



Standard Shear Test Method for Bulk Solids Using the Schulze Ring Shear Tester¹

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1. Scope

1.1 This method covers the apparatus and procedures for measuring the unconfined yield strength of bulk solids during both continuous flow and after storage at rest. In addition, measurements of internal friction, bulk density, and wall friction on various wall surfaces are included. The SI system of units has been used throughout.

1.2 The most common use of this information is in the design of storage bins and hoppers to prevent flow stoppages due to arching and ratholing, including the slope and smoothness of hopper walls to provide mass flow. Parameters for structural design of such equipment may also be derived from this data. Another application is the measurement of the flowability of bulk solids, for example, for comparison of different products or optimization.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 653 Terminology Relating to Soil, Rock, and Contained Fluids²
- D 6128 Standard Shear Testing Method for Bulk Solids Using the Jenike Shear Cell³

3. Terminology

3.1 Definitions of terms used in this test method are in accordance with Terminology D 653.

3.2 *adhesion test*, n —a static wall friction test with time consolidation.

3.3 *angle of internal friction*, ϕ_i , n —the angle between the axis of normal stress (abscissa) and the tangent to the yield locus.

3.4 *angle of wall friction*, ϕ' , n —the arctan of the ratio of

the wall shear stress to the wall normal stress.

3.5 *bin*, n —a container or vessel for holding a bulk solid, frequently consisting of a vertical cylinder with a converging hopper. Sometimes referred to as silo, bunker or elevator.

3.6 *bulk density*, ρ_b , n —the mass of a quantity of a bulk solid divided by its total volume.

3.7 *bulk solid*, n —an assembly of solid particles handled in sufficient quantities that its characteristics can be described by the properties of the mass of particles rather than the characteristics of each individual particle. It may also be referred to as a granular material, particulate solid, or powder. Examples are sugar, flour, and ore.

3.8 *bunker*, n —synonym for *bin*, but sometimes understood as being a bin without any or only a small vertical part at the top of the hopper.

3.9 *consolidation*, n —the process of increasing the unconfined yield strength of a bulk solid.

3.10 *critical state*, n —a state of stress in which the bulk density of a bulk solid and the shear stress in the shear zone remain constant during shear under constant normal stress.

3.11 *effective angle of friction*, δ , n —the inclination of the effective yield locus (EYL).

3.12 *effective yield locus (EYL)*, n —straight line passing through the origin of the σ , τ -plane and tangential to the steady state Mohr circle, corresponding to steady state flow conditions of a bulk solid of given bulk density.

3.13 *elevator*, n —synonym for *bin*. Commonly used in the grain industry.

3.14 *failure (of a bulk solid)*, n —plastic deformation of an overconsolidated bulk solid subject to shear, causing dilation and a decrease in strength.

3.15 *flow, steady state*, n —continuous plastic deformation of a bulk solid at critical state.

3.16 *flow function*, FF , n —the plot of unconfined yield strength versus major consolidation stress for one specific bulk solid.

3.17 *granular material*, n —synonym for *bulk solid*.

3.18 *hopper*, n —the converging portion of a bin.

3.19 *major consolidation stress*, σ_1 , n —the major principal stress given by the Mohr stress circle of steady state flow. This Mohr stress circle is tangential to the effective yield locus.

3.20 *Mohr stress circle*, n —the graphical representation of a

¹ This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.24 on Characterization and Handling of Powders and Bulk Solids.

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² *Annual Book of ASTM Standards*, Vol 04.08.

³ *Annual Book of ASTM Standards*, Vol 04.09.