Assignment - 2

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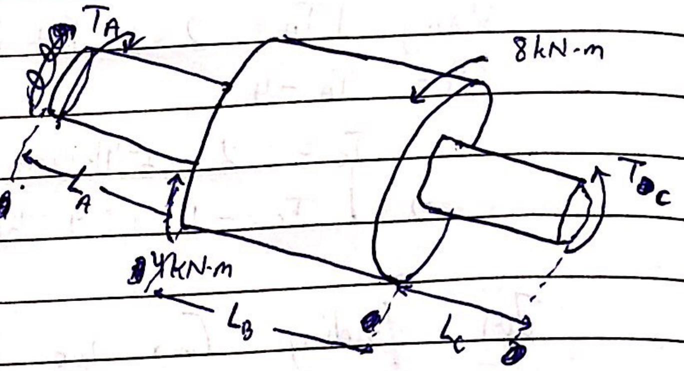
Given :-



$G = 80\ GPa$

$L_A = L_B = 200\ mm$

$L_c = 240\ mm$

Diam $A_D = 25\ mm$

$C_D = 25\ mm$

$B_D = 50\ mm$

Sol. Removed the clamped and applied T_A & T_C instead of it.

Now Using eqbm eqn.

$$\circlearrowleft + \quad \Sigma T = 0$$

$$\Rightarrow T_A + 4 - 8 - T_C = 0$$

$$\Rightarrow T_A - T_C = 4 \quad \text{--- (1)}$$

Since we have two variable and only one eqn. so ~~its~~ ~~it~~ now since ~~it~~ is clamped at both ends so net angle of twist will be zero

angle of twist $\phi = \dfrac{TL}{GJ_A}$ when $J_A = \dfrac{\pi r^4}{2} = \dfrac{\pi d^4}{32}$

So $\phi_A = \dfrac{T_A L_A}{GJ_A}$; $\phi_B = \dfrac{T_B L_B}{GJ_B}$; $\phi_C = \dfrac{T_C L_C}{GJ_C}$

and $\Sigma \phi_i = 0$

$$\Rightarrow \frac{T_A L_A}{GJ_A} + \frac{T_B L_B}{GJ_B} + \frac{T_C L_C}{GJ_C} = 0$$

$$\Rightarrow \frac{T_A 200}{(25)^4} + \frac{(T_A+4)200}{(50)^4} + \frac{(T_A-4)240}{(25)^4} = 0$$

$$\Rightarrow 3200\ T_A + 200\ T_A + 800 + 3840\ T_A - 15360 = 0$$

$$\Rightarrow 80\ T_A + 5\ T_A + 20 + 96\ T_A - 384 = 0$$

$$\Rightarrow 181\ T_A = 364$$

$$\Rightarrow \boxed{T_A = \frac{364}{181}} \Rightarrow \boxed{T_A = 2.011\ kN\text{-}m}$$

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Using $\boxed{T_A = 2.011 \text{ kN-m}}$

$T_C = T_A - 4.$

$\Rightarrow T_C = 2.011 - 4 \text{ kN-m}$

$\Rightarrow \boxed{T_C = -1.989 \text{ kN-m}}$ $\boxed{T_B = 6.011 \text{ kN-m}}$

For finding τ_{max} we know that

$$\tau_{max} = \frac{TR}{J}$$

$$\Rightarrow \tau_{max,A} = \frac{T_A R_A}{J_A} = \frac{16 T_A}{\pi d^3} = 656 \text{ MPa.}$$

$$\tau_{max_B} = \frac{16 T_B}{\pi D_B^3} = 245 \text{ MPa}$$

$$\tau_{max,c} = \frac{16 T_c}{\pi d_c^3} = 648 \text{ MPa}$$

Since we have to find τ_{max} in entire rod so it will be $\max\{\tau_{max,A}, \tau_{max,B}, \tau_{max,c}\}$ which is.

$$\boxed{\tau_{max} = 656 \text{ MPa}}$$

Now calculating angle of Twist $= 7.58°$

$$\phi_A = \frac{T_A L_A}{G J_A} = \frac{32}{\pi} \frac{T_A L_A}{G d_A^4} = .13116 \text{ rad}$$

$$\phi_B = \frac{32}{\pi} \frac{T_B L_B}{G d_B^4} = .0245 \text{ rad} = 1.404°$$

$$\phi_C = \frac{32}{\pi} \frac{-T_c L_c}{G d_c^4} = .1556 \text{ rad} = -8.919°.$$

So the angle at $C - C'$ will be $\phi_A + \phi_B$ or $-\phi_C$

$\Rightarrow$

$$\boxed{\text{Ans} = 8.919°}$$