

WP 130

Verification of stress hypotheses



Learning objectives/experiments

- generation of multi-axial loads on test samples made of ductile metals:
 - ▶ steel, copper, brass, aluminium
- generation of various load moments
 - ▶ pure bending moment
 - ▶ pure twisting moment
 - ▶ combined bending moment and twisting moment
- determination of the yield point
- verification of the Rankine yield criterion
- verification of the Tresca yield criterion
- representation in Mohr's circle of stresses and strains

Description

- **verification of the Rankine yield criterion and the Tresca yield criterion**
- **multi-axial loads of test specimens made of ductile metals by pure bending, pure torsion or a combination of the two**
- **loading of the test specimen without shear force by compensation for the influence of dead-load**

Stress hypotheses are applied in the science of the strength of materials when calculating comparative stresses where unequal stresses are combined.

The following stress hypotheses, taking into account material properties, have been tried and proven in practice: Rankine yield criterion (direct stress hypothesis), von Mises yield criterion (change of shape hypothesis) and Tresca yield criterion (shear stress hypothesis).

The experimental unit WP 130 is used to verify these comparative stress hypotheses on test specimens made of various metals. For the purpose, a multi-axial stress state is produced at a point on the specimen and the resulting deformation is measured.

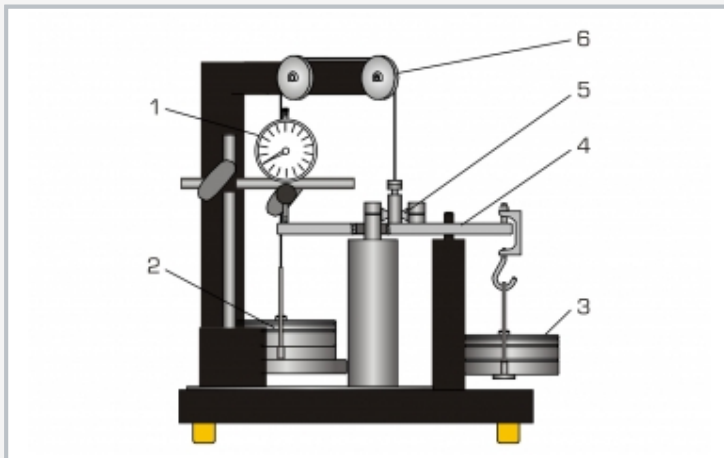
The specimen is clamped on one end to the fixed frame. A loading plate is clamped to the specimen on the other end. A weight is attached on the outer circumference of the plate. A balance weight compensates for the dead-load of the plate and the applied weight. As a result only direct and shearing stress occur at a point on the test specimen and shear forces are avoided.

The loading plate has a graduation grid enabling weights to be attached at 15° increments. This permits purely bending moment and twisting as well as combined load moments to be achieved. Diametrically opposite the weight, measuring points are provided on the loading plate to measure the deformation. This enables the deformation at the point of maximum deflection to be measured.

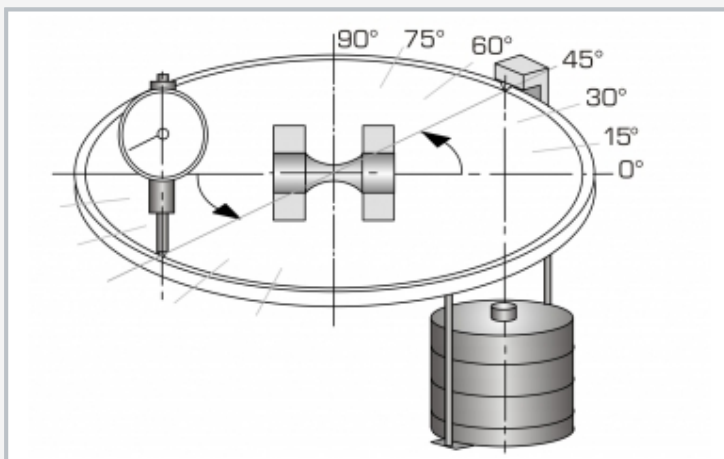
The various elements of the experiment are clearly laid-out and housed securely in a storage system.

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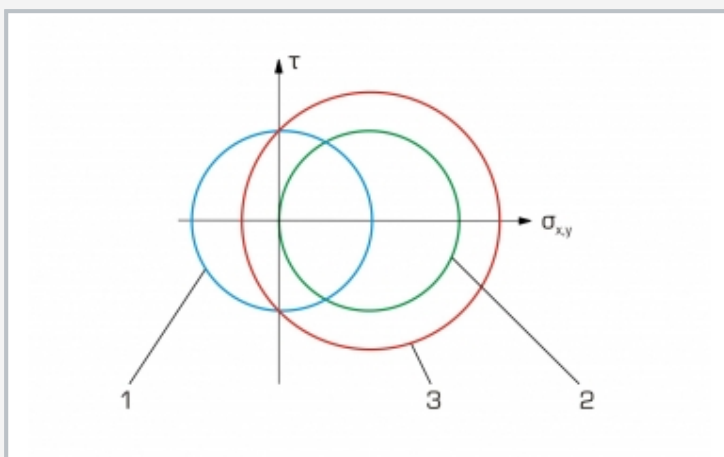
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1 dial gauge, 2 balance weight, 3 weight, 4 loading plate, 5 test specimen in clamps, 6 deflection roller and cable to compensate for the dead-load of the plate



Clamped specimen: 0° = pure bending, 90° = pure torsion, all angle settings between = combined loading



Mohr's circles for combined loading: bending with simultaneous torsion; 1 pure torsion, pure bending, 3 bending and torsion together; σ direct stresses, τ shear stresses

Specification

- [1] experiments verifying comparative stress hypotheses from the science of the strength of materials
- [2] 7 different load combinations of bending and torsion
- [3] loading of the test specimen without shear force by compensation for the influence of dead-load
- [4] test specimens made of steel, copper, brass, aluminium
- [5] generation of load moments by means of weight and lever arm
- [6] measurement of the deformation at the point of maximum deflection
- [7] storage system to house the components

Technical data

Specimens

- length: 49mm
- clamping length: 11,5mm
- specimen diameter in measuring cross-section: $\varnothing = 4\text{mm}$

Weights to place load on specimens

- 1x 2N (hanger), 1x 1N, 1x 2N, 1x 4N, 2x 8N

Weights to compensate for the load and the loading plate

- 1x1N, 2x2N, 1x4N, 2x8N

Lever arm: 100mm

Deformation

- measuring range: 0...10mm
- graduation: 0,01mm

LxWxH: 390x330x360mm

Weight: approx. 17kg

LxWxH: 720x480x178mm (storage system)

Weight: approx. 10kg (storage system)

Scope of delivery

- 1 experimental unit
- 16 round test specimens (4x St, 4x Cu, 4x Al, 4x brass)
- 1 set of weights (loading)
- 1 set of weights (compensation)
- 1 hexagon socket wrench
- 1 storage system with foam inlay
- 1 set of instructional material

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Optional accessories

020.13001	WP 130.01	Set of 4 Specimens Alum., Copper, Steel Brass, 1 each
020.13021	WP 130.21	Set of 4 Specimens Aluminum
020.13022	WP 130.22	Set of 4 Specimens Copper
020.13023	WP 130.23	Set of 4 Specimens Steel
020.13024	WP 130.24	Set of 4 Specimens Brass
020.30009	WP 300.09	Laboratory trolley