Designation: D4380 – 20

Standard Test Method for Determining Density of Construction Slurries[1]

This standard is issued under the fixed designation D4380; 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*

1.1 This test method covers the determination of the density of slurries used in slurry construction techniques, such as those used to drill borings, maintain trench stability, perform ground improvement, and form hydraulic barriers. This test method is modified from API Recommended Practice 13B.

1.2 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses are provided for information only and are not considered standard. Reporting of test results in units other than SI shall not be regarded as nonconformance with this standard.

1.2.1 Note that unitless specific gravity is equivalent to SI density in g/cm^3.

1.2.2 It is common practice in the engineering/construction profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This practice implicitly combines two separate systems of units; the absolute and the gravitational systems. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit of mass. However, the use of balances and scales recording pounds of mass (lbm) or recording density in lbm/ft^3 shall not be regarded as nonconformance with this standard.

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this test method.

1.3.1 For purposes of comparing a measured or calculated value(s) with specified limits, the measured or calculated value(s) shall be rounded to the nearest decimal of significant digits in the specified limit.

1.3.2 The procedures used to specify how data are collected/recorded or calculated in the 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 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D6026 Practice for Using Significant Digits in Geotechnical Data

2.2 *American Petroleum Institute (API) Standard:*

API RP 13B Recommended Practice Standard Procedure for Testing Drilling Fluids (Section 1)[3]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms used in this standard, refer to Terminology D653.

4. Summary of Test Method

4.1 The mass of a fixed volume of the slurry is measured using a mechanical balance. The weight of the slurry is

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.16 on Grouting.

Current edition approved Nov. 1, 2020. Published November 2020. Originally approved in 1984. Last previous edition approved in 2012 as D4380–12. DOI: 10.1520/D4380-20.

[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.

[3] Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, http://www.api.org.

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

balanced against a rider counterweight on a graduated beam. The density of the slurry is then read directly off the graduated scale.

5. Significance and Use

5.1 This test method is used to determine the density of construction slurries in the laboratory and field. For freshly mixed slurry, this test method may be used as an indicator of mix proportions. For in-trench slurry or in-borehole slurry, a certain value may be specified for maintaining trench or borehole stability.

NOTE 1—The quality of the result produced by this standard depends on the competence of the personnel performing it and the suitability of the equipment and facilities being used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself ensure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Mud Balance*—A mechanical balance of sufficient accuracy to permit measurement within ±0.01 g/cm^3. A typical mud balance is illustrated in Fig. 1. The mud balance consists of a graduated beam balanced over an intermediate knife edge point. A mud cup of known volume is attached to one end of the beam, and a well is attached to the other end of the beam. A cap is included with the mechanical balance and is placed on the cup to discharge excess volume in the cup and prevent spilling from the cup. A typical mud balance cap is shown in Fig. 2. Weights can be added to the well to calibrate the beam (see 7.1 for calibration procedure). A rider is attached to the graduated beam and is free to slide along the beam for balancing the mass of the mud in the cup. A level bubble is mounted on the beam to verify the balance point.

6.2 *Thermometer*—A thermometer with a range of 0 to 105°C with a resolution of 1°C.

7. Calibration

7.1 The apparatus calibration should be checked frequently with fresh water using the procedure stated in Section 9. Check that the balance is free to rotate in the vertical plane. If not free to rotate in the vertical plane, check that the balance point is clean and free of foreign material. Check that the balance and the inside and outside of the cup and cap are free of foreign material. Fresh water should give a density reading of 1.00 g/cm^3 (8.34 lb/gal or 62.4 lb/ft^3) at 20°C (68°F). If it does not, measure the temperature of the water with the thermometer and check that the density produced by the water corresponds accurately to the temperature of the water. If the density does not correspond to the water temperature, add weights to the well at the end of the graduated arm or remove weights from the well as necessary to achieve the 1.00 g/cm^3 reading.

7.2 To check the calibration of the thermometer, fill a container with ice and cold water, stir the water, allow the water to sit for 3 minutes, and insert the thermometer into the water. The thermometer should return a reading of 0°C (32°F) if the thermometer is not touching the container. If not, replace the thermometer or recalibrate the thermometer in accordance with manufacturer recommendations.

8. Sampling and Test Specimen

8.1 Obtain a 0.5L representative sample of the slurry to be tested using dippers, buckets, mud or slurry samplers, or equivalent equipment from a laboratory slurry mix or field construction operation.

8.2 The specimen should be sampled from thoroughly-mixed slurry immediately prior to testing.

NOTE 2—When allowed to sit undisturbed, slurries containing clay and/or other viscosity modifiers may form a gel, which may affect the flow into the cup and produce an unrepresentative specimen. Particles in slurries may also settle if allowed to sit, which may result in variable density in the sample and an unrepresentative specimen.

9. Procedure

9.1 Verify calibration of apparatus, and verify that balance, cup, and cap are clean and free of old slurry or other foreign materials.

9.2 Set up the apparatus base approximately level.

9.3 Fill the clean, dry cup with slurry to be tested. Gently tap the side of the slurry cup to break up any entrained gases. Make sure there are no bubbles on the top of the slurry.

9.4 Place the cap on the cup, and rotate the cap until firmly seated. Some of the slurry should be expelled through the hole in the cap as the cap is seated.

9.5 Cover the hole in the cap. Wash or wipe the excess slurry from the outside of the cup.

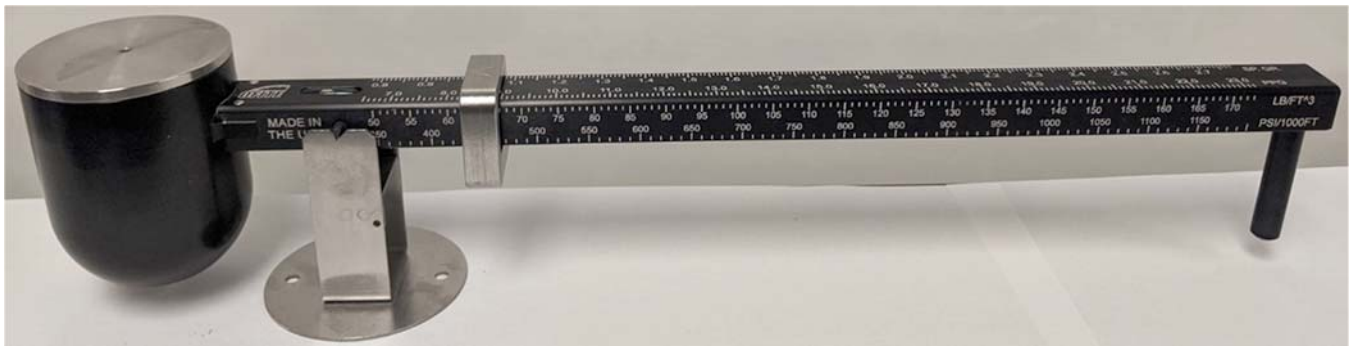

Photo courtesy of University of Texas at Austin.

FIG. 1 Mud Balance

Photo courtesy of University of Texas at Austin.

FIG. 2 Mud Balance Cap

9.6 Place the beam on the support and balance it by moving the rider along the graduated scale. The beam is horizontal when the leveling bubble is on the center line.

9.7 Read the density as indicated on the rider, and record the density to the nearest 0.01 g/cm^3.

9.8 Remove the cap, measure the temperature of the slurry in the cup, and record the temperature to the nearest 1°C.

9.9 Empty the sample from the cup and clean and dry the instrument thoroughly after each use.

10. Report: Test Data Sheet(s)/Form(s)

10.1 Record the following sample/specimen information:

10.1.1 Project Name/Designation;

10.1.2 Project location;

10.1.3 Specimen material/mix design;

10.1.4 Date and time;

10.1.5 Source of the slurry tested, such as its station and depth;

10.1.6 Initials of person who conducted the test.

10.2 Record as a minimum the following data about the slurry in the cup:

10.2.1 The slurry density to the nearest 0.01 g/cm^3.

10.2.2 The slurry temperature to the nearest 1°C.

11. Precision and Bias

11.1 *Precision*—Test data on precision is not presented due to the nature of this test method. It is either not feasible or too costly at this time to have ten or more agencies participate in an in situ testing program at a given site.

11.1.1 Subcommittee D18.16 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

11.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

12. Keywords

12.1 bentonite; borehole; boring; cutoff; density; slurry; specific gravity; stability; trench