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Examples

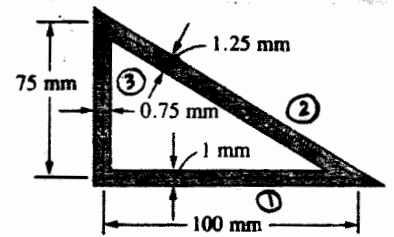
Torsion: Thin-Walled Closed Sections

Example

Given:

A thin-walled aluminum tube ($G = 28 \text{ GPa}$)
with the cross section shown

$$T = 280 \text{ N}\cdot\text{m}$$



Req'd.:

- the shear flow q
- the shearing stress in each segment
- the angle of twist per unit length

Soln.:

$$a) \quad q = \frac{T}{2A_m}$$

$$A_m = \frac{1}{2} (0.1)(0.075) = 3.75 (10)^3 \text{ m}^2$$

$$\Rightarrow q = \frac{280}{2 (3.75) (10)^3} \Rightarrow q = 37333 \text{ N/m}$$

$$b) \quad \tau = \frac{q}{t}$$

$$\Rightarrow \tau_{\text{①}} = \frac{37333}{0.001} \Rightarrow \tau_{\text{①}} = 37.33 \text{ MPa}$$

$$\tau_{\text{②}} = \frac{37333}{0.00125} \Rightarrow \tau_{\text{②}} = 29.86 \text{ MPa}$$

$$\tau_{\text{③}} = \frac{37333}{0.00075} \Rightarrow \tau_{\text{③}} = 49.78 \text{ MPa} \quad \leftarrow \tau_{\text{max}} @ t_{\text{min}}$$

$$c) \quad \frac{d\phi}{dz} = \frac{T}{4G A_m^2} \sum_{i=1}^n \frac{S_i}{t_i}$$

$$\sum_{i=1}^3 \frac{S_i}{t_i} = \frac{100}{1} + \frac{125}{1.25} + \frac{75}{0.75} = 300 \quad \leftarrow \text{note } \frac{S}{t} = \frac{\text{any unit}}{\text{same unit}}$$

$$\Rightarrow \frac{d\phi}{dz} = \frac{280 (300)}{4 (28) (10)^9 [3.75 (10)^3]^2} \Rightarrow \frac{d\phi}{dz} = 0.05333 \text{ rad/m}$$