



Standard Test Method for Time of Setting of Hydraulic Cement Mortar by Modified Vicat Needle¹

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1. Scope

1.1 This test method covers the determination of the time of setting of hydraulic cement mortar by means of the modified Vicat needle.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

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. (Warning—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure. The use of gloves, protective clothing, and eye protection is recommended. Wash contact area with copious amounts of water after contact. Wash eyes for a minimum of 15 min. Avoid exposure of the body to clothing saturated with the liquid phase of the unhardened material. Remove contaminated clothing immediately after exposure.)*

2. Referenced Documents

2.1 ASTM Standards:²

- C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
- C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement
- C 187 Test Method for Normal Consistency of Hydraulic Cement
- C 219 Terminology Relating to Hydraulic Cement
- C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

- C 511 Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- C 778 Specification for Standard Sand
- C 845 Specification for Expansive Hydraulic Cement
- C 1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in the Physical Testing of Hydraulic Cements
- D 1193 Specification for Reagent Water

3. Terminology

3.1 Terms used in this standard are defined in Terminology C 219.

4. Summary of Test Method

4.1 A mortar is prepared with the cement to be tested, using stipulated quantities of cement and water, and sufficient standard sand to produce a required consistency as determined by a stipulated penetration using the plunger of the modified Vicat apparatus. Mortar of the proper consistency is then tested for time of setting, using the needle of the modified Vicat apparatus for the determination of a stipulated penetration. The time required to obtain the stipulated penetration of the modified Vicat needle is the time of setting.

5. Significance and Use

5.1 The purpose of this test method is to establish whether or not a cement complies with a specification limit on time of setting. It has been found to be particularly applicable for the determination of the setting time of expansive cements (see Specification C 845).

6. Apparatus

6.1 *Tamper and Trowel*, conforming to the requirements of Test Method C 109.

6.2 *Vicat Apparatus*, conforming to the requirements of Test Method C 187, with the following modifications:

¹ This test method is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.30 on Time of Set.

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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.

6.2.1 For consistency determination, the plunger end of the movable rod shall be 17.5 ± 0.5 mm in diameter instead of 10 mm, and the total mass of the movable rod (including the 17.5-mm plunger) shall be 400 ± 0.5 g.

6.2.2 For time of setting determination, a 2 ± 0.05 -mm stainless steel needle shall be substituted for the 1-mm needle. The total mass of the movable rod with the 2-mm needle shall be 300 ± 0.5 g.

6.3 *Mold for Consistency and Setting Time*—A smooth cylindrical brass ring 76 ± 0.5 mm inside diameter (3-in. brass tubing) by 40 ± 1 mm deep, cemented to a plane, non-absorptive plate, or smooth cylindrical brass cups having the above dimensions.

6.4 *Mixer, Bowl, Paddle, and Scraper*, conforming to the requirements of Practice C 305.

6.5 *Glass Graduates*, conforming to the requirements of Specification C 1005.

6.6 *Masses and Mass Determining Devices*, conforming to the requirements of Specification C 1005.

7. Reagents and Materials

7.1 *Graded Standard Sand*, conforming to the requirements of Specification C 778.

7.2 *Mixing Water*—Potable water is satisfactory for routine tests. For all referee and cooperative tests, reagent water conforming to the requirements of Specification D 1193 for Type III or Type IV grade of reagent water shall be used.

8. Sampling

8.1 When the test is part of acceptance testing, sample the cement in accordance with Practice C 183.

9. Conditioning

9.1 Maintain the temperature of the room, dry materials, paddle, bowl, and molds at $23.0 \pm 3.0^\circ\text{C}$.

9.2 Maintain the temperature of the mixing water at $23.0 \pm 2.0^\circ\text{C}$.

9.3 The relative humidity of the laboratory shall not be less than 50 %.

9.4 The moist closet or moist room shall be in accordance with Specification C 511.

10. Procedure

10.1 *Preparation of Mortar*:

10.1.1 Mix 750 g of cement, 375 mL of water, and the quantity of graded standard sand required to give the consistency specified below under “Test for Consistency” in accordance with the mortar mixing procedure described in Practice C 305.

10.1.2 Upon completion of mixing, place a layer of mortar about 20 mm in thickness in the mold and puddle with the tamper. Hold the tamper with the 25-mm side parallel to the radius of the mold for 14 strokes spaced equally around the outside of the mold. Apply an additional four strokes to the

center of the specimen with the longitudinal axis of the tamper at the center of the mold and rotate the tamper 45° between each stroke. Then fill the mold to overflowing with mortar and puddle as specified for the first layer. Cut off the mortar to a plane surface flush with the top of the mold in two operations. First, with the trowel held at about a 20° angle, start at one side of the mold, 10 mm above the mold, and finish the stroke by cutting the mortar off the top of the mold at the opposite side. Second, starting from the opposite direction, cut the mortar flush with the top of the mold by drawing the straight edge of the trowel (held nearly perpendicular to the mold) with a sawing motion across the top of the mold.

10.2 *Test for Consistency*—Center the mortar confined in the mold under the movable rod of the modified Vicat apparatus described above. Bring the plunger in contact with the surface of the mortar and tighten the setscrew. Then set the movable indicator to the upper zero mark on the scale, or take an initial reading, and release the rod 35 to 50 s after starting to fill the mold. The mortar shall have the desired consistency when the rod settles to a point 20 ± 4 mm below the original surface 30 s after being released. Cover the bowl containing the remainder of the mortar with the lid while the consistency test is being made. Make trial mortars with varying percentages of standard sand until the desired consistency is obtained.

10.3 *Test for Time of Setting*—Mix the mortar remaining in the bowl at medium speed (285 ± 10 rpm) for 30 s after it has been found that the mortar has the proper consistency. Following the completion of the mixing, mold the test specimen as specified above. Immediately after molding, place the test specimen in the moist closet or moist room where it shall remain except when penetration tests are being made. Allow the time of setting specimen to remain in the moist closet or moist room for 30 min without being disturbed. Then, using the modified Vicat apparatus described above, bring the needle in contact with the surface of the mortar and tighten the setscrew. Set the movable indicator to the upper zero mark on the scale, or take an initial reading. Release the rod quickly by releasing the setscrew, and allow the needle to settle for 30 s. Determine the penetration of the needle at this time and every 30 min thereafter until the needle fails to penetrate to the bottom of the mold. Then, take penetration tests every 10 min until a penetration of 10 mm or less is obtained. Perform no penetration test closer than 10 mm from any previous penetration test or from the inside edge of the mold. Record the results of all penetration tests, and, by interpolation, determine the time when a penetration of 10 mm is obtained. The difference, in minutes, between the time of contact of cement and water in the mortar mixing procedure and the time a penetration of 10 mm is obtained is the time of setting.

10.4 *Precautions*—Maintain testing apparatus on a rigid surface, free of vibration during the penetration test. Do not oil the plunger of the Vicat apparatus at any time, but keep the plunger and guide bearing clean at all times.

11. Calculation

11.1 Calculate the time of setting to the nearest minute as follows:

$$\left(\left(\frac{B-A}{C-D} \right) \times (C-10) \right) + A \quad (1)$$

where:

A = time in minutes of last penetration greater than 10 mm,

B = time in minutes of first penetration less than 10 mm,

C = penetration reading at Time *A*, and

D = penetration reading at Time *B*.

12. Report

12.1 Report the time of setting in minutes, to the nearest minute.

13. Precision and Bias

13.1 The multilaboratory standard deviation has been found to be 15.2 min. Therefore, the results of two properly con-

ducted tests from two different laboratories on samples of the same cement should not differ by more than 45 min. (See Note 1)

13.2 No information can be presented on the bias of the procedure in this test method for measuring time of setting because no material having an accepted reference value is available.

NOTE 1—These numbers represent, respectively, the 1s and d2s limits as defined in Practice C 670.

14. Keywords

14.1 hydraulic-cement mortar; time of setting; Vicat needle, expansive

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