PROBLEM 5.1 A THIN-WALLED STEEL TUBE, 1m LONG, WITH THE CROSS-SECTION SHOWN, IS TRANSMITTING A TORQUE OF 2 kN·m. THE 50·mm DIMENSIONS IS BETWEEN WALL CENTERS. FOR THE MATERIAL LET E = 210GPA AND ν = 0.29. DETERMINE (a) THE AVERAGE SHEAR STRESS IN THE WALL AND (b) THE TOTAL ANGLE OF TWIST OF THE TUBE.

GIVEN:

1. THIN WALLED CROSS-SECTION SHOWN.
2. MATERIAL PROPERTIES $E = 210GPa$, $\nu = 0.29$ $\Rightarrow G = \frac{E}{2(1+\nu)} = 81.40GPa$
3. APPLIED TORQUE 2 kN·m.
4. LENGTH OF TUBE IS 1m

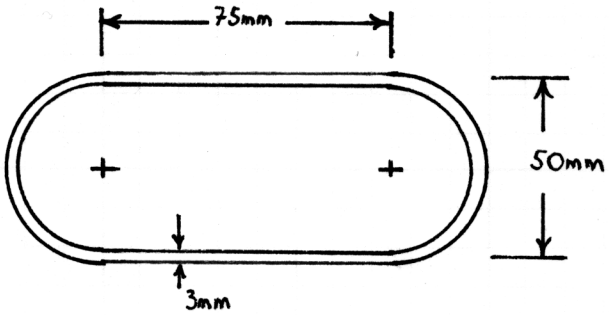
ASSUMPTIONS:

1. SMALL DEFLECTIONS
2. LINEAR-ELASTIC RESPONSE

FIND:

1. AVERAGE SHEAR STRESS IN THE WALLS
2. THE TOTAL ANGLE OF TWIST IN THE TUBE.

FIGURE:



SOLUTION:

THE AVERAGE SHEAR STRESS IS CALCULATED FROM

$$\tau = \frac{2(10^3)\,N\cdot m}{2\cdot(0.003m)\cdot[0.05m\cdot 0.075m + \pi\cdot(0.05m/2)^2]} = 58.34MPa$$

THE ANGLE OF TWIST CAN NOW BE CALCULATED.

$$\Phi = \frac{2\times10^3 N\cdot m\cdot 1m}{4\cdot[0.075m\cdot 0.05m + \pi\cdot(0.05m/2)^2]^2\cdot 81.40\times10^9\frac{N}{m^2}}\cdot\left[\frac{2\cdot\pi\cdot\left(\frac{0.05m}{2}\right) + 2\cdot 0.075m}{0.003m}\right]$$

$$= 0.0193\cdot\frac{180^\circ}{\pi} = 1.10^\circ$$

SUMMARY: THIS IS A STRAIGHT FORWARD APPLICATION OF THE THEORY PRESENTED. CARE MUST BE TAKEN IN PROPERLY INTERPRETING THE ANGLE OF TWIST CALCULATION TO BE IN RADIANS.