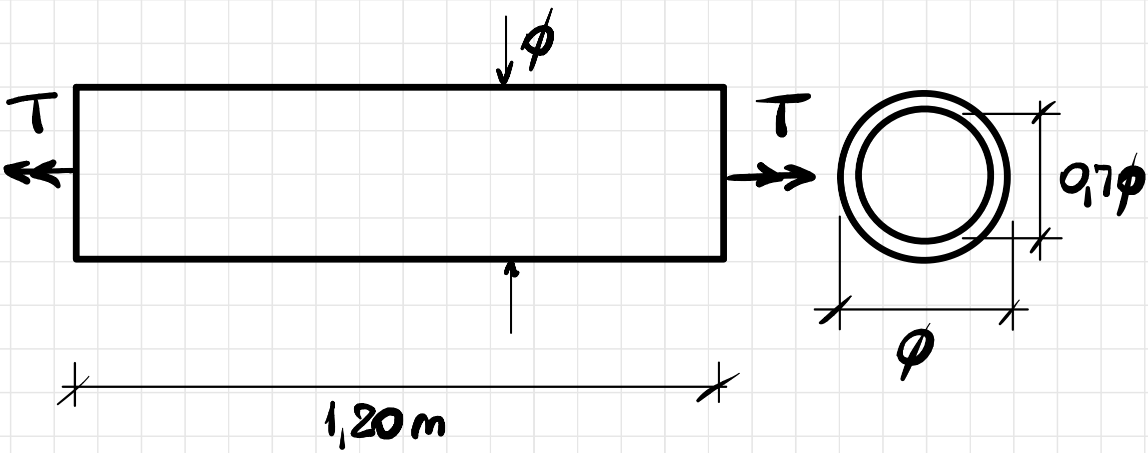
Um eixo circular vazado transmite uma potência de 250 HP a 800 rpm. Achar o valor de ϕ, dado $\bar{\tau} = 750\ kgf/cm^2$. Sabe-se que a rotação entre as extremidades não pode ultrapassar 0,01 rad. ($G = 10^6\ kgf/cm^2$)



Solução:

$$P = \frac{2\pi\omega T}{60 \cdot 75} \longrightarrow T = \frac{2250}{\pi}\frac{P}{\omega}$$

$$T = \frac{2250}{\pi} \cdot \frac{250}{800} = 223{,}81\ kgf.m$$

$$T = 22381\ kgf.cm$$

$$J = \frac{\pi}{32}\left(\phi_e^4 - \phi_i^4\right) = \frac{\pi}{32}\left(\phi^4 - (0{,}7\phi)^4\right)$$

$$J = 0{,}0746\,\phi^4$$

Dimensionamento:

1 Tensão de cisalhamento máxima:

$$\tau \leqslant \bar{\tau} \rightarrow \frac{T}{J}\cdot\frac{\phi}{2} \leqslant \bar{\tau}$$

$$\frac{T\cdot\phi}{0{,}0746\phi^4\cdot 2} \leqslant \bar{\tau} \rightarrow \frac{T}{0{,}1492\phi^3} \leqslant \bar{\tau}$$

$$\phi \geqslant \sqrt[3]{\frac{T}{0{,}1492\bar{\tau}}} \rightarrow \phi \geqslant \sqrt[3]{\frac{22381}{0{,}1492\cdot 750}}$$

$$\boxed{\phi \geqslant 5{,}848\,cm}$$

② Giro máximo:

$$\theta \leq \bar{\theta} = 0{,}01 \longrightarrow \frac{T \cdot \ell}{GJ} \leq \bar{\theta}$$

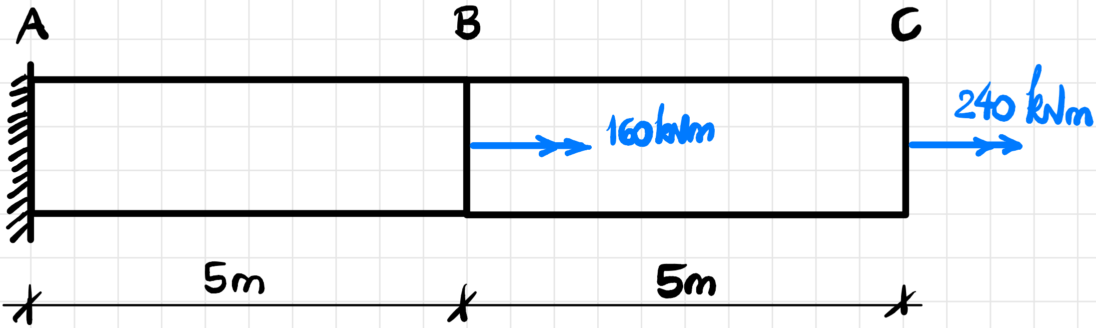
$$J \geq \frac{T\ell}{G\bar{\theta}} \longrightarrow 0{,}0746\phi^4 \geq \frac{T\ell}{G\bar{\theta}}$$

$$\phi \geq \sqrt[4]{\frac{T\ell}{0{,}0746G\bar{\theta}}} \longrightarrow \phi \geq \sqrt[4]{\frac{22381 \cdot 120}{0{,}0746 \cdot 10^6 \cdot 0{,}01}}$$

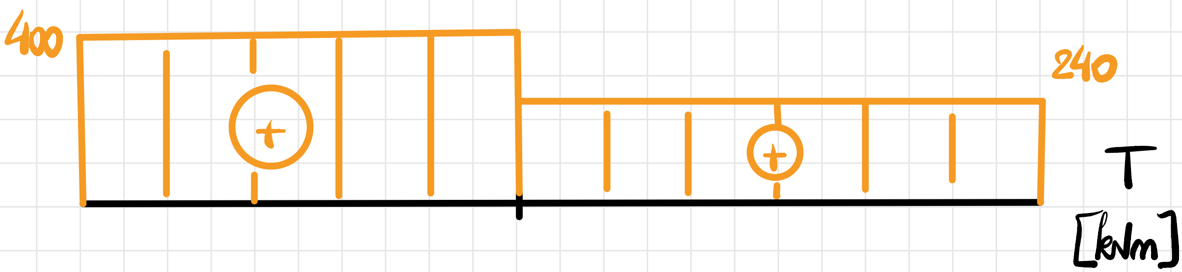
$$\phi \geq 7{,}746\,cm$$

Assim, o diâmetro mínimo é 7,75cm.

Determinar o raio da barra AC (circular, cheia) sendo $G = 70\ GPa$, $\tau_e = 150\ MPa$ e $\theta_{máx,C} = 0{,}05\ rad$ e $s = 1{,}5$.



Diagramas:



Dimensionamento:

① Tensão de cisalhamento máxima:

$$\text{máx}(\tau_{AB}, \tau_{BC}) \leq \bar{\tau}$$

$$\tau_{AB} \leq \frac{\tau_R}{S} \longrightarrow \frac{T_{AB} \cdot R}{J} \leq \frac{\tau_R}{S}$$

$$\frac{2T_{AB}}{\pi R^4} \cdot R \leq \frac{\tau_R}{S} \longrightarrow \frac{2T_{AB}}{\pi R^3} \leq \frac{\tau_R}{S}$$

$$R \geq \sqrt{\frac{2T_{AB}S}{\pi \tau_R}} \longrightarrow R \geq \sqrt{\frac{2 \cdot 400 \cdot 10^3 \cdot 1{,}5}{\pi \cdot 150 \cdot 10^6}}$$

$$\therefore \; R \geq 0{,}137\,m$$

② Giro máximo:

$$|\theta_C| \leq \theta_{máx,C} \longrightarrow |\theta_{AB} + \theta_{BC}| \leq \theta_{máx,C}$$

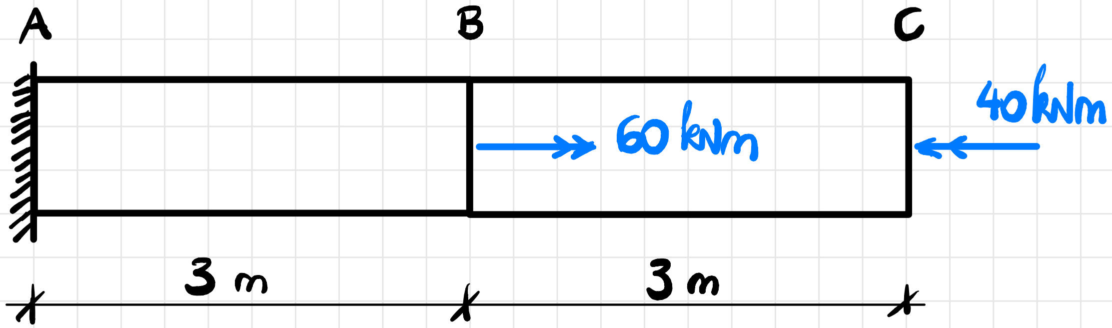
$$\left| \frac{T_{AB}\, l_{AB}}{G.J} + \frac{T_{BC}.\, l_{BC}}{G.J} \right| \leq \theta_{máx,C}$$

$$\frac{2l}{\pi G R^4} |T_{AB} + T_{BC}| \leq \theta_{máx,C} \longrightarrow R \geqslant \sqrt[4]{\frac{2l\,|T_{AB} + T_{BC}|}{\pi\, G\, \theta_{máx,C}}}$$

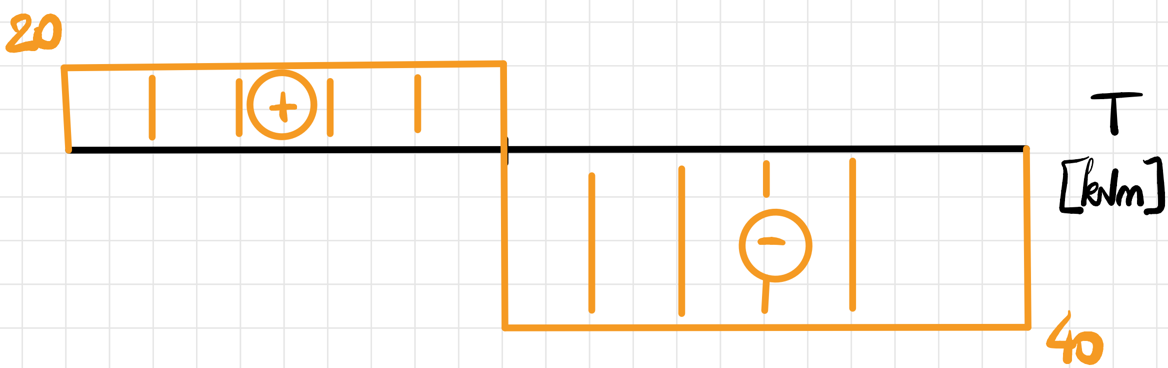
$$R \geqslant \sqrt[4]{\frac{2.5.|400+240|.10^3}{\pi.70.10^9.0{,}05}} \longrightarrow R \geqslant 0{,}155m$$

Logo $R_{min} = 0{,}155m.$

Determinar o raio da barra AC (circular, cheia) sendo $G = 80\ GPa$, $\tau_e = 160\ MPa$ e $\theta_{máx,C} = 0{,}01\ rad$ e $s = 2$.



Diagramas:



Dimensionamento:

① Tensão de cisalhamento máxima:

$$\max\left(\tau_{AB}, |\tau_{BC}|\right) \leq \bar{\tau}$$

$$|\tau_{BC}| \leq \frac{\tau_R}{S} \rightarrow \frac{|T_{BC}|}{J} \cdot R \leq \frac{\tau_R}{S}$$

$$\frac{2|T_{BC}|}{\pi R^3} \leq \frac{\tau_R}{S} \longrightarrow R \geqslant \sqrt[3]{\frac{2|T_{BC}|S}{\pi \tau_R}}$$

$$R \geqslant \sqrt[3]{\frac{2 \cdot 40 \cdot 10^3 \cdot 2}{\pi \cdot 160 \cdot 10^6}} \longrightarrow R \geqslant 0{,}0683\,m$$

② Giro máximo:

$$|\theta_C| \leqslant \theta_{máx,C} \longrightarrow |\theta_{AB} + \theta_{BC}| \leqslant \theta_{máx,C}$$

$$\left| \frac{T_{AB}\, l_{AB}}{G \cdot J} + \frac{T_{BC} \cdot l_{BC}}{G \cdot J} \right| \leqslant \theta_{máx,C}$$

$$\frac{2l}{\pi G R^4} |T_{AB} + T_{BC}| \leqslant \theta_{máx,C} \longrightarrow R \geqslant \sqrt[4]{\frac{2l\,|T_{AB} + T_{BC}|}{\pi G \theta_{máx,C}}}$$

$$R \geqslant \sqrt[4]{\frac{2 \cdot 3 \cdot |+20 - 40| \cdot 10^3}{\pi \cdot 80 \cdot 10^9 \cdot 0{,}01}} \longrightarrow R \geqslant 0{,}083\ m$$

Logo $R_{min} = 0{,}083\,m$.