

CE 200

Flow properties of bulk solids



Description

- **determination of the flow properties of bulk solids using a ring shear tester for the design of silos**
- **easy handling based on unlimited shear travel**
- **professional evaluation software**

The flow properties of a powder or bulk solid determine how it behaves during handling. For example, material may flow irregularly out of silos, or the flow of bulk solid may come to a stop. In order to avoid these problems in practice, silos can be designed on the basis of measurements using shear testers, such as the Jenike shear tester or a ring shear tester.

In a ring shear tester, a bulk sample is contained in a ring-shaped shear cell. A normal force is exerted on the sample by way of a lid. A hanger from which a variable weight is suspended generates this normal force. A motor moves the shear cell relative to the lid in order to apply shear to the sample. For compaction (pre-shearing) the sample is subjected to a large normal force. An electronically amplified force transducer measures the shear forces which are then recorded by data acquisition software over time.

After pre-shearing, shearing to failure is executed with a reduced normal force (strength measurement) and likewise recorded by the software. From the shear force characteristics, properties such as the compressive strength and internal friction of the bulk solid can be determined. To determine the density of the bulk solid, the volume of the bulk sample is ascertained by recording the lowering of the lid using a vernier caliper gauge. So as to also take into account the influence of the hopper wall material on the outflow behaviour, a separate measurement is performed with a ring-shaped sample of the wall material.

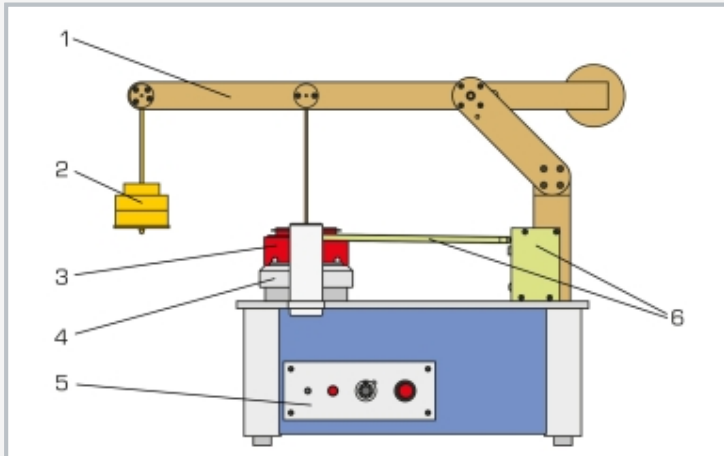
An evaluation software is available to determine the flow properties from the experimental results. The flow properties identified are used to determine the optimum geometry of a silo's discharge hopper. Trainer CE 210 is provided for practical verification of the design results obtained in terms of mass flow/funnel flow. The ring shear tester and the evaluation software were developed by **Prof. Dr. Schulze (from Braunschweig / Wolfenbüttel University of Applied Sciences)**.

Learning objectives/experiments

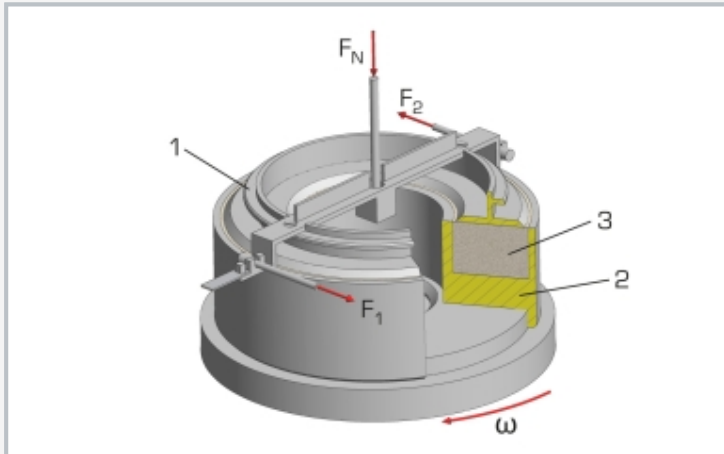
- recording the shear force characteristics of bulk solids
- yield locus and wall yield locus design
- determination of flow properties
 - ▶ compressive strength
 - ▶ internal friction
 - ▶ density
 - ▶ wall friction angle
- determination of the optimum hopper geometry of a bulk solids silo

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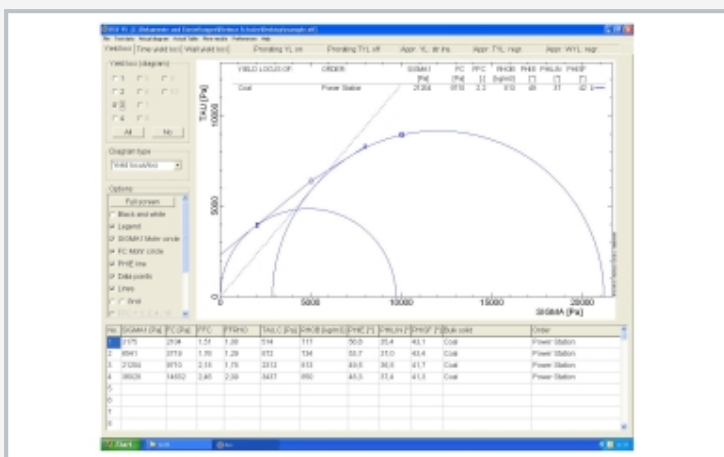
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1 loading system for generation of normal force, 2 weights, 3 shear cell, 4 drive unit, 5 controls, 6 force sensor (shear force) with tie rod



Shear cell for determination of yield loci: 1 lid, 2 shear cell, 3 bulk solid; F_1, F_2 shear forces, F_N normal force, ω direction of rotation of shear cell



Screenshot from evaluation software: yield locus with Mohr's circles

Specification

- [1] design of bulk solids silos using a ring shear tester
- [2] 1 ring-shaped shear cell to determine yield loci
- [3] 1 ring-shaped shear cell with sample of wall material to determine wall yield loci
- [4] shearing of the bulk solid sample by motor rotation of the shear cell
- [5] vertical loading of the sample via ring-shaped lid with weights
- [6] force sensor to measure the shear forces
- [7] vernier caliper gauge to measure the change in height and density of the bulk sample
- [8] GUNT software for data acquisition via USB under Windows 10
- [9] GUNT software to record the shear force characteristics
- [10] evaluation software to determine the relevant bulk solid parameters

Technical data

Shear cell

- sample volume: approx. 70cm³
- material: aluminium

Shear cell with sample of wall material

- sample volume: approx. 15cm³
- material: aluminium

Motor

- power consumption: max. 75W
- speed: 500...3000min⁻¹

1 set of weights

- 4x 500g
- 2x 200g
- 2x 100g
- 2x 50g

Measuring ranges

- force: 0...40N
- balance: 0...1000g

230V, 50Hz, 1 phase

230V, 60Hz, 1 phase; 120V, 60Hz, 1 phase

UL/CSA optional

LxWxH: 400x240x330mm

Weight: approx. 18kg

Required for operation

PC with Windows

Scope of delivery

- 1 experimental unit
- 1 shear cell
- 1 shear cell with sample of wall material
- 1 vernier caliper gauge
- 1 GUNT software + USB cable
- 1 evaluation software
- 1 packing unit of bulk solid
- 1 balance
- 1 set of instructional material

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Optional accessories

020.30009 WP 300.09 Laboratory trolley