

## FL 140

### Stress and strain analysis on a thick-walled cylinder



#### Description

- **direct stresses and strains of a thick cylinder under internal pressure**
- **cylinder with strain gauge application on surface and in wall**
- **triaxial stress state in cylinder wall**

In contrast to thin-walled vessels, when designing thick-walled vessels allowance must be made for an uneven distribution of stresses through the thickness of the wall. The stress state in a thick-walled vessel under internal pressure is triaxial. The direct stresses and strains occur: radial, circumferential, hoop and axial.

Since the stresses and strains occurring in a vessel are not measured directly, they are determined by measuring strains on the surface. Strain gauges are employed to record the strains electrically and the stresses and strains are determined from those measurements.

The FL 140 experimental unit is used to investigate direct stresses and strains occurring on a thick-walled cylinder subjected to internal pressure. The oil-filled cylinder is made up of two halves, and is sealed on both sides. Internal pressure is generated inside the vessel with a hydraulic pump.

A pressure gauge indicates the internal pressure. An eccentric groove is cut between the two halves of the cylinder, in which the strain gauges are mounted at various radial points. Additional strain gauges are mounted on the inner and outer surfaces of the cylinder. Radial, hoop and axial strains are measured, enabling the strain state to be fully recorded.

The measuring amplifier FL 152 displays the recorded signals as measured value readouts. To assist and visualise evaluation of the experiment, the measured values can be imported into the application software.

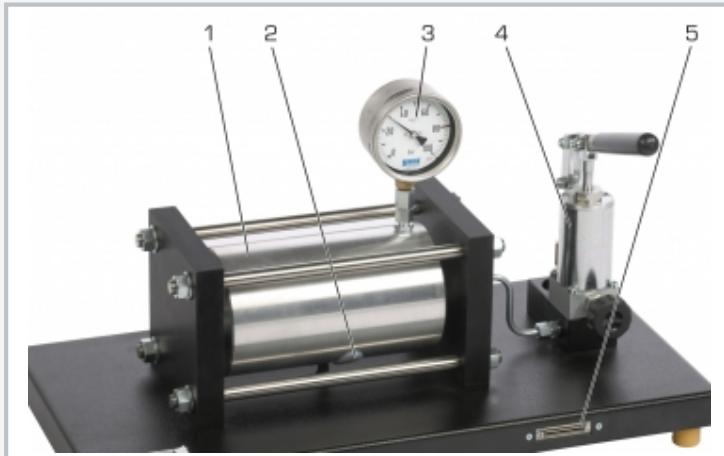
Mohr's circle for stress and strain analysis is used to represent the triaxial stress state in the cylinder wall graphically. The direct stresses and strains are calculated from the measured strains, applying the appropriate law of elasticity.

#### Learning objectives/experiments

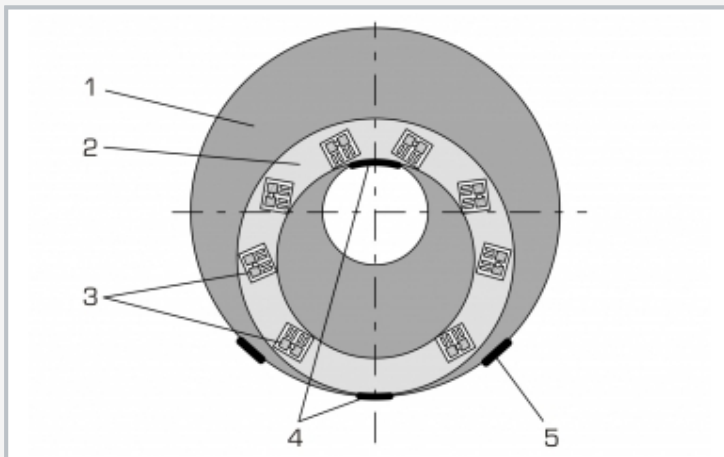
- measurement of elongations by strain gauges
- application of Mohr's circle for the triaxial stress state
- determination of the distribution of direct stress in
  - ▶ radial, tangential and axial direction
- investigation of correlations between elongation, pressure and stress in the triaxial stress state

# FL 140

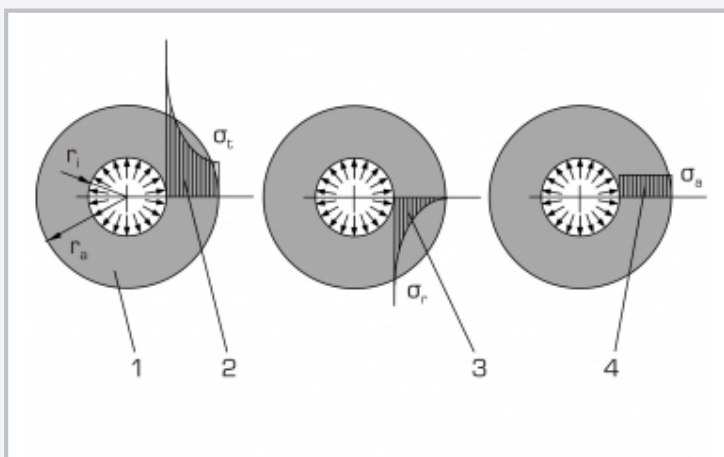
## Stress and strain analysis on a thick-walled cylinder



1 cylinder, 2 strain gauge measuring point, 3 pressure gauge, 4 hydraulic pump, 5 connection for measuring amplifier FL 152



Strain gauge layout in cylinder wall and on the surface:  
1 cylinder, 2 eccentric groove, 3 strain gauge measuring point, radial/hoop, 4 strain gauge measuring point, hoop, 5 strain gauge measuring point, axial



Distribution of stress in cylinder wall: 1 cylinder,  $r_i$  inner radius,  $r_o$  outer radius, 2 distribution of stress in hoop direction  $\sigma_t$ , 3 distribution of stress in radial direction  $\sigma_r$ , 4 distribution of stress in axial direction  $\sigma_a$

### Specification

- [1] investigation of the stresses and strains in a thick-walled cylinder under internal pressure
- [2] two-part cylinder with flat groove
- [3] strain gauge application at various radial points in the groove and on the cylinder surface
- [4] hermetically sealed hydraulic system, maintenance-free to generate pressure
- [5] hydraulic system with hydraulic pump and manometer
- [6] FL 152 measuring amplifier required
- [7] software for analysing measured values in FL 152

### Technical data

#### Aluminium cylinder

- length: 300mm
- diameter:  $\varnothing=140\text{mm}$
- wall thickness: 50mm
- internal pressure: max.  $7\text{N/mm}^2$  (70bar)

#### Strain gauge application

- 11 strain gauges: half-bridges, 350 Ohm
- gauge factor:  $2,00 \pm 1\%$
- supply voltage: 10V

#### Pressure gauge

- 0...100bar
- accuracy: class 1,0

LxWxH: 700x350x330mm

Weight: approx. 32kg

### Scope of delivery

- 1 experimental unit
- 1 set of instructional material

## FL 140

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#### Required accessories

021.15200      FL 152      Multi-channel measuring amplifier

#### Optional accessories

020.30009      WP 300.09      Laboratory trolley