INTERNATIONAL

~~Designation:D6683–01~~ Designation: D 6683 – 08

Standard Test Method for ~~Measuring Bulk Density Values of Powders and Other Bulk Solids~~Measuring Bulk Density Values of Powders and Other Bulk Solids as Function of Compressive Stress[1]

This standard is issued under the fixed designation D 6683; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

~~1.1This test method covers an apparatus and procedure for determining a range of bulk densities of powders and other bulk solids as a function of compaction pressure.~~ *

1.1 This test method covers an apparatus and procedure for determining a range of bulk densities of powders and other bulk solids as a function of compressive stress.

1.2 This test method should be performed in the laboratory under controlled conditions of temperature and humidity.

~~1.3This test method is similar to those of B212-89(1995) Test Method for Apparent Density of Free-Flowing Metal Powders, D29-86(1994) Test Methods for Sampling and Testing Lac Resins, D2854-89(1993) Test Method for Apparent Density of Activated Carbon.~~

~~1.4The values stated are in SI Units and are to be regarded as the standard.~~

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026.

1.3.1 The procedures used to specify how data are collected/recorded or calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives, and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *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:* [2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 4753~~Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Testing Soil, Rock, and Related Construction Materials[2]~~ Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D 6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

~~3.1Definitions of terms used in this test method shall be in accordance with Terminology D653~~

3.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 ~~*Definitions of Terms Specific to This Standard:*~~

[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.~~

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

~~3.2.1 *area of the lid* (A_l)—this is the area of the cover in m~~ Definitions of Terms Specific to This Standard:

3.3 *maximum effective head*—height of a column of material that has no shear stresses along its vertical walls. Used in calculation of maximum applied mass, this value can be approximated, for example, by using the height of the cylindrical section of the bin to be analyzed, m.

3.4 *Symbols:*

3.4.1 A^{cup}—inside cross-sectional area of density cup, m^2.

~~3.2.2 *incremental height* (h_m)—the height due to the addition of weights in m.~~

~~3.2.3 *initial bulk density* (ρ)—the initial density (Kg/m~~

3.4.2 AM^{max}—calculated value of maximum applied mass, kg.

3.4.3 D_{cup}—inside diameter of density cup, m.

3.4.4 EH_{max}—maximum effective head to be applied to material in density cup, m.

3.4.5 $M_{mat'l}$—mass of material in density cup, kg.

3.4.6 V_i—calculated volume of material in density cup at ith consolidation step, m^3~~) when the cup is filled, prior to compressing the material with the weights.~~

~~3.2.4 *initial height* (H_i)—the initial height prior to compressing the specimen in m.~~

~~3.2.5 *maximum consolidation pressure* (P_m)—the maximum desired pressure at which a bulk density value is to be determined in kPa.~~

~~3.2.6 *maximum force* (W_m)—the weight that produces the maximum consolidation pressure (P_m) appropriate for the application: (W_m=P_m×A_l). Units are in kN.~~ .

3.4.7 $(\rho_b)_{approx}$—approximate value of material's bulk density used in calculation of maximum applied mass, kg/m^3.

3.4.8 $(\rho_b)_i$—calculated bulk density value at ith consolidation step, kg/m^3.

3.4.9 $(\rho_b)_{initial}$— calculated initial bulk density value, kg/m^3.

3.4.10 π—a transcendental number, approximately 3.14.

3.4.11 σ_i—calculated compressive stress at ith consolidation step, N/m^2.

3.4.12 σ_{max}—maximum compressive stress to be applied to material in density cup, N/m^2.

4. Summary of Test Method

4.1 Bulk density values are determined by ~~measuring~~calculating the volume ~~change~~ of a given mass of bulk solid under increasing ~~compaction pressure conditions.~~ compressive stress.

5. Significance and Use

~~5.1 The data from this test can be used to estimate the bulk density of materials in bins, hoppers and for material handling applications such as silos.~~

~~5.2 The test results can be greatly affected by the sample selected for testing. For meaningful results it is necessary to select a representative sample of the particulate solid with respect to moisture content, particle size distribution and temperature. For the tests an appropriate size sample should be available, and a fresh material should be used for each individual test specimen.~~

~~5.3 Initial bulk density may or may not be used as the minimum bulk density. This will depend on the material being tested.~~

~~5.4 Bulk density values may be dependent upon the magnitude of the load increments. Traditionally, the load is doubled for each increment resulting in a load-increment ratio of 1. Smaller than standard load increment ratios may be desirable for materials that are highly sensitive to the load increment ratio.~~

~~5.5 Bulk density values may be dependent upon the duration of each load increment. Traditionally, the load duration is the same for each increment and equal to 15 s. For some materials, the rate of consolidation is such that complete consolidation (dissipation of excess pore pressure) will require significantly more than 15 s.~~

5.1 The data from this test can be used to estimate the bulk density of materials in bins and hoppers and for material handling applications such as feeders.

5.2 The test results can be greatly affected by the sample selected for testing. For meaningful results it is necessary to select a representative sample of the particulate solid with respect to moisture (water) content, particle-size distribution and temperature. For the tests an appropriate size sample should be available, and fresh material should be used for each individual test specimen.

5.3 Initial bulk density, $(\rho_b)_{initial}$, may or may not be used as the minimum bulk density. This will depend on the material being tested. For example, the two are often close to the same for coarse (most particles larger than about 6 mm), free-flowing bulk solids, but not for fine, aeratable powders.

5.4 Bulk density values may be dependent upon the magnitude of the applied mass increments. Traditionally, the applied mass is doubled for each increment resulting in an applied mass increment ratio of 1. Smaller than standard increment ratios may be desirable for materials that are highly sensitive to the applied mass increment ratio. An example of the latter is a material whose bulk density increases 10% or more with each increase in applied mass.

5.5 Bulk density values may be dependent upon the duration of each applied mass. Traditionally, the duration is the same for each increment and equal to 15 s. For some materials, the rate of compression is such that complete compression (no change in volume with time at a given applied compressive stress) will require significantly more than 15 s.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors. Practice D 3740 was developed for agencies engaged in the testing or inspection (or both) of soil and rock. As such it is not totally applicable to agencies performing this standard. However, users of this standard should recognize that the framework of Practice D 3740 is appropriate for evaluating the quality of an agency performing this standard. Currently there is no known qualifying national authority that inspects agencies that perform this standard.

6. Apparatus

~~A schematic of the arrangement of the test apparatus of the system is shown in~~

6.1 A typical embodiment of the test apparatus is shown in Fig. 1.

~~6.1~~

6.2 *Balance*~~, having a capacity to determine mass by using weight per class GP1 scale as per method ASTM document D4753~~, having a capacity and readability to determine mass of the specimen and applied masses to four significant digits in accordance with Table 1 in Guide D 4753.

~~6.2~~

6.3 *Stand*, to support the density cup, and to mount the dial indicator. The stand must be level and securely mounted on a vibration free base to support the test apparatus.

~~6.3*Density Cup*, with cover to contain the test specimen. Density cup cover has a ball mounted in the center. The density cup is to be a cylindrical cup with the minimum cell diameter of 64 mm and a minimum height of 21 mm or five times the diameter of the largest particle whichever results largest cell height. The ratio of diameter to height must be at least 3:1.~~

6.4 ~~*Weights*, to be used with the weight hanger for consolidation purposes.~~ Density Cup, with cover to contain the test specimen. Density cup cover has a ball mounted in the center, which acts as a pivot point to ensure that only a vertical force is exerted on the cover by the applied mass. The density cup is to be a cylindrical cup with the minimum cell diameter of 64 mm and a minimum inside height of 21 mm or five times the diameter of the largest particle whichever results in the larger cell height. The ratio of cell diameter-to-height must be at least 3:1.

6.5 ~~*Weight Hanger*, to support weights, and guide load onto the density cup cover.~~ Applied masses, to be used with the hanger for applying compressive stress.

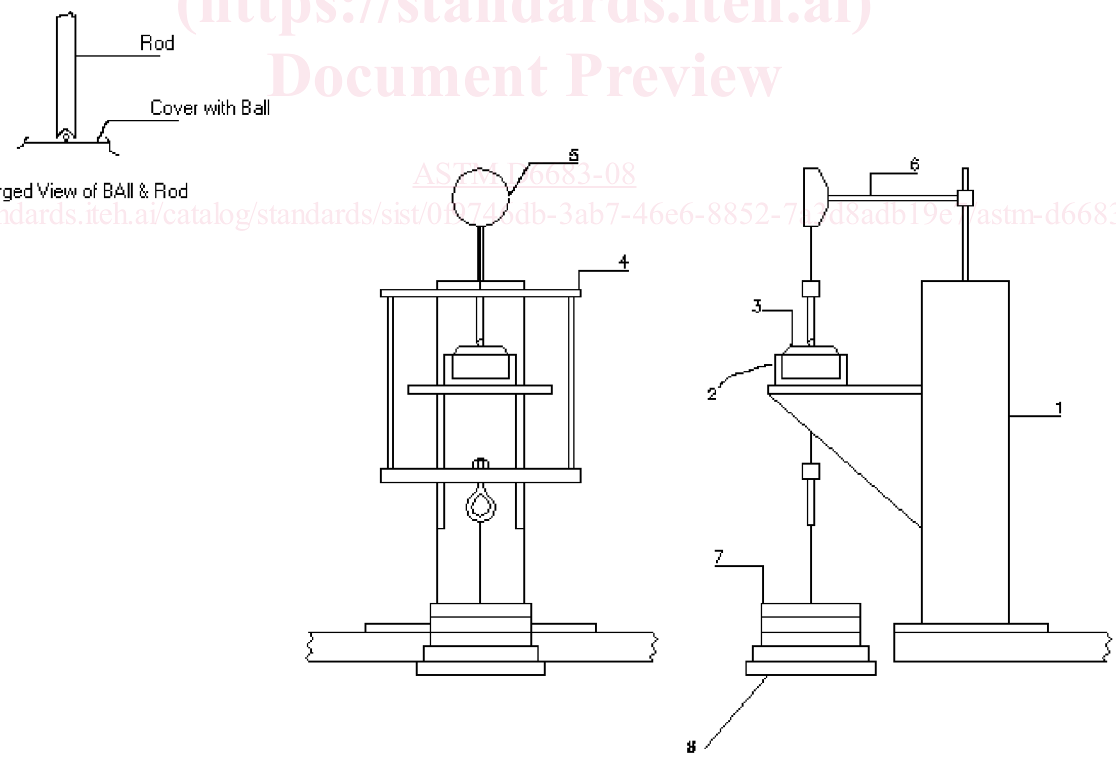

FIG. 1 Test Apparatus

1. Stand
2. Density cup
3. Cover
4. Hanger
5. Dial indicator
6. Dial indicator holder
7. Applied masses
8. Support