THIN WALL CYLINDER

1. OBJECTIVE:

1. To study the stress and strain developed in a thin wall cylinder under internal pressure.
2. To determine the Poisson's ratio (ν) and the Young's modulus of elasticity (E) for the cylinder material.

2. APPARATUS:

Fig. 1 shows a thin walled cylinder of aluminum containing a freely supported piston. The piston can move in or out to alter the end conditions by use of the adjustment screw. A pressure gauge fits onto the cylinder. Six strain gauges are positioned onto the cylinder at different angels to measure the strain.(see fig.2) The apparatus is connected to P.C. so that all readings of the stain gauges can be taken out from the computer. Cylinder contains way of relieving cylinder of all longitudinal stress (open end condition).

3. THEORY:

In a thin cylinder, where the ratio of wall thickness to internal diameter is less than about (1/20), the value of stress may be assumed to be constant throughout the wall thickness, so the radial stress will be ignored.

The two principal stresses, circumferential (hoop) and longitudinal see (fig. 3) will be given by the following equations:

$$\sigma_H = \frac{pd}{2t} \quad \text{and} \quad \sigma_L = \frac{pd}{4t}$$

$$\varepsilon_H = \frac{\sigma_H}{E} - \upsilon \frac{\sigma_L}{E}$$

$$\varepsilon_L = \frac{\sigma_L}{E} - \upsilon \frac{\sigma_H}{E}$$

For open end conditions ($\sigma_L = 0$)

$$\varepsilon_H = \frac{\sigma_H}{E} \quad \text{and} \quad \varepsilon_L = -\upsilon \frac{\sigma_H}{E}$$

$$\upsilon = \frac{-\varepsilon_L}{\varepsilon_H}$$

4. PROCEDURE:

I:YOUNG'S MODULUSE EXPERIMENT:

1. Verify the open end condition:
    a- Return valve shall be fully unscrewed.
    b- Screw the adjustment screw until it reaches the stop.
2. From the main menu select experiments, then select Young's modulus.
3. From the tools menu select calibrate, this will set zero to all the transducers.
4. Close the return valve; take reading at no pressure by pressing F5.
5. Increase the pressure slowly (using the hand pump), then take readings with F5 every 0.5 MPa steps.

Π:POISSON'S RATIO EXPERIMENT:

1. Repeat steps 1 to 4.
2. Increase the pressure using the hand pump to 3 Mpa.
3. Press F5 to store the strain gauge and pressure readings.
4. Fill the results into tables 1 and 2.

5. RESULTS:

I:YOUNG'S MODULUSE EXPERIMENT:

Cylinder pressure (MN/m^2)	Hoop stress σ_H (MN/m^2)	Measured hoop strain ε_H ($\mu\varepsilon$)	
		Gauge No. 1	Gauge No. 6

Π:POISSON'S RATIO EXPERIMENT:

P= MN/m^2

Gauge No.	Actual strain ($\mu\varepsilon$)	Theoretical strain ($\mu\varepsilon$)	Error
1			
2			
3			
4			
5			
6			

6. ANALYSIS:

1. Plot the hoop stress σ_H against the hoop strain ε_H

Where: $$\sigma_H = \frac{pd}{2t}$$ and $$\varepsilon_H = \frac{\varepsilon_{gage1} + \varepsilon_{gage6}}{2}$$

2. Determine the modulus of elasticity (E) from the above graph and compare your results with the theoretical value.

3. Calculate the Poisson's ratio for open end conditions using the following equation.

$$\upsilon = \frac{-\varepsilon_{L1}}{\varepsilon_{H1}}$$

Where ε_{L1} = Actual strain reading of gauge 2.
ε_{H1} = Average actual strain readings of gauges 1&6.

4. Calculate the theoretical principal hoop and longitudinal strains for Poisson's experiment and compare your results with the experimental values.