



SNS COLLEGE OF TECHNOLOGY
(An Autonomous Institution)
DEPARTMENT OF AEROSPACE ENGINEERING



Subject Code & Name: 19AST203 Aircraft Structural Mechanics

TOPIC: Shear flow in single and multicell under bending with walls effective

Q) Find twist of ^{cell} shell of length 50cm of Aluminium Alloy as shown in fig. Take $E = 70 \text{ GPa}$. Torque, $T = 100 \text{ kN}$

Soln:-

$$E = 70 \times 10^9 \text{ Pa}$$
$$E = 2G(1 + \nu)$$
$$\nu = 0.33 \text{ (for Al)}$$
$$70 \times 10^9 = 2G(1 + 0.33)$$
$$2.66G = 70 \times 10^9$$
$$G = \frac{70 \times 10^9}{2.66}$$
$$G = 26.9 \text{ GPa}$$

Area of

Cell ① $A_1 = \frac{\pi r^2}{2} = 245.5 \text{ cm}^2$

Cell ② $A_2 = l \times b = 25 \times 25 = 625 \text{ cm}^2$

Cell ③ $A_3 = l \times b = 25 \times 25 = 625 \text{ cm}^2$

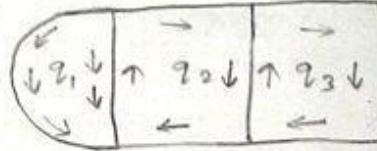
$$a_1 = \frac{S_1}{t_1} = \frac{2\pi r / 2}{t_1} = \frac{\pi (12.5)}{0.1} = 392.7$$
$$a_{12} = \frac{S_{12}}{t_{12}} = \frac{25}{0.1} = 250$$

$$a_2 = \frac{S_2}{t_2} = \frac{25}{0.2} + \frac{25}{0.2} = 250$$

$$a_{23} = \frac{S_{23}}{t_{23}} = \frac{25}{0.1} = 250$$

$$a_3 = \frac{S_3}{t_3} = \frac{25}{0.3} + \frac{25}{0.3} + \frac{25}{0.2} = 291.67$$

$$\theta = \frac{1}{2AG} \int q \frac{ds}{t}$$



for cell ①.

$$2G\theta_1 = \frac{1}{A_1} [q_1 a_1 + (q_1 - q_2) a_{12}]$$

$$= \frac{1}{245.7} [392.7q_1 + 250q_1 - 250q_2]$$

$$2G\theta_1 = 0.618q_1 - 1.018q_2 \quad \text{--- ①}$$

$$2G\theta_2 = \frac{1}{A_2} [q_2 a_2 + (q_2 - q_1) a_{12} + (q_2 - q_3) a_{23}]$$

$$= \frac{1}{625} [250q_2 + 250q_2 - 250q_1 + 250q_2 - 250q_3]$$

$$2G\theta_2 = -0.4q_1 + 1.2q_2 - 0.4q_3 \quad \text{--- ②}$$

$$2G\theta_3 = \frac{1}{A_3} [q_3 a_3 + (q_3 - q_2) a_{23}]$$

$$= \frac{1}{625} [291.67q_3 + 250q_3 - 250q_2]$$

$$2G\theta_3 = 0.8667q_3 - 0.4q_2 \quad \text{--- ③}$$

$$T = 2A_1q_1 + 2A_2q_2 + 2A_3q_3$$

$$100 \times 10^3 \times 10^2 = 2 \times 245.7 \times q_1 + 2 \times 625 \times q_2 + 2 \times 625 \times q_3$$

$$10 \times 10^6 = 490.8 q_1 + 1250 q_2 + 1250 q_3 \quad \text{--- (4)}$$

Assume $\theta_1 = \theta_2 = \theta_3 = 0$

$$\textcircled{1} = \textcircled{2}$$

$$2.618 q_1 - 1.018 q_2 = -0.4 q_1 + 1.2 q_2 - 0.4 q_3$$

$$2.618 q_1 + 0.4 q_1 - 1.018 q_2 - 1.2 q_2 + 0.4 q_3 = 0$$

$$3.018 q_1 - 2.218 q_2 + 0.4 q_3 = 0 \quad \text{--- (5)}$$

$$\textcircled{2} = \textcircled{3}$$

$$-0.4 q_1 + 1.2 q_2 - 0.4 q_3 = 0.866 q_3 - 0.4 q_2$$

$$-0.4 q_1 + 1.2 q_2 + 0.4 q_2 - 0.4 q_3 - 0.866 q_3 = 0$$

$$-0.4 q_1 + 1.6 q_2 - 1.266 q_3 = 0 \quad \text{--- (6)}$$

Solve (4), (5), (6)

(4) & (5),

$$490.8 q_1 + 1250 q_2 + 1250 q_3 = 10 \times 10^6 \quad \text{---}$$

