

# WP 120

## Buckling behaviour of bars



### Learning objectives/experiments

- investigation of buckling behaviour under the influence of
  - ▶ different supports and clamps
  - ▶ different bar lengths and cross-sections
  - ▶ different materials
  - ▶ additional lateral load
- testing Euler's theory: buckling on elastic bars
- calculating the expected buckling force with Euler's formula
- graphical analysis of the deflection and the force
- determine elastic modulus for an unknown material (GFRP)
- measure force and deflection
- with the WP 120.01 expansion set investigation of buckling behaviour under the influence of
  - ▶ different cross-section shapes
  - ▶ eccentric application of force

### Description

- investigation of all relevant buckling problems
- verification of Euler's theory of buckling
- experiments with eccentric application of force and lateral load

In engineering mechanics, loss of stability is known as buckling. The bar axis laterally deflects under the effect of compressive forces and with increasing load until it suddenly and violently fails, just before the fracture strength is reached. The stresses in the bar are often still in the elastic region.

WP 120 investigates the buckling behaviour of bars under different influences. All relevant buckling problems are demonstrated in experiments.

In this experiment, a bar is clamped or supported at both ends in the experimental unit, depending on the buckling case. A height-adjustable loading member and a hand-operated spindle are used to apply a compressive force to the bar. An axial support between the spindle and bar support prevents torsional stress on the test bar. The applied force is hydraulically measured and displayed on a force gauge. A dial gauge indicates the lateral deflection of the bar.

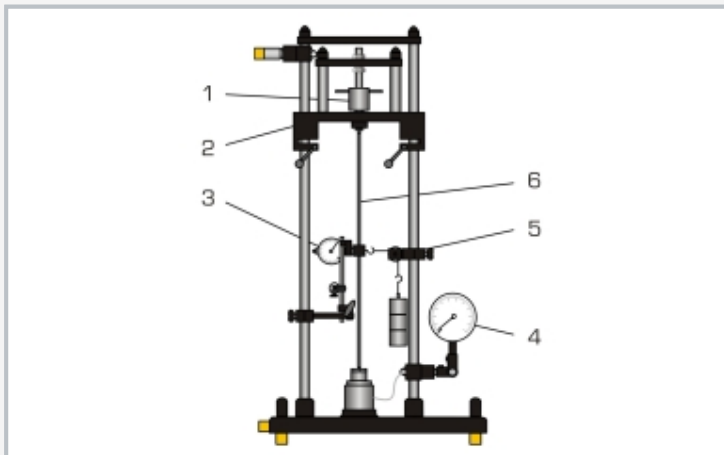
Experiments demonstrate how various factors such as bar length, material and support type affect the buckling behaviour. Additional shear forces can be generated on the test bar by means of a lateral load mechanism.

The experiments can be conducted in a vertical or horizontal position; the force gauge can be rotated by 90°.

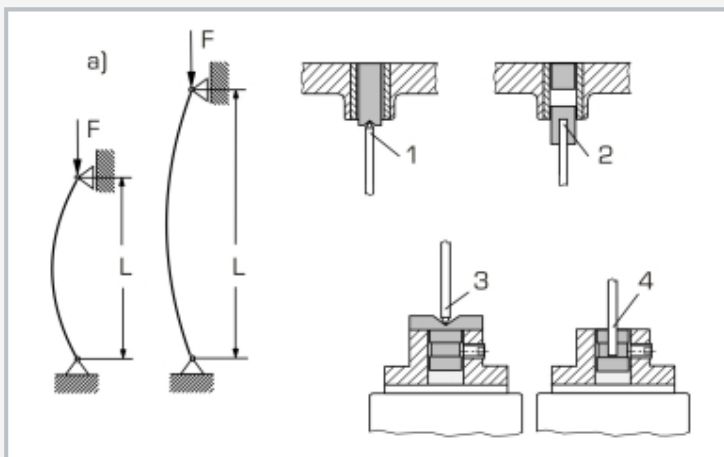
An expansion set with sample bars expands the scope of experiments that can be conducted with WP 120. The parts of the experiment are clearly laid out and securely housed in a storage system.

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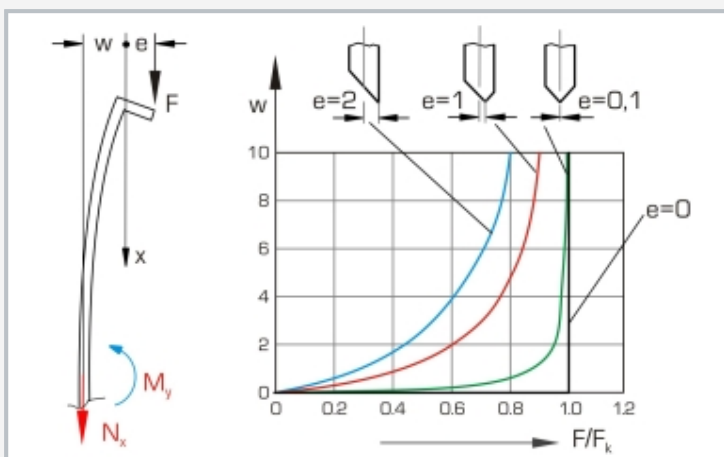
## Buckling behaviour of bars



1 spindle, 2 height-adjustable load member, 3 dial gauge for lateral deflection of the test bar, 4 dynamometer, 5 mechanism for generating a lateral load, 6 test bar



a) experiment on how bar length affects the buckling behaviour:  $F$  applied force,  $L$  bar length; 1 top movable support, 2 top clamp, 3 bottom movable support, 4 bottom clamp



Experiment with eccentric application of force (WP 120.01):  
 $F$  applied force,  $e$  eccentricity,  $w$  deflection,  $M_y$  bending moment,  $F/F_k$  compressive force based on critical compressive force; diagram: deflection of the test bar for varying eccentricity

### Specification

- [1] investigation of all relevant buckling cases
- [2] verification of Euler's theory of buckling
- [3] experiments in the horizontal or vertical position
- [4] test bars with different lengths made of different materials
- [5] test bars pinned or fixed
- [6] spindle for applying forces
- [7] lateral load mechanism generates shear forces
- [8] force measurement using a hydraulic dynamometer
- [9] measurement of lateral deflection with a dial gauge
- [10] further experiments with WP 120.01 expansion set
- [11] storage system for parts

### Technical data

#### Test bars

- quantity: 11
- bar lengths: 350...700mm (max.)
- materials: aluminium, copper, brass, steel, GFRP
- cross-sections: 20x4mm, 25x6mm, 25x10mm

#### Load spindle

- force: max. 2000N
- stroke: max. 10mm
- Lateral deflection: max. 20mm
- Sample holder hole diameter:  $\varnothing$  20mm

#### Weight for lateral load: max. 20N

- 1x 5N (hanger), 3x 5N

#### Measuring ranges

- force: 0...2500N, graduation: 50N
- deflection: 0...20mm, graduation: 0,01mm

LxWxH: 620x450x1150mm

Weight: approx. 63kg

LxWxH: 1170x480x178mm (storage system)

Weight: approx. 12kg (storage system)

### Scope of delivery

- 1 experimental unit
- 1 set of specimens
- 1 set of measuring instruments
- 1 storage system with foam inlay
- 1 set of instructional material

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Optional accessories

WP 120.01	Set of 10 test bars
WP 300.09	Laboratory trolley