Section Properties Calculations

- Inner diameter d = $D - 2t = 0.209 - 2(0.002) = 0.205$ m
- Second moment of area for hollow circular section:

$$I = \frac{\pi}{64}(D^4 - d^4)$$

- Substituting:

$$I \approx \frac{\pi}{64}(0.209^4 - 0.205^4) \approx 6.967 \times 10^{-6} m^4$$

(This is slightly larger than $I_{req} = 6.954 \times 10^{-6} m^4$)

- Cross-sectional area:

$$A = \frac{\pi}{4}(D^2 - d^2) \approx 0.00130062\, m^2$$

- Mass of beam (approx):

$$m = A \cdot L \cdot \rho = 0.00130062 \times 1.20 \times 7,850 \approx 12.25 \text{ kg}$$

<u>Check deflection with chosen section:</u>

- Using $I = 6.96693 \times 10^{-6} m^4$
- $\delta_{tip} = \frac{33{,}379.6455883}{EI} = \frac{33{,}379.6455883}{200 \times 10^9 \times 6.96693 \times 10^{-6}} \approx 0.02395578\, m = 23.96\, mm$
- Allowed deflection (2% of L) = $0.02 \times 1.20 = 0.024\, m = 24.0\, mm$