## About computer-aided hopper design

Ring Shear Testers are applied not only on flowability testing, e. g., for product development or quality control, but also on hopper design for flow. In this case, hopper slope angles and outlet dimensions are calculated in dependence on the measured flow properties, e.g., with the goal to achieve mass flow, and to avoid flow obstructions.

The new hopper design software imports flow properties of bulk solids measured with Schulze Ring Shear Testers by directly reading files of the RST-CONTROL software. Results obtained with other testers can be entered through a template for Microsoft EXCEL*. The software interactively (controlled by the user) generates the required graphs of unconfined yield strength, bulk density, internal friction, and other important properties. Interactivity is important to allow a transparent approach, and to be able to intervene in critical products to avoid errors by "stubborn" application of the design methods.

Finally, the software generates a set of hopper design data such as wall inclination angles for different hopper shapes, and critical outlet dimensions to avoid cohesive arches or stable ratholes where the important effect of time consolidation is taken into account.

With the new software, time-consuming iteration cycles at stress-dependent friction angles are no longer required: All stress-dependencies specified by measured data are taken into account. Thus, e.g., the hopper slope angle required for mass flow can be specified as a function of outlet size or local hopper cross section, respectively.

The results are available as a comprehensive pdf document from which all steps of the interpretation can be understood in retrospect. This is vital for a complete documentation of a hopper design.

In addition to the design of mass flow silos for conical, wedge-shaped, and asymmetric wedge-shaped hoppers, taking into account the time consolidation, the design of funnel flow silos is also included. The software uses newly calculated design parameters (e. g., flow factors, ff) based on Jenike's original differential equations published in Bulletins 108/123. However, other approaches are included and can be applied alternatively.

System requirements: Microsoft Windows 7/8/10*, USB port for copy protection dongle, screen resolution min. 1024 x 768

*) Microsoft Windows 7, Microsoft Windows 8, Microsoft Windows 10 and Microsoft EXCEL are trademarks of Microsoft Corp., USA

## Products

Dr. Dietmar Schulze Schüttgutmesstechnik develops and fabricates Ring Shear Testers for the measurement of flow properties of powders and bulk solids. Our first Ring Shear Tester, developed in the early 1990's, was the base of ASTM D6773. Our current product portfolio includes the automatic Ring Shear Testers RST-XS.s, and RST-01.pc.

RST-XS.s

RST-01.pc

The small tester RST-XS.s is operated with shear cells ranging from 3.5 cm³ to 70 cm³ specimen volume. For the larger tester RST-01.pc shear cells up to 900 cm³ specimen volume are available so that particles up to about 10 mm (depending on particle size distribution) can be tested.

Testers are delivered with software RST-CONTROL 95 for automatic measurement of flow properties (yield locus, wall friction, time consolidation, ...). Further, all tools for calibration are included.

For both testers we offer a range of accessories: Wall friction cells (with exchangeable wall coupon; wall coupons can be added by the customer, if required), low stress shear cells (RST-XS.s), time consolidation benches (to measure the effect of time on strength apart from the tester) and related weights.

More information: **www. dietmar-schulze.de**

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# Computer-aided Hopper Design

Interactive hopper design software

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# From a bulk material's sample to the appropriate hopper

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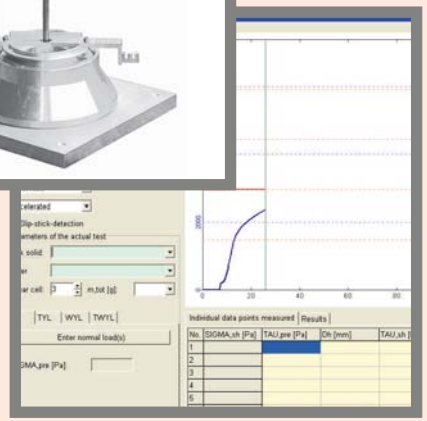
## Start

**1** Measure the bulk solid's flow properties (Ring Shear Tester and control software RST-CONTROL 95)

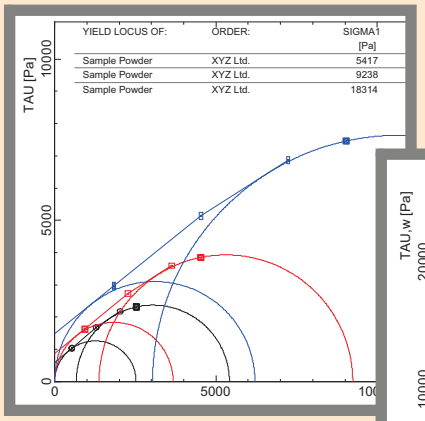
Shear cell of Ring Shear Tester RST-01.pc

Time consolidation test



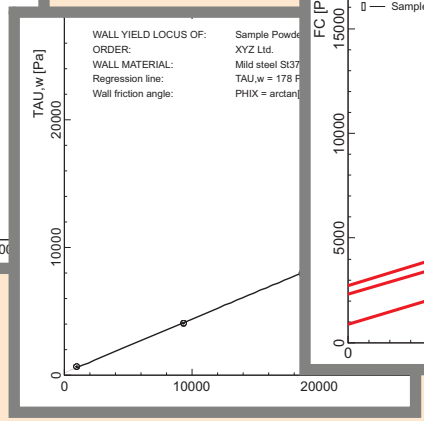
RST-CONTROL 95

Yield loci

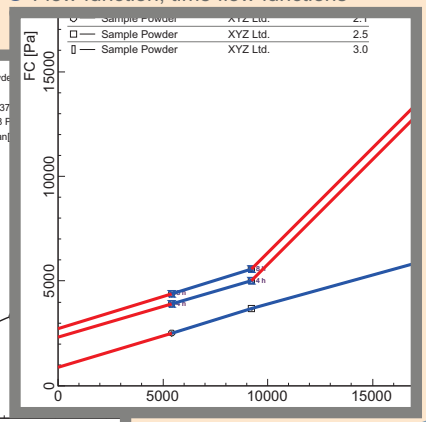



**2** Test results: Strength, bulk density, internal friction, wall friction, and time consolidation

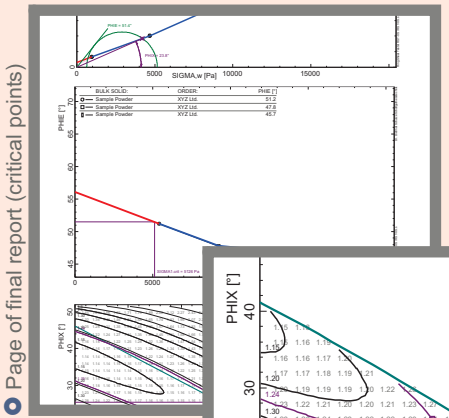
Wall yield locus



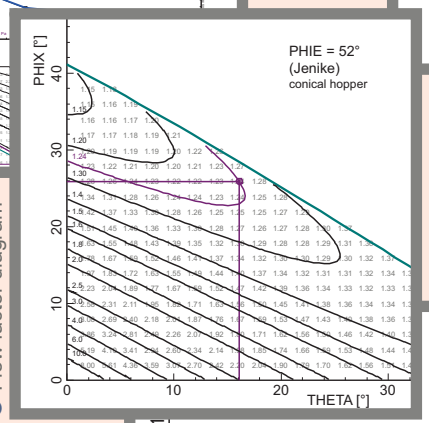

Flow function, time flow functions



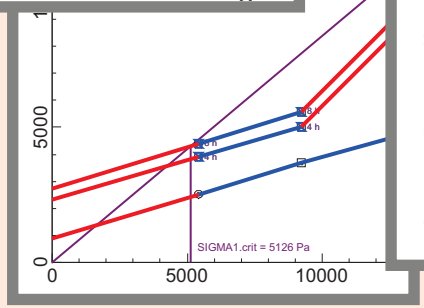

Page of final report (critical points)



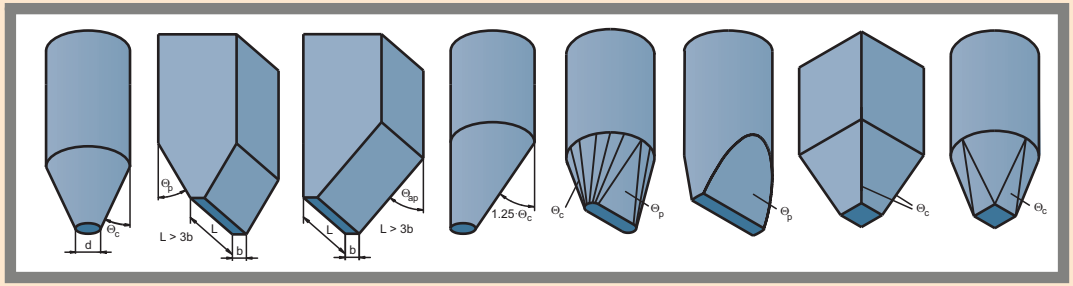
Flow factor diagram




Determination of critical outlet diameter

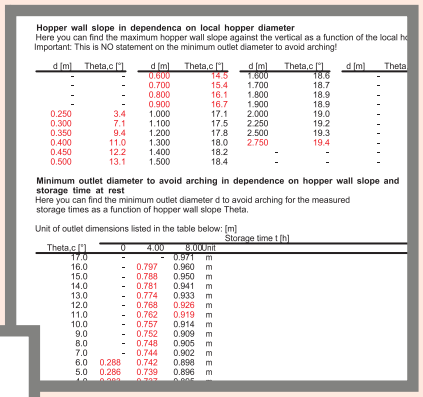



Application of design results on various silo types (example)




**4** Finally apply results to get the optimal silo.

Page of final report (slope vs. diameter)




**3** Computer-aided hopper design: Program generates ff-diagrams, interactively determines outlet dimensions and hopper angles, and creates a final report.

Maximum hopper slope vs. diameter