Designation: C1712 – 14

Standard Test Method for Rapid Assessment of Static Segregation Resistance of Self-Consolidating Concrete Using Penetration Test[1]

This standard is issued under the fixed designation C1712; 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 rapid assessment of static segregation resistance of normal-weight self-consolidating concrete (SCC). The test does not measure static segregation resistance directly, but provides an assessment of whether static segregation is likely to occur.

1.2 The test apparatus and protocol were developed based on tests with SCC mixtures containing saturated surface dry (SSD) coarse aggregates ranging in relative density from 2.67 to 2.79 and in nominal maximum size from 9.5 mm to 25 mm. For SCC mixtures outside these ranges, testing is recommended to establish a correlation between penetration depth and static segregation measured in accordance with Test Method C1610/C1610M. This test method shall not be used to assess the static segregation resistance of self-consolidating concrete containing lightweight aggregates or heavyweight aggregates without prior testing to establish a correlation.

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

1.4 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes shall not be considered as requirements of the 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.* (**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]

C125 Terminology Relating to Concrete and Concrete Aggregates

C143/C143M Test Method for Slump of Hydraulic-Cement Concrete

C172 Practice for Sampling Freshly Mixed Concrete

C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C1610/C1610M Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique

C1611/C1611M Test Method for Slump Flow of Self-Consolidating Concrete

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 *static segregation resistance, n*—resistance of a concrete mixture to segregation of the mortar component from the coarse aggregate while the concrete is at rest and before initial setting.

4. Summary of Test Method

4.1 This test method uses a penetration apparatus (shown in Figs. 1 and 2) and an inverted slump mold (Fig. 3). A sample of freshly mixed self-consolidating concrete is placed in an inverted slump mold without tamping or vibration. The hollow cylinder attached to a metal rod is aligned in the center of the inverted slump mold as shown in Fig. 3. The hollow cylinder is then lowered onto the surface of the concrete and released to freely penetrate into the fresh concrete. The penetration depth

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.47 on Self-Consolidating 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**

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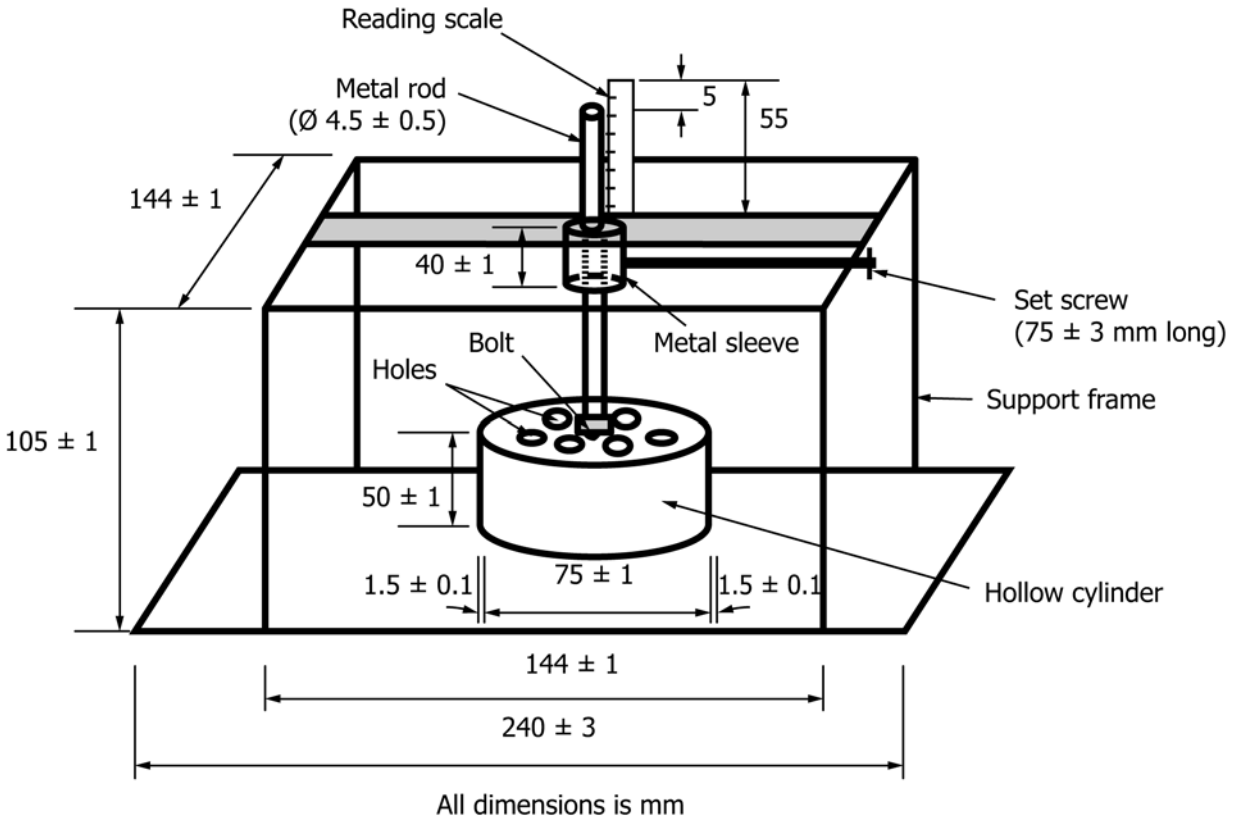

FIG. 1 Dimension of Penetration Apparatus

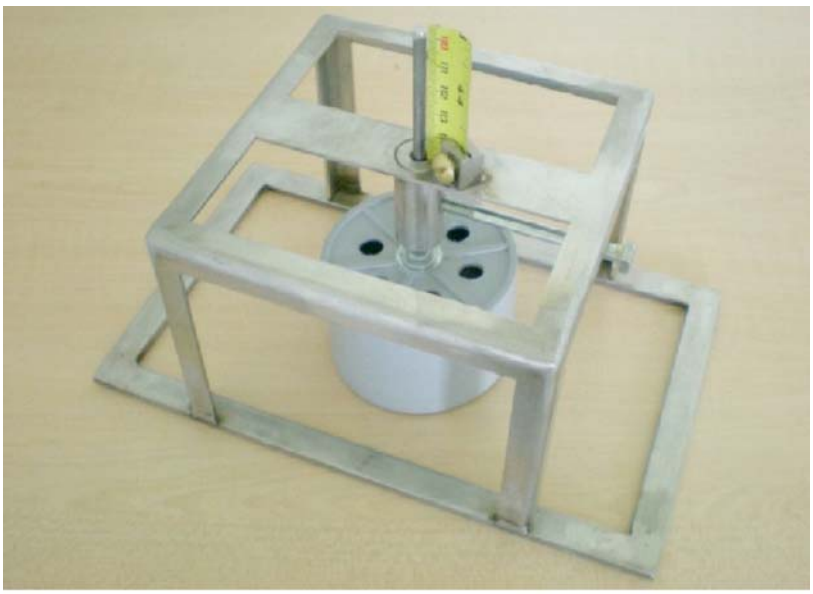

FIG. 2 Penetration Apparatus

(*Pd*) is determined and used to assess the static segregation resistance of the self-consolidating concrete mixture (**1-5**).[4]

[4] The boldface numbers in parentheses refer to a list of references at the end of this standard.

5. Significance and Use

5.1 This test method is for the rapid assessment of the static segregation resistance of self-consolidating concrete.

FIG. 3 Penetration Test

5.2 The method is useful for rapid assessment of the static segregation resistance of self-consolidating concrete during mixture development in the laboratory as well as prior to placement of the mixture in the field. Test Method C1610/C1610M for static segregation of SCC is not sufficiently rapid, and the non-mandatory Visual Stability Index as determined through the procedure described in Appendix X1 of Test Method C1611/C1611M is highly subjective and qualitative.

5.3 Appendix X1 provides non-mandatory criteria that may be used to indicate the degree of static segregation resistance of self-consolidating concrete mixtures.

6. Apparatus

6.1 *Mold*—The slump mold is used in this test method and shall conform to Test Method C143/C143M.

6.2 *Penetration Apparatus*—The penetration apparatus, shown in Fig. 1, consists of a support frame, a metal sleeve, a set screw, a penetration head and a reading scale. The penetration head, consisting of a non-corrosive hollow cylinder and a metal rod, has a mass of 45 ± 1 g. The rod is bolted vertically into the center of the top of the hollow cylinder and acts as a unit with the cylinder. The inner diameter, wall thickness, and height of the hollow cylinder are 75 ± 1 mm, 1.5 ± 0.1 mm, and 50 ± 1 mm, respectively. Holes are symmetrically drilled on the top surface of the hollow cylinder to allow air to escape during the penetration test. At least two holes with a minimum diameter of 6 mm must be provided (see Note 1). The reading scale shall be 55 mm long and marked in 1 mm increments. The scale is mounted on the support frame and adjacent to the metal rod, as shown in Figs. 1 and 2. With both the support frame and the hollow cylinder resting on a flat surface, the top of the metal rod shall be 5 mm below the top of the reading scale (see Note 2). The diameter of the metal rod shall be 4.5 ± 0.5 mm. The inner diameter of the metal sleeve shall be 0.7 ± 0.1 mm larger than the diameter of the metal rod to minimize friction as the rod slides.

NOTE 1—The number and size of the holes may be chosen to be greater than the minimum stated in 6.2 to achieve the required mass (45 ± 1 g) of the penetration head. The hollow cylinder shown in Fig. 2 is made of Polyvinyl Chloride (PVC) and has six holes on the top surface; each hole has a diameter of approximately 10 mm.

NOTE 2—This enables the top of the metal rod to be used as the mark for taking both the initial and final readings since it will always lie within the range of the reading scale when the surface of the concrete in the mold is properly leveled (see 8.5).

6.3 *Base Plate (Optional)*—As described in Test Method C1611/C1611M.

6.4 *Strike-off Bar*—As described in Test Method C173/C173M.

6.5 *Sample Receptacle*—A pan or wheelbarrow that is water-tight, has a nonabsorbent surface, and is large enough to allow both remixing of the entire sample and retain a volume of concrete sufficient to fill the mold.

6.6 *Pouring Vessel for SCC*—A water-tight container having a volume such that concrete is not spilled during placement in the mold.

NOTE 3—A pouring vessel with a pouring lip is useful in reducing the probability of concrete spilling while filling the mold.

6.7 *Other Tools*—Items such as shovels and scoops capable of remixing the concrete in the sample receptacle, filling the pouring vessel, or both.

7. Sample

7.1 Obtain a sample of freshly mixed self-consolidating concrete in accordance with Practice C172 or Practice C192/C192M, and place it in the sample receptacle.

8. Procedure

8.1 Perform this test on a flat, level, nonabsorbent work surface such as a concrete floor or base plate. Use a base plate in conditions where a flat, level surface is not available, such as on a construction site. When the base plate is used, position and shim the base plate so that it is fully supported. Dampen the work surface, removing any standing water. Do not subject the work surface or mold to vibration or disturbance.

8.2 *Conditioning the Penetration Apparatus*—Dampen the hollow cylinder, then hold the apparatus in the horizontal position and release the set screw. Spin the penetration head to ensure that the space between the metal sleeve and the metal rod is free of any obstruction. Tighten the screw softly to hold the rod in the sleeve.

8.3 *Remixing of Sample*—Remix the sample, obtained in accordance with 7.1, in the sample receptacle using a shovel or scoop so that the concrete is homogeneous.

8.4 Dampen the interior of the mold and place it on the work surface, or centered on the base plate, with the smaller opening facing down.

8.5 *Fill Pouring Vessel*—Immediately fill the pouring vessel with a portion of SCC from the sample receptacle, either by passing the pouring vessel through the concrete or by scooping concrete into the vessel.

8.6 *Filling Procedure*—Immediately fill the mold with SCC by tilting the pouring vessel. Position the lowest point on the rim of the pouring vessel no more than 125 mm above the top of the mold. Ensure an even distribution of concrete, without rodding the concrete or tapping the sides of the mold, while filling the mold.

8.7 If necessary, repeat the procedures in 8.5 and 8.6 until the mold is filled slightly above its rim.

8.8 *Strike Off*—Strike off the surface of the concrete with the strike-off bar. Allow the concrete to stabilize for 80 ± 5 s after finishing strike-off before measuring the penetration.

8.9 *Positioning the Penetration Apparatus*—While the concrete is stabilizing, place the penetration apparatus on the top of the inverted slump mold, making sure that the hollow cylinder is aligned in the center of the inverted mold (see Fig. 3 and Note 4).

NOTE 4—Aligning the corners of the frame approximately on the circumference of the slump mold will ensure alignment of the hollow cylinder in the center of the mold.

8.10 *Measuring the Penetration Depth (Pd):*

8.10.1 *Initial Reading*—Hold the metal rod attached to the hollow cylinder with one hand and release the set screw. Lower the hollow cylinder carefully so that it just touches the surface of the concrete. Tighten the screw and take the initial reading on the reading scale at the mark that is in line with the top of the metal rod.

8.10.2 *Final Reading*—At the end of the period over which the concrete is allowed to stabilize (80 ± 5 s after completion of strike-off), release the set screw so that the hollow cylinder freely penetrates the fresh concrete. Wait for 30 ± 2 s after releasing the set screw and take the final reading on the reading scale at the mark that is in line with the top of the metal rod. After taking the reading, remove the penetration apparatus. Between uses, wash the penetration apparatus and remove any free water on the surfaces of the hollow cylinder and the metal rod with a cloth or paper towel.

9. Calculation

9.1 Calculate the penetration depth, *Pd*, according to the following equation:

$$Pd = d_2 - d_1 \quad (1)$$

where:

d_1 = initial reading (mm), and
d_2 = final reading (mm).

10. Report

10.1 Concrete mixture designation.

10.2 The penetration depth (*Pd*) to the nearest 1 mm.

11. Precision and Bias

11.1 *Precision*—The estimation of the precision of this test method is provisional. Repeatability standard deviations were determined on five replicate batches of SCC mixtures at each of four levels of mean penetration depth (**5**). At a mean penetration depth of 3 mm, the repeatability standard deviation was 1 mm; at a mean penetration depth of 13 mm, the repeatability standard deviation was 2 mm; and at mean penetration depths of 23 mm and 30 mm, the repeatability standard deviation was 3 mm. The differences in repeatability standard deviation are small over the range of mean penetration depths of 3 to 30 mm. The average repeatability standard deviation over this range of mean penetration depths is 2 mm.

11.2 *Bias*—This test method has no bias because the values determined can only be defined in terms of the test method.

12. Keywords

12.1 penetration depth; penetration test; rapid test; segregation; self-consolidating concrete; stability; static segregation resistance

APPENDIX

(Nonmandatory Information)

X1. DEGREE OF STATIC SEGREGATION RESISTANCE OF CONCRETE MIXTURES

X1.1 The criteria for the different degrees of static segregation resistance are provided in Table X1.1 and are based on evaluations of SCC mixtures with nominal maximum aggregate sizes in the range of 9.5 to 25 mm. These criteria were developed through a correlation between penetration depth and static segregation measured in accordance with Test Method C1610/C1610M (**1-5**).

TABLE X1.1 Degree of Static Segregation Resistance[A]

Penetration depth (*Pd*)	Degree of static segregation resistance
$Pd \leq 10$ mm	Resistant
10 mm < Pd < 25 mm	Moderately resistant
$Pd \geq 25$ mm	Not resistant

[A] These criteria were developed based on use of the penetration apparatus with an inverted slump mold and are valid for SCC mixtures with a total aggregate volume fraction of less than 65 %. The criteria may be different if a sample container other than the inverted slump mold is used.

REFERENCES

(1) Bui V., Attiogbe, E., Vojtko, D., Schaef S., and See H., "A Rapid Test for Segregation Resistance of Self-Consolidating Concrete,"*NRMCA Concrete Technology Forum*, Dallas, Texas, USA, May 22–24, 2007.

(2) Bui, V., Montgomery, D., Hinczak, I., and Turner, K., "Rapid Testing Method for Segregation Resistance of Self-Compacting Concrete, "*Cement and Concrete Research Journal*, Vol 32, No. 9, 2002, pp. 1489–1496.

(3) Bui, V., and Shah, S. P., "Rapid Methods for Testing Quality of Self-Consolidating Concrete,"*Proceedings of First North American Conference on the Design and Use of Self-Consolidating Concrete*, Chicago, USA, November 12–13, 2002, pp. 311–316.

(4) Bui, V., Montgomery, D., Hinczak, I., and Turner, K., "Rapid Testing Methods for Segregation Resistance and Filling Ability of Self-Compacting Concrete," *Proceedings of the Fourth CANMET/ACI/JCI International Conference on Recent Advances in Concrete Technology*, Tokushima, Japan, SP 179-6, 1998 , Ed. V. M. Malhotra, pp. 85–103.

(5) Bui, V., and Attiogbe, E., "A Rapid Evaluation of Stability of Self-Consolidating Concrete," *Proceedings of Third North American Conference on the Design and Use of Self-Consolidating Concrete*, Chicago, USA, November 10–12, 2008.

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this standard since the last issue (C1712 – 09) that may impact the use of this standard. (Approved April 1, 2014.)

(1) Revised 6.5.
(2) Added new 6.7 with Note, and 6.8.
(3) Revised Section 8.
(4) Moved old 8.7.3 to new Section 9.

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