Standard Test Method for Determining Consistency and Density of Roller-Compacted Concrete Using a Vibrating Table[1]

This standard is issued under the fixed designation C1170/C1170M; 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.

ε^1 NOTE—Editorial corrections were made to 10.2.6 in June 2014.

1. Scope*

1.1 This test method is used to determine the consistency of concrete using a vibrating table and a surcharge and to determine the density of the consolidated concrete specimen. This test method is applicable to freshly mixed concrete, prepared in both the laboratory and the field, having a nominal maximum size aggregate of 50 mm [2 in.] or less. If the nominal maximum size of aggregate is larger than 50 mm [2 in.], the test method is applicable only when performed on the fraction passing the 50-mm [2-in.] sieve with the larger aggregate being removed in accordance with Practice C172.

1.2 This test method, intended for use in testing roller-compacted concrete, may be applicable to testing other types of concrete such as cement-treated aggregate and mixtures similar to soil-cement.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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 and health practices and determine the applicability of regulatory limitations prior to use.* (**Warning—**Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.[2])

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C29/C29M Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
C125 Terminology Relating to Concrete and Concrete Aggregates
C172 Practice for Sampling Freshly Mixed Concrete
C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
C1067 Practice for Conducting a Ruggedness Evaluation or Screening Program for Test Methods for Construction Materials
D1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *extremely dry consistency, n*—for the purpose of this standard, the consistency of concrete having no slump and a Vebe consistency greater than 30 s when measured with Procedure A.

3.2.2 *stiff consistency, n*—for the purpose of this standard, the consistency of concrete having no slump and a Vebe consistency ranging from 5 to 20 s when measured with Procedure B.

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.45 on Roller-Compacted Concrete.

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[2] Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

[3] 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**

3.2.3 *Vebe consistency, n*—the time required for a given mass of concrete to be consolidated by vibration in a cylindrically shaped mold under a surcharge mass.

3.2.4 *very stiff consistency, n*—for the purpose of this standard, the consistency of concrete having no slump and a Vebe consistency ranging from 20 to 30 s when measured with Procedure A or B.

4. Summary of Test Method

4.1 A vibrating table is used to measure the consistency of stiff to extremely dry concrete mixtures (see Note 1). Density of the compacted specimen is measured by determining the mass of the consolidated specimen and dividing by its volume.

NOTE 1—Further description of concrete of this consistency is given in ACI 207.5R[4] and ACI 211.3R.[5]

4.2 Two procedures are provided:

4.2.1 *Procedure A* uses a 22.7 kg [50 lb] surcharge mass placed on top of the test specimen. Procedure A shall be used for testing concrete of extremely dry consistency or when the Vebe consistency by Procedure B is 30 s or greater (see Note 2).

NOTE 2—Further description of the test procedure using a 22.7 kg [50 lb] surcharge can be found in the U.S. Bureau of Reclamation's Technical Memorandum No. 8.[6]

4.2.2 *Procedure B* uses a 12.5 kg [27.5 lb] surcharge mass placed on top of the test specimen. Procedure B shall be used for testing concrete of stiff consistency or when the Vebe consistency by Procedure B is less than 20 s (see Note 3).

NOTE 3—Further description of the test procedure using a 12.5 kg [27.5 lb] surcharge can be found in the U. S. Army Corps of Engineer's test procedure CRD-C-53-01.[7]

4.2.3 Either Procedure A or B can be used for testing concrete with a very stiff consistency or when the Vebe consistency by Procedure A or B ranges from 20 to 30 s.

5. Significance and Use

5.1 This test method is intended to be used for determining the consistency and density of stiff to extremely dry concrete mixtures common in roller-compacted concrete construction.

5.1.1 Because of the stiff to extremely dry consistency of some roller-compacted concrete mixtures, the standard Vebe test method of rodding the specimen in a slump cone is substituted by Procedures A and B.[8]

5.2 Procedure A uses a 22.7 kg [50 lb] surcharge and is used for concrete consolidated by roller-compaction methods when the consistency of the concrete is very stiff to extremely dry.

5.3 Procedure B uses a 12.5 kg [27.5 lb] surcharge and is used for concrete consolidated by roller-compaction methods when the consistency of the concrete is stiff to very stiff consistency, but not extremely dry.

6. Apparatus

6.1 *Vibrating Table*—A vibrating table with a steel deck approximately 20-mm [¾-in.] thick with dimensions of approximately 380 mm [15 in.] in length, 250 mm [10 in.] in width, and 300 mm [12 in.] in height. The vibrating table shall be constructed in such a manner as to prevent flexing of the table during operation. The table deck shall be activated by an electromechanical vibrator. The table shall produce a sinusoidal vibratory motion with a frequency of at least 60 ± 2 Hz [3600 ± 100 vibrations per min] and a double amplitude of vibration of 0.43 ± 0.08 mm [0.0170 ± 0.0030 in.] when a 27 ± 2-kg [60.0 ± 2.5-lb] surcharge is bolted to the center of the table. The vibrator and table shall have a total mass of at least 90 kg [200 lb]. The table shall be level and have sufficient mass or be secured to prevent displacement of the apparatus during performance of the test.

6.2 *Cylindrical Mold*—The cylindrical mold shall be made of steel or other hard metal resistant to corrosion by cement paste and shall have an inside diameter of 240 ± 2 mm [9 ½ ± 1⁄16 in.], a depth of 200 ± 2 mm [7 ¾ ± 1⁄16 in.], and a wall thickness of 6 ± 2 mm [¼ ± 1⁄16 in.]. The mold shall be equipped with permanently affixed slotted metal brackets so it can be rigidly clamped to the vibrating table. The top rim of the mold shall be smooth, plane, and parallel to the bottom of the mold and shall be capable of providing an air and watertight seal when a glass or plastic plate is placed on the top rim.

6.3 *Swivel Arm and Guide Sleeve*—A metal guide sleeve with a clamp assembly or other suitable holding device mounted on a swivel arm (see Fig. 1). The swivel arm and guide sleeve must be capable of holding the metal shaft with the attached 22.7 kg [50 lb] or 12.5 kg [27.5 lb] cylindrical mass in a position perpendicular to the vibrating surface and allowing the shaft to slide freely when the clamp is released. The inside diameter of the guide sleeve shall be 3 ± 2 mm [⅛ ± 1⁄16 in.] larger than the diameter of the metal shaft of the surcharge. The swivel arm must be capable of maintaining the guide sleeve in a locked position directly over the center of the vibrating surface. The swivel arm shall be capable of being rotated away from the center of the table.

6.4 *Surcharge Assembly*—A cylindrical steel mass with a circular plastic plate attached to its base and a metal shaft at least 450 mm [18 in.] in length and 16 ± 2 mm [⅝ ± 1⁄16 in.] in diameter attached perpendicularly to the plate and embedded in the center of the mass. The shaft shall slide through the guide sleeve without binding. The plastic plate shall be approximately 13 mm [½ in.] in thickness and shall have a diameter of 230 ± 3 mm [9 ± ⅛ in.]. The edge of the plastic plate shall not be chipped or rounded. The surcharge assembly including the plastic plate and the metal shaft shall have a mass of either of

[4] ACI 207.5R, *Report on Roller-Compacted Concrete*, 1999. Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333, http://www.concrete.org.

[5] ACI 211.3R, *Guide for Selecting Proportions for No-Slump Concrete*, 2002. Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333, http://www.concrete.org.

[6] *Guidelines for Designing and Constructing Roller-Compacted Concrete Dams*, ACER Technical Memorandum No. 8, Bureau of Reclamation, Denver, CO, Appendix A, 1987.

[7] *Test Method for Consistency of No-Slump Concrete Using the Modified Vebe Apparatus*, CRD-C-53-01, U. S. Army Corps of Engineers, Vicksburg, MS, 2001.

[8] *ACI Manual of Concrete Practice*, Part 1, 2005. Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333, http://www.concrete.org.

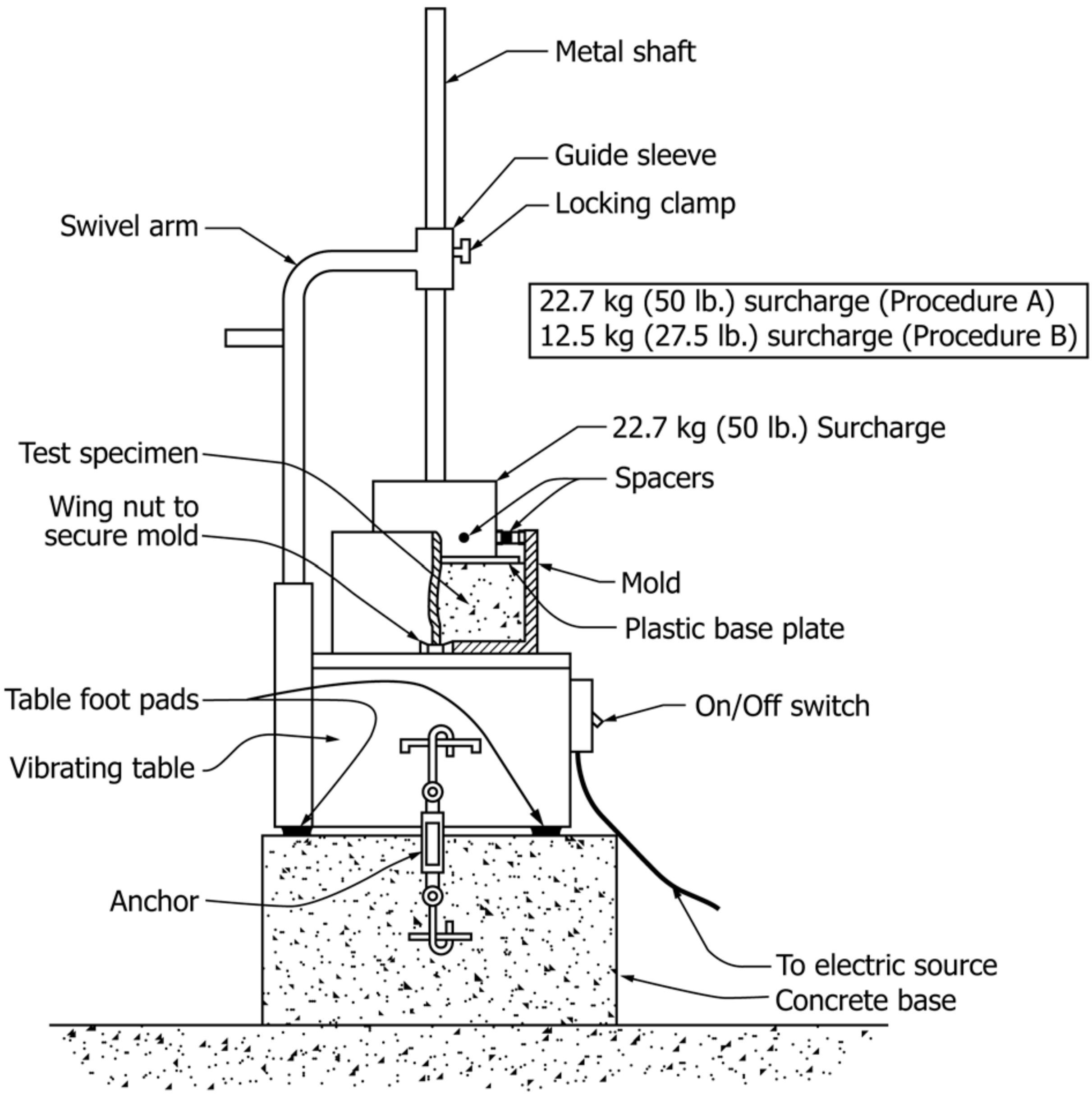

FIG. 1 Vibrating Table—Consistency Test

the following:

Procedure A—22.7 ± 0.5 kg [50 ± 1 lb], or

Procedure B—12.5 ± 0.5 kg [27.5 lb ± 1 lb].

6.4.1 The cylindrical steel mass shall include a minimum of six spacers affixed to the side of the mass. The spacers shall be located at equal distances around the circumference of the mass (see Fig. 2). The center of each spacer shall be located a maximum distance of 40 mm [1 ⅝ in.] from the bottom of the plastic plate. Each spacer shall project from the side of the mass so that, when centered in the cylindrical mold, each spacer almost touches the inside of the mold. The distance between each spacer and the inside of the mold shall not exceed 0.5 mm [0.02 in.] when the mass is centered in the mold. The spacers shall not bind so that the centered mass with spacers is allowed to freely move up and down throughout the upper half of the mold (see Note 4). The surcharge assembly including the steel mass with spacers, plastic plate, and the metal shaft shall have a mass of 22.7 ± 0.5 kg [50 ± 1 lb] or 12.5 ± 0.5 kg [27.5 lb ± 1 lb].

NOTE 4—It is advisable that the spacers be made of material that is softer than the steel used to make the cylindrical mold to avoid damage to the mold. Bolts made of nylon or brass may be used for spacers. The cylindrical steel mass can be drilled and tapped at each spacer location to receive the bolt. Washers or nuts may be added or the bolt heads milled to adjust the distance between each spacer and the inside of the mold.