

# CE 210

## Flow of bulk solids from silos



### Description

- adjustable silo geometry
- different types of discharge: mass flow, funnel flow and arching

Silos are used for the large-scale storage of a wide variety of bulk solids. The stored bulk solids are then seamlessly supplied to production processes. To achieve this goal, the silo has to be designed as a mass flow silo.

The CE 210 trainer provides a practical demonstration of the types of discharge from different silos: mass flow, funnel flow and arching. The type of discharge that occurs is dependent on the flow properties of the bulk solids, the silo geometry and the wall material.

The trainer includes two identically shaped silos with transparent front walls and different wall materials. The silos have a wedge-shaped discharge hopper whose inclination and width are adjustable. The trainer has been developed in conjunction with **Professor Dr. Schulze (University of Applied Sciences Braunschweig / Wolfenbüttel)**.

The outflow behaviour is characterised by the measured time, the weight of the bulk solids, the silo geometry and the observed discharge type. The acquired data can also be used to review silo design in practice.

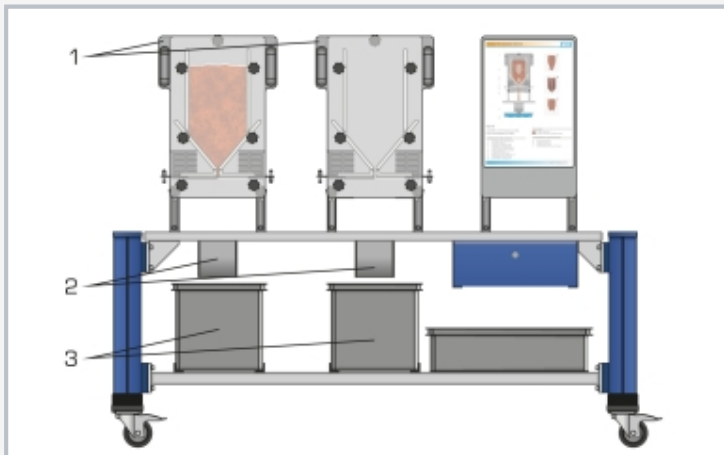
Flour (German type 405) is recommended as additional bulk solid for the experiments with arching.

### Learning objectives/experiments

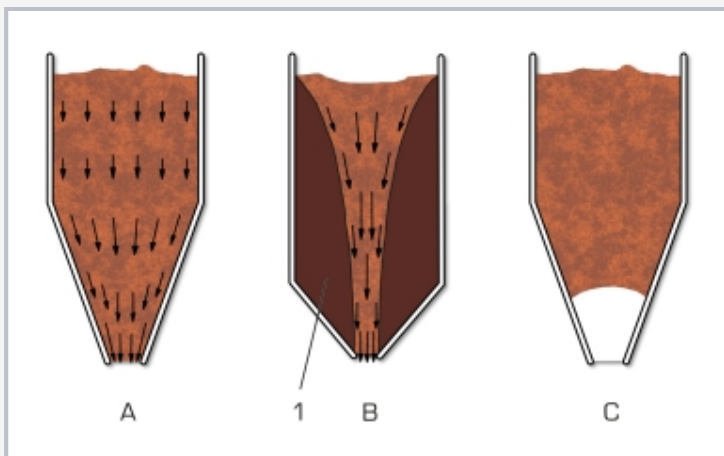
- how wall material and inclination of the hopper walls affect the outflow time
- demonstrate typical discharge types in silos:
  - ▶ mass flow
  - ▶ funnel flow
  - ▶ arching
- how flow properties affect outflow time and flow profiles
- comparison of different bulk solids
- review of the silo design

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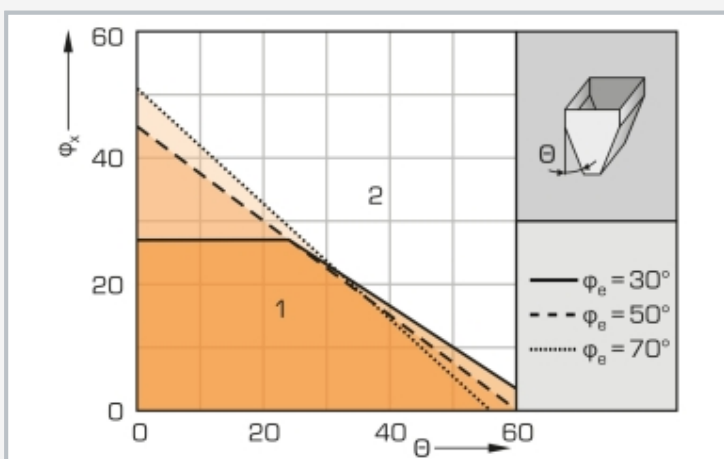
## Flow of bulk solids from silos



1 silo, 2 hopper, 3 collecting tank



A mass flow: all bulk solids are in motion  
 B funnel flow: the bulk solids in the centre are in motion, the bulk solids in dead zones (1) are at rest  
 C arching: the flow of bulk solid comes to a standstill



Design diagram of a wedge-shaped silo for different effective friction angle  $\phi_e$   
 1 mass flow, 2 funnel flow;  $\phi_e$  wall friction angle,  $\theta$  inclination of the discharge hopper

### Specification

- [1] investigation of the outflow of bulk solids from silos with wedge-shaped discharge hoppers
- [2] demonstration of arching, mass flow and funnel flow with different bulk solids
- [3] two silos with different hopper wall materials
- [4] front walls of the silo made of transparent material
- [5] silos can be removed for cleaning
- [6] angle of the hopper wall adjustable while retaining constant outlet cross-section
- [7] tamper for compacting the bulk solids
- [8] stopwatch for determining outflow times

### Technical data

- 2 silos with wedge-shaped hopper
- base body cross-section: 200x200mm
  - wide outlet 10...70mm
  - height of silo section: approx 300mm
  - height of hopper: approx. 50...140mm
  - volumes: approx. 14...18L

- 2 bulk solids
- plastic granulate: 2...5mm
  - spelt husks: 5...15mm

- Balance
- with tare function
  - up to 10kg
  - power supply: 230V, 50Hz, 1 phase;  
120V, 60Hz, 1 phase; UL/CSA optional

- Stopwatch
- 0...10h

LxWxH: 1830x790x1420mm  
 Weight: approx. 190kg

### Required for operation

- 1 other bulk solid (e.g. flour of German type 405)

### Scope of delivery

- 1 trainer
- 1 storage system
- 2 collecting tanks with lid
- 1 balance
- 1 packing unit of plastic granulate (20L)
- 1 packing unit of spelt husks (24L)
- 1 set of accessories
- 1 set of instructional material