

# SE 110.16

## Parabolic arch



The illustration shows SE 110.16 in the frame SE 112

### Description

- **statically determinate or statically indeterminate parabolic arch under load**
- **deformations of the arch under load**
- **bearing reactions of the arch**

Parabolic arches are popular elements in construction engineering. They can be employed as bridges or beams for example. Normally these bridges are statically indeterminate. The special feature of the parabolic arch is that in the arch only normal forces and bending moments occur, but no shear forces. That is the case when the arch is subjected to a uniform distributed load and both ends are mounted in fixed supports. This enables arches to be constructed from loosely set stones – a construction technique which has been in existence for many centuries. Loads acting upon the inner of the arch are primarily compressive forces in the direction of the normal force at every point of the arch.

SE 110.16 includes a pre-shaped parabolic arch. It can be subjected to point or distributed loads. It is possible to suspend an elastic roadway and load it.

One of the arch's bearings is fixed, the other is horizontally movable. Weights are used to undo this movement. The floating bearing thus becomes a fixed bearing. Additional weights compensate for the vertical bearing reaction.

Dial gauges record the deflection of the arch under load and the horizontal displacement of the floating bearings. As long as the floating bearing is movable, the arch is statically determinate, though it is substantially deformed under load. As soon as the floating bearing becomes immovable, the arch is no longer statically determinate and is deformed only to a minor degree.

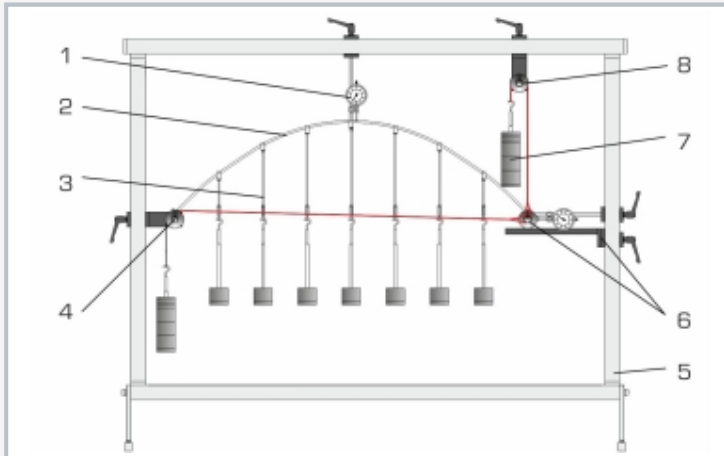
All the component elements of the experiment are clearly laid-out and housed securely in a storage system. The complete experimental setup is arranged in the frame SE 112.

### Learning objectives/experiments

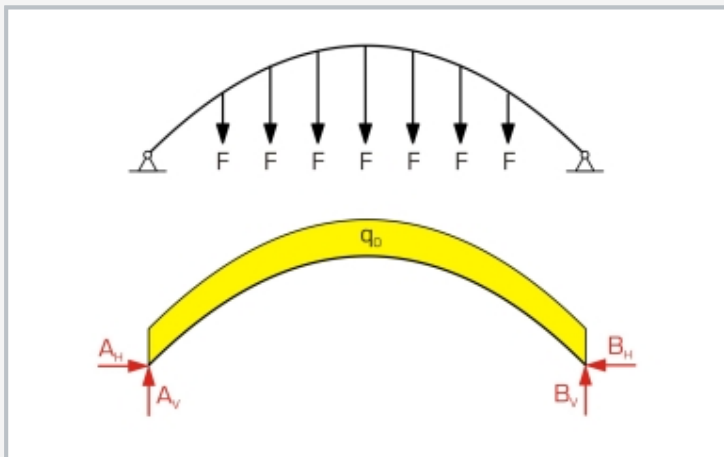
- mechanical principles of the parabolic arch
- differences between statically determinate and statically indeterminate arches
- measurement of the deformations of the arch under load
- measurement of the bearing reactions on the statically indeterminate arch under load
- calculation of the bearing reactions
- influence of load on reaction forces and deformation of the arch
  - ▶ point load
  - ▶ distributed load
  - ▶ suspended elastic roadway under load

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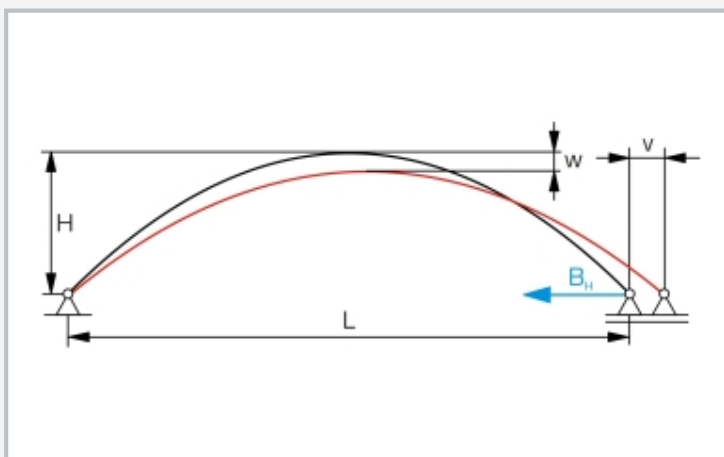
## Parabolic arch



1 dial gauge, 2 arch, 3 shackle, 4 fixed bearing, 5 frame SE 112, 6 floating bearing with support plate, 7 weight, 8 deflection roller, red: cable; not shown: elastic roadway



Top: forces on the statically indeterminate parabolic arch, bottom: free-body diagram with distributed load  $q_0$  in yellow (generated from evenly distributed point loads  $F$ ) and bearing reactions  $F_A + F_B$  in red



Deformation of the statically determinate arch under distributed load:  $L$  length,  $H$  height,  $w$  deflection,  $v$  horizontal displacement on the floating bearing; black arch without load

### Specification

- [1] investigation of a parabolic arch, optionally statically determinate (1 fixed bearing, 1 floating bearing) or indeterminate (2 fixed bearings)
- [2] loading of the arch with a distributed load by way of 7 evenly distributed loads or by point loads or by suspended roadway with loads
- [3] 2 dial gauges record the deformation of the arch under load
- [4] weights to compensate for the reactions of a fixed bearing
- [5] roadway with 1 set of shackles to be suspended into the arch; shackles in graduated length
- [6] storage system to house the components
- [7] experimental setup in frame SE 112

### Technical data

Parabolically pre-shaped steel arch

- length: 1000mm
- height: 280mm
- cross-section: 20x6mm

Roadway made of PVC

- dead-weight: approx. 2,6N
- LxWxH: 900x70x3mm

Dial gauge

- measuring range: 0...25mm
- graduation: 0,01mm

Weights

- 11x 1N (7+4 hanger)
- 7x 1N (shackle)
- 36x 1N
- 19x 5N

LxWxH: 1170x480x178mm (storage system)

Weight: approx. 38kg (total)

### Required for operation

Mounting frame SE 112

### Scope of delivery

- 1 arch with 7 shackles + 7 hangers
- 1 roadway with shackles
- 1 set of weights
- 2 deflection rollers with fixture
- 1 bearing
- 2 dial gauges
- 1 storage system with foam inlay
- 1 set of instructional material

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### Required accessories

SE 112                    Mounting frame

### Optional accessories

SE 110.30              Dial gauges