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Assignment # 07

Sol. 1 $l = 5m = 5 \times 10^3 mm$

$D = 50 mm$

$N = 600$ RPM

$\tau_{max} = 60 MN/m^2 = 60 N/mm^2$

$\frac{T}{J} = \frac{\tau}{R}$ $\quad \because J = \frac{3.14}{32} \times (50)^4$

$\Rightarrow T = \frac{60 N/mm^2 \times 61.32 \times 10^4 mm^4}{25 mm} = 61.32 \times 10^4 mm^4$

$= 147.168 \times 10^4 N\text{-}mm$

$W = \frac{2\pi N}{60} = \frac{2 \times 3.14 \times 600}{60}$

$= 62.8$ Rad/sec

Power $= WT$

$= 1471.68 N\text{-}m \times 62.8$ Rad/sec

$= 92421.5$ Watt

$= 92.5$ KW

here $C = 80 GN/m^2 = 80 \times 10^3 N/mm^2$

$\frac{T}{J} = \frac{C\theta}{L} \Rightarrow \theta = \frac{TL}{JC}$

$\theta = \frac{147.168 \times 10^4 N\text{-}mm \times 5 \times 10^3 mm}{61.32 \times 10^4 mm^4 \times 80 \times 10^3 N/mm^2}$

$\theta = .15$ Rad

$= .15 \times \frac{180}{3.14} = 8.599$

$= 8.56°$

Sol. 2. $\frac{D_i}{D_o} = 0.75 \Rightarrow D_i = 0.75 D_o$

$l = 4 \times 10^3$ mm

Power $= 10^6$ watt

$N = 120$ RPM

$\tau_{max} = 70 \times 10^3$ N/mm^2

$\theta = 1.75^\circ \times \frac{3.14}{180} = 0.03$ Rad.

$10^6 = T\omega$

$\Rightarrow T = \frac{10^6}{\omega} = \frac{10^6 \times 60}{2 \times 3.14 \times 120}$

$= 7.96 \times 10^4$ N-m

$= 7.96 \times 10^7$ N-mm

$\frac{T}{J} = \frac{C\theta}{L}$

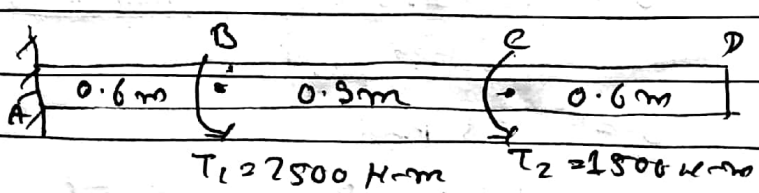
$\Rightarrow \frac{7.96 \times 10^7 \times 32}{3.14 \times (D_o^4 - D_i^4)} = \frac{80 \times 10^3 \times .03}{4 \times 10^3}$

$\sim \frac{254.72 \times 10^7}{2.15 D_o^4} = \frac{2.4}{4}$

$\Rightarrow D_o^4 = 19.75 \times 10^8$

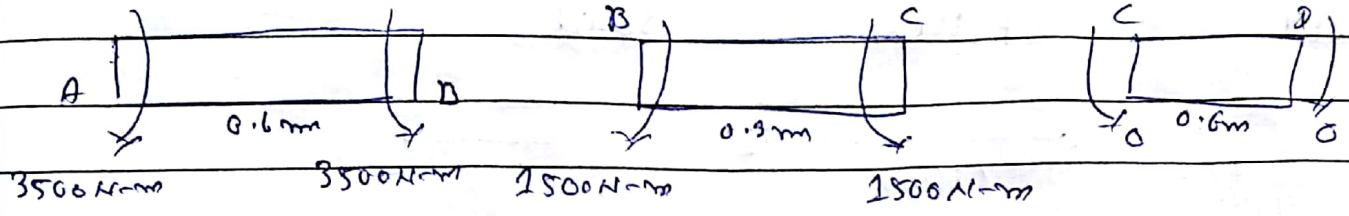
$\Rightarrow D_o = 210$ mm

Sol 3:



$C = 0.8 \times 10^5$ N/mm^2

$D = 80$ mm



$$\frac{T}{J} = \frac{\tau}{R} \Rightarrow \tau = \frac{RT}{J}$$

$$\tau_{AB} = \frac{40 \times 3500 \times 10^3 \times 32}{3.14 \times (80)^4}$$

$$= \frac{4 \times 3500 \times 32}{3.14 \times 8^4}$$

$$= 34.83 \text{ MPa}$$

$$\tau_{BC} = \frac{40 \times 1500 \times 10^3 \times 32}{3.14 \times (80)^4}$$

$$= 14.92 \text{ MPa}$$

$$\tau_{CD} = 0$$

here $J = \frac{\pi}{32} \times D^4 = \frac{3.14 \times (80)^4}{32}$

$= 401.92 \times 10^4 \text{ mm}^4$

$\frac{T}{J} = \frac{\theta C}{L}$

$\Rightarrow \theta = \frac{TL}{CJ}$

$$\theta_{B/A} = \frac{3500 \times 10^3 \text{ (N-mm)} \times 0.6 \times 10^3 \text{ (mm)}}{0.8 \times 10^5 \text{ (N/mm}^2\text{)} \times 401.92 \times 10^4 \text{ (mm}^4\text{)}}$$

$$= \frac{35 \times 0.6}{8 \times 401.92} = 0.00653 \text{ Rad}$$

$$\theta_{C/B} = \frac{1500 \times 10^3 \times 0.9 \times 10^3}{0.8 \times 10^5 \times 401.92 \times 10^4}$$

$$= \frac{15 \times 0.9}{8 \times 401.92} = 0.00419$$

$$\theta_{T/A} = \theta_{B/A} + \theta_{C/B}$$

$$= 0.01072 \text{ Rad.}$$

Sol4.

$D_o = D = 50\ mm$

$D_i = 30\ mm$

$T = 680\ N-m$

$$J_H = \frac{\pi}{32} \times (D_o^4 - D_i^4)$$

$$= \frac{3.14}{32} (50^4 - 30^4)$$

$$= 53.38 \times 10^4\ mm^4$$

$$J_S = \frac{3.14 \times 625}{32} \times 10^4$$

$$= 61.33 \times 10^4\ mm^4$$

$$\theta_H = \frac{250 \times 680 \times 10^3}{53.38 \times 10^4 \times 0.75 \times 10^5} \times \frac{180}{3.14}$$

$$= 0.7434^\circ$$

$$\theta_S = \frac{350 \times 680 \times 10^3}{61.33 \times 10^4 \times 0.75 \times 10^5} \times \frac{180}{3.14}$$

$$= 0.7566$$

$$\theta_T = \theta_H + \theta_S$$

$$= 0.5^\circ$$

$$\frac{T}{J} = \frac{\tau}{R} \Rightarrow \tau = \frac{TR}{J}$$

$$\tau_H = \frac{680 \times 10^3 \times 25}{53.38 \times 10^4} = 31.85\ N/mm^2$$

$$= 31.85\ MPa$$

$$\tau_S = \frac{680 \times 10^3 \times 25}{61.33 \times 10^4} = 27.72\ N/mm^2$$

$$= 27.72\ MPa$$

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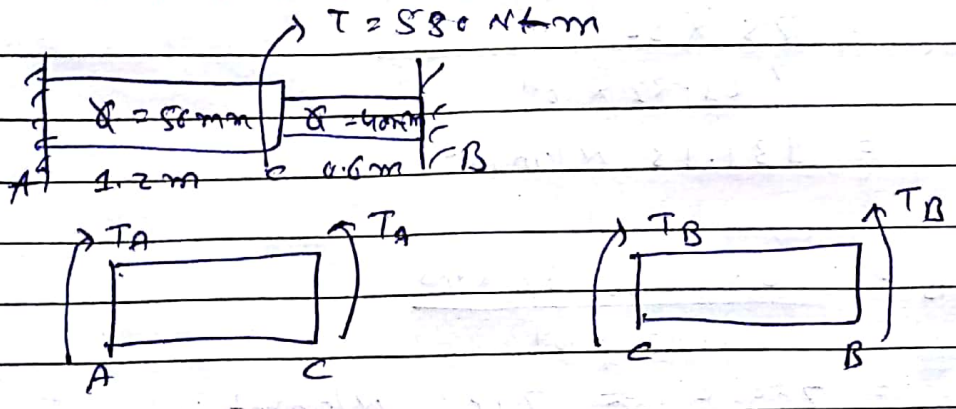
15.



here $T_B = T_A + 580$ ... (1)

and $\theta_{C/A} = \theta_{B/C}$ ... (2)

$\frac{T}{J} = \frac{C\theta}{l}$ ⇒ $J_{AC} = \frac{3.14}{32} \times (50)^4$

$= 61.32 \times 10^4 \text{ mm}^4$

$\Rightarrow \theta = \frac{lT}{JC}$

$J_{CB} = \frac{3.14}{32} \times (40)^4$

$= 25.12 \times 10^4 \text{ mm}^4$

$\theta_{C/A} = \frac{12 \times 10^3 \times T_A}{61.32 \times 10^4 \times C}$ & $\theta_{B/C} = \frac{.6 \times 10^3 \times T_B}{25.72 \times 10^4 \times C}$

From equation (2):

$\frac{12 \times T_A}{61.32} = \frac{T_B \times 6}{25.12}$

From eq. (1):

$T_B = 1.22 T_B + 580 \Rightarrow T_B = -2636.36 \text{ N-m}$

& $T_A = -3216.36 \text{ N-m}$

$\frac{T}{J} = \frac{\tau}{R} \Rightarrow \tau = \frac{RT}{J}$

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$$\tau_{AC} = \frac{25 \times 3216.38 \times 10^3}{61.32 \times 10^4}$$

$$= 131.13 \ N/mm^2$$

$$\tau_{CB} = \frac{20 \times 2638.36 \times 10^3}{25.22 \times 10^4}$$

$$= 209.5 \approx 210 \ N/mm^2$$