

## Thin Cylinders – Tutorial

1. Show that the circumferential stress in a spherical vessel of diameter  $D$  and thickness  $t$  subjected to internal pressure  $p$  is given by:

$$\sigma_{\theta} = \frac{pD}{4t}$$

A spherical pressure vessel, 3 m diameter and 15 mm thick, is made from steel plate having Young's modulus  $207 \text{ GN/m}^2$  and Poisson's ratio 0.28.

If a strain gauge is attached to the surface of the vessel, what value of strain will it record when the vessel is subjected to internal pressure  $4 \text{ MN/m}^2$ .

[ 695 microstrain ]

2. An alloy steel cylindrical pressure vessel, 5 m diameter and 20 mm thick, has strain gauges attached to its outer surface in the longitudinal and circumferential directions.

When the cylinder is subjected to internal pressure it is observed that the circumferential strain readings are four times the longitudinal values.

Determine the value of the Poisson's ratio for the material.

Taking the value of Young's modulus as  $207 \text{ GN/m}^2$ , determine the value of internal pressure which will result in a longitudinal strain of 150 microstrain.

[ 0.286,  $1.16 \text{ MN/m}^2$  ]

3. A thin cylinder, 200 mm diameter, 500 mm long and 3 mm thick, is made from aluminium alloy having  $E = 69 \text{ GN/m}^2$  and  $\nu = 0.32$ .

It is constrained at its ends to prevent any change in length when pressurized.

If the cylinder is subjected to an internal pressure of  $1.8 \text{ MN/m}^2$  determine:

- i) the circumferential and longitudinal stresses;
- ii) the change in diameter.

[  $60 \text{ MN/m}^2$ ,  $19.2 \text{ MN/m}^2$  0.156 mm ]

4. Show that the change of capacity of a thin cylinder subjected to internal pressure is given by:

$$\delta V = V( 2\varepsilon_{\theta} + \varepsilon_L )$$

where  $V$  is the initial capacity (enclosed volume).

Hint: determine separately:

- i) the change of capacity due to the change of diameter assuming no change in length;
  - ii) the change of capacity due to the change of length assuming the diameter remains unchanged;
- and combine the two results.