Technical Description

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 cylinder and 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 measurement amplifier FL 151 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 equation of elasticity.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

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 cylinder with hydraulic pump, 5 connection for measurement amplifier FL 151

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 \( \sigma_r \), 3 distribution of stress in radial direction \( \sigma_\theta \), 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. Hydraulic cylinder with hydraulic pump to generate pressure  
5. Hermetically sealed hydraulic system, maintenance-free  
6. Multi-pin connector for measurement amplifier FL 151 provided

### Technical Data

**Aluminium cylinder**  
- Length: 300 mm  
- Diameter: \( d=140 \) mm  
- Wall thickness: 50 mm  
- Internal pressure: max. 7 N/mm² (70 bar)

**Strain gauge application**  
- 11 strain gauges: half-bridges, 350 Ohm  
- Gauge factor: 2.00 +/- 1%  
- Supply voltage: 10 V

**Pressure gauge:** 0...100 bar, accuracy: class 1.0

### Dimensions and Weight

**LxWxH:** 700x350x330 mm  
**Weight:** approx. 32 kg

### Scope of Delivery

1 experimental unit  
1 set of instructional material

### Order Details

021.14000 FL 140 Stress and Strain Analysis on a Thick-Walled Cylinder

G.U.N.T Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Phone +49 (40) 67 08 54-0, Fax +49 (40) 67 08 54-42, E-mail sales@gunt.de, Web http://www.gunt.de

We reserve the right to modify our products without any notifications.
**FL 140**  
**Stress and Strain Analysis on a Thick-Walled Cylinder**

Available accessories and options:

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>021.15100</td>
<td>FL 151 Multi-channel measurement amplifier</td>
</tr>
</tbody>
</table>