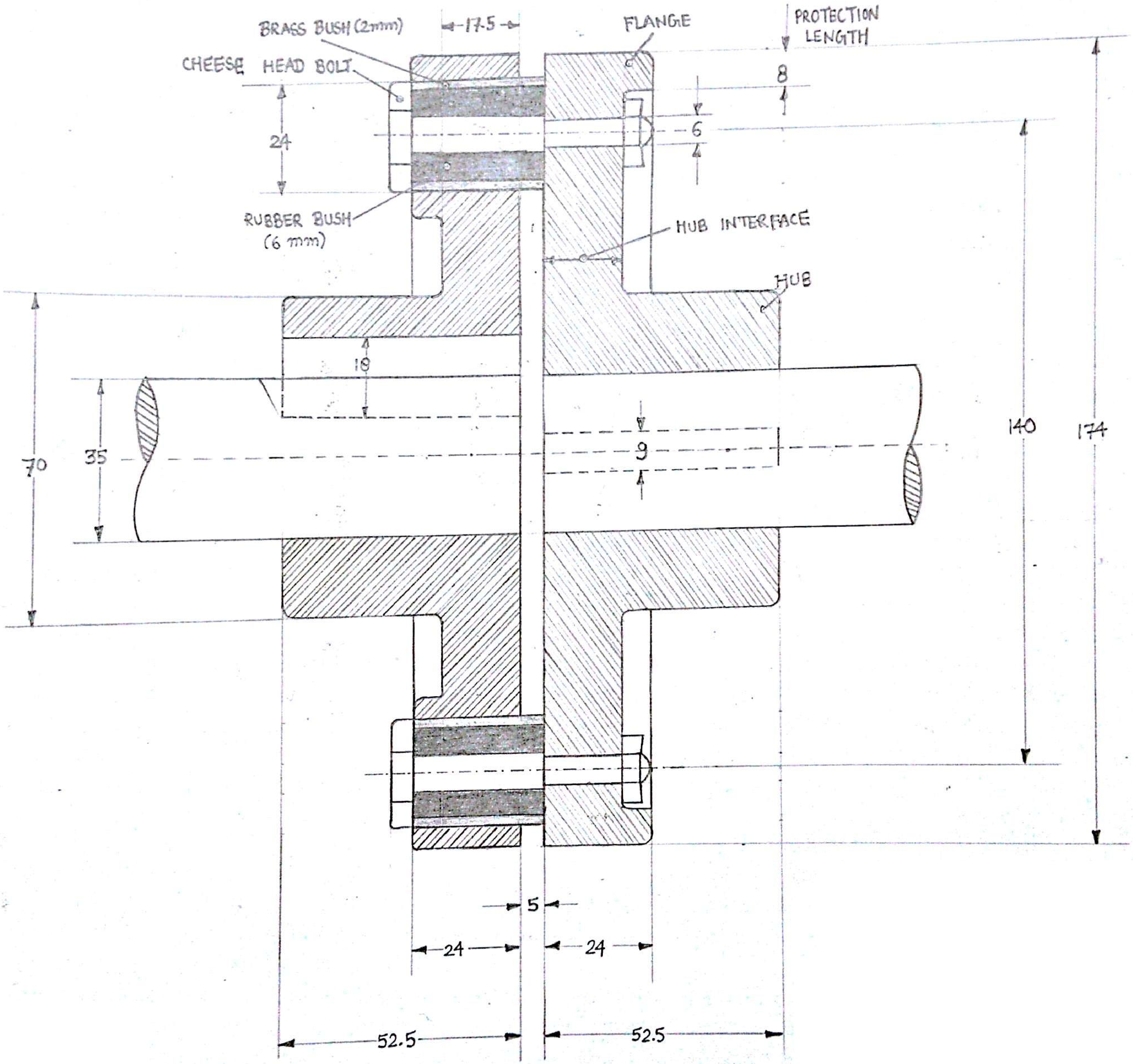

BUSHED-PIN FLEXIBLE COUPLING

Power = 20 kW , N = 720 rpm, $\eta_f = 2$

For Shaft

$P_1 = 1.5P$

$\Rightarrow P_1 = 1.5 \times 20$ kW
$= 30$ kW

$P_1 = T\omega$

$\Rightarrow T = \dfrac{30\times10^3}{720\times\frac{2\pi}{60}} = 397.09$ Nm

$\tau = \dfrac{0.5S_{yt}}{2} = \dfrac{0.5\times380}{2} = 95$ MPa

$\tau = \dfrac{16T}{\pi d^3} \Rightarrow d^3 = \dfrac{16\times397.09}{\pi\times95\times10^6}$

$\Rightarrow d^3 = 2.133\times10^{-5}\, m^3$

$\Rightarrow d = 27.73$ mm (minimum)

$\therefore d \approx 30$ mm (from standard shaft size)

For Hub

$D = 2d = 2\times30 = 60$ mm

$L = 1.5d = 1.5\times30 = 45$ mm

$\tau = \frac{15}{2}$ MPa $= 7.5$ MPa

$\tau = \dfrac{16TD}{\pi(D^4 - d^4)}$

$\Rightarrow \tau = \dfrac{16T}{\pi}\dfrac{2d}{(2d)^4 - d^4} = \dfrac{32Td}{\pi(15d^4)}$

$\Rightarrow \tau = \dfrac{32T}{15\pi d^3}$

$\Rightarrow d^3 = \dfrac{32}{15\pi}\cdot\dfrac{T}{\tau} = \dfrac{32}{15\pi}\times\dfrac{397.89}{7.5\times10^6}$

$\Rightarrow d = 33.02$ (minimum)

So, $d = 35$ mm

$D = 2d = 70$ mm

$L = 1.5d = 52.5$ mm

For key

$L = 1.5d = 52.5$ mm

$\tau = \dfrac{0.5\times400}{2} = 100$ MPa

$\tau = \dfrac{2T}{dwL}$

$w = \dfrac{2T}{dL\tau}$

$w = \dfrac{2\times357.89}{35\times10^{-3}\times52.5\times10^{-3}\times100\times10^6}$

$w = 4.33\times10^{-3}$ m

$\Rightarrow w = 4.33$ mm (minimum)

$w = \frac{1}{4}d = \frac{1}{4}\times35 = 8.75$ mm

So, $w = 9$ mm

Now, $\tau = \sigma_c$

$\Rightarrow \dfrac{2T}{dwL} = \dfrac{4T}{dhL}$

$\Rightarrow h = 2w$

$\therefore h = 2\times9$ mm

$h = 18$ mm

For Flange

$t_f = 0.5d = 0.5\times35 = 17.5$ mm

$\tau_{max} = \frac{15}{2} = 7.5$ MPa

$\tau = \dfrac{T}{\pi D t_f \times \frac{D}{2}}$

$\Rightarrow \tau = \dfrac{397.89}{\pi\times70\times17.5\times35\times10^{-9}}$

$\Rightarrow \tau = 2.953$ MPa

$\because \tau < \tau_{max}$

so, $t_f = 17.5$ mm

For rubber bushes and pins

N=6

$105 \le D_1 \le 140$

$d_1 = 0.5d/\sqrt{N}$

$d_1 = 7.144$ (pin diameter)

$D_1 = 3d$

$F = \dfrac{T}{N\left(\frac{D_1}{2}\right)} = \dfrac{397.89}{6\times\frac{105}{2}\times10^{-3}}$

$F = 1.263\times10^3$ N

$\tau = \dfrac{F}{(\pi d_1^2/4)} = \dfrac{1.263\times10^3}{\pi\times\frac{(7.144)^2}{4}\times10^{-6}}$

$\tau = 31.5$ MPa ≤ 35 MPa

$d_2 = d_1 + 2$ mm $+ 4$ mm $+ 12$ mm
$= (7.144 + 2 + 4 + 12)$ mm

$\Rightarrow d_2 = 25.144$ mm

$l_2 = d_2$

$P_b = \frac{1.263 \times 10^3}{25.144 \times 25.144 \times 10^{-6}}$

$P_b = 1.997$ MPa $\geq$ 1 MPa (Not Allowed)

So, Taking $D_1 = 4d = 140$ mm

$F = \frac{T}{N \frac{D_1}{2}} = \frac{397.89}{6 \times 70 \times 10^{-3}}$

$F = 0.9473 \times 10^3$ N

$P_b = \frac{947.3}{(25.144)^2 \times 10^{-6}}$

$\Rightarrow P_b = 1.490 \geq 1$ MPa (Not Allowed)

So, Taking $N = 8$, $D_1 = 4d = 140$ mm

$F = \frac{397.89}{8 \times \frac{140}{2} \times 10^{-3}} = 710.52$ N

$d_1 = 0.5 \times \frac{35}{\sqrt{8}} = 6.1871$ mm

$d_2 = (6.1871 + 2 + 4 + 12)$ mm

$= 24.187$ mm

$P_b = \frac{710.52}{(24.187)^2 \times 10^{-6}}$

$= 1.182$ MPa > 1 MPa (Not Allowed)

So, Taking $N = 10$, $D = 4d = 140$ mm

$F = \frac{397.89}{10 \times \frac{140}{2} \times 10^{-3}} = 568.41$ N

$d_1 = 0.5 \times \frac{35}{\sqrt{10}} = 5.533$ mm $\simeq 6$ mm

$d_2 = (6 + 2 + 4 + 12)$ mm

$= 24$ mm

$l_2 = d_2 = 24$ mm

$P_b = \frac{568.41}{(24)^2 \times 10^{-6}}$ Pa

$P_b = 0.9868$ MPa ≤ 1 $\therefore$ Allowed

$\tau = \frac{F}{\frac{\pi d_1^2}{4}} = \frac{568.41}{\frac{\pi \times 6^2}{4} \times 10^{-6}} = 20.1$ MPa ≤ 35 MPa

So, $D_1 = 140$ mm, $N = 10$, $d_1 = 6$ mm, $d_2 = 24$ mm

$l_p = (l_2 + 5)$ mm $= 29$ mm

$M = \frac{F l_p}{2} = \frac{568.41 \times 29 \times 10^{-3}}{2}$

$M = 8.241$ Nm

$\therefore \sigma_b = \frac{M}{Z} = 8.24 \times \frac{d_1}{2} \times \frac{32}{\pi d_1^4}$

$= 8.24 \times \frac{6}{2} \times \frac{32}{\pi \times 6^4} \times 10^9$

$= 194.3$ MPa

$\tau = 20.1$ MPa

$\therefore \sigma_{max} = \sqrt{\frac{\sigma_b^2}{4} + \tau^2}$

$= 99.2$ MPa.