



Standard Test Method for Shear Testing of Bulk Solids Using the Jenike Shear Cell¹

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1. Scope

1.1 This method² covers the apparatus and procedures for measuring the cohesive 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.

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.

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. Terminology

2.1 Definitions:

2.1.1 *angle of internal friction*, ϕ_i —the angle between the tangent to the yield locus and the abscissa.

2.1.2 *angle of wall friction*, ϕ' —the arctan of the ratio of the wall shear stress to the wall normal stress.

2.1.3 *bin*—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.

2.1.4 *bulk density*, ρ —the mass of a quantity of a bulk solid divided by its total volume

2.1.5 *bulk solid*—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. May also be referred to as granular material, particulate solid, or powder. Examples are sugar, flour, ore, and coal.

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

2.1.7 *consolidation*—the process of increasing the strength of a bulk solid.

2.1.8 *effective angle of friction*, δ —the inclination of the effective yield locus (EYL) as defined by Jenike.

2.1.9 *effective yield locus (EYL)*—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.

2.1.10 *elevator*—synonym for bin, commonly used in the grain industry.

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

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

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

2.1.14 *granular material*—synonym for bulk solid.

2.1.15 *hopper*—the converging portion of a bin.

2.1.16 *major consolidation stress*, σ_1 —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.

2.1.17 *Mohr stress circle*—the graphical representation of a state of stress in coordinates of normal and shear stress, that is, in the σ , τ -plane.

2.1.18 *normal stress*, σ —the stress acting normally to the considered plane.

2.1.19 *particulate solid*—synonym for bulk solid.

2.1.20 *powder*—synonym for bulk solid, particularly when the particles of the bulk solid are fine.

2.1.21 *silo*—synonym for bin.

2.1.22 *shear stress*, τ —a stress acting parallel to the surface of the plane being considered.

2.1.23 *shear test*—an experiment to determine the flow properties of a bulk solid by applying different states of stress and strain to it.

2.1.24 *shear tester*—an apparatus for performing shear tests.

2.1.25 *time angle of internal friction*, ϕ_t —inclination of the time yield locus of the tangency point with the Mohr stress circle passing through the origin.

2.1.26 *time yield locus*—the yield locus of a bulk solid which has remained at rest under a given normal stress for a certain time.

¹ This testing method is under the jurisdiction of ASTM Committee D-18 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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