



Designation: C359 – 21

Standard Test Method for Early Stiffening of Hydraulic-Cement (Mortar Method)¹

This standard is issued under the fixed designation C359; 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 early stiffening in hydraulic-cement mortar.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.3 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of 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, health, and environmental 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)*

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:³

C183/C183M Practice for Sampling and the Amount of Testing of Hydraulic Cement

C185 Test Method for Air Content of Hydraulic Cement Mortar

C187 Test Method for Amount of Water Required for Nor-

mal Consistency of Hydraulic Cement Paste

C219 Terminology Relating to Hydraulic and Other Inorganic Cements

C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

C778 Specification for Standard Sand

C1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in Physical Testing of Hydraulic Cements

E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

3. Terminology

3.1 For definitions of terms used in this test method, refer to Terminology C219.

4. Summary of Test Method

4.1 A mortar is prepared with the cement to be tested, using specified quantities of cement, standard sand, and an amount of water that will produce a mortar with an initial penetration of 46 ± 3 mm, using the modified Vicat apparatus. Measurements of penetration are made at stipulated intervals after the beginning of the mixing procedure. Upon completion of the first series of penetration measurements, the mortar is returned to the mixer to be remixed. Following the remix procedure, an additional penetration, termed the remix penetration, is determined. The report is a tabulation of the penetration measurements and the amount of mixing water used.

5. Significance and Use

5.1 The purpose of this test method is to determine the degree to which a cement mortar develops early stiffening. It is intended for use by those interested in methods for determining the potential early stiffening of hydraulic-cement.

5.2 When used for estimating the relative tendency of a cement to manifest early stiffening, a judgment may be made by comparing the behavior in the penetration series (see 10.4.1 and 10.4.2) and the remix procedure (see 10.4.3) to differentiate a relatively less serious and less persistent tendency to

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 Section on Safety, Manual of Cement Testing, *Annual Book of ASTM Standards*, Vol 04.01.

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

early stiffening (false set) from one that is more persistent and, consequently, more serious (flash set).

5.3 Severe false setting in a cement may cause difficulty from a placing and handling standpoint, but it is not likely to cause difficulties where concrete is mixed for a longer time than usual, as usually occurs in transit mixing, or where it is remixed prior to placing or transporting, in concrete pumping operations. It is most likely noticed where concrete is mixed for a short period of time in stationary mixers and transported to the forms in non-agitating equipment, as on some paving jobs, and when concrete is made in an on-site batch plant.

5.4 Cements with severe false setting usually require slightly more mixing water to produce the same consistency, which may result in slightly lower strengths and increased drying shrinkage.

5.5 Early stiffening resulting from false set is not likely to cause a cement to fail the applicable time of setting requirement.

5.6 Early stiffening resulting from flash set, depending on severity, can cause a cement to fail the applicable time of setting requirement.

6. Apparatus

6.1 *Vicat Apparatus*, conforming to the requirements of Fig. 1 in Test Method C187, with the following modifications:

6.1.1 The 1 mm needle shall be replaced by a mass, such that the total mass of the 10 mm plunger, indicator, and added mass shall be 400 ± 0.5 g.

6.2 *Spoon*, conforming to the requirements of Test Method C185.

6.3 *Mixer, Bowl, Paddle, and Scraper*, conforming to the requirements of Practice C305.

6.4 *Glass Graduates*, 200 or 250 mL capacity, conforming to the requirements of Specification C1005.

6.5 *Masses and Mass Determining Devices*, conforming to the requirements of Specification C1005. The devices for determining mass shall be evaluated for continuing precise performance utilizing the procedure in Specification C1005, Appendix X1, using a verification check mass of approximately 1000 g.

6.6 *Thermometer*, ASTM No. S12C or S12F, conforming to the requirements of Specification E2251.

6.7 *Flat Trowel*, having a sharpened straight-edged steel blade 100 to 150 mm in length. The edges when placed on a plane surface shall not depart from straightness by more than 1 mm.

6.8 *Clock Timer*, having a readability to the nearest second.

6.9 *Containers*, approximately 50 by 50 by 150 mm (2 by 2 by 6 in.) inside dimensions (Fig. 1). These containers, which may be made of any suitable materials such as sheet metal or plastic, shall be rigid, watertight, and at least 50 mm (2 in.) deep.

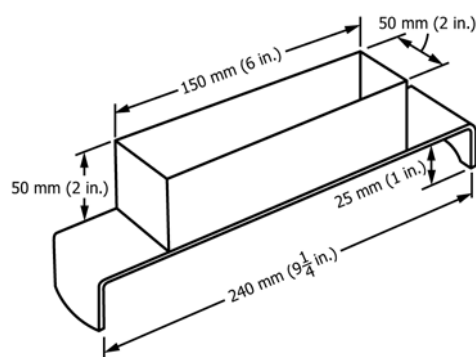


FIG. 1 Container for Early Stiffening Tests

7. Reagents and Materials

7.1 *Standard Sand, 20-30 and Graded*, conforming to the requirements of Specification C778.

7.2 *Mixing Water*—Potable water is satisfactory for routine tests. Use reagent water for all referee and cooperative tests.

8. Sampling

8.1 When the test is part of acceptance testing, sample the cement in accordance with Practice C183/C183M.

9. Conditioning

9.1 Maintain the temperature and humidity of the mixing room in accordance with Specification C511.

9.2 The mixing apparatus shall be within the temperature range of the mixing room prior to testing.

NOTE 1—This test method may adjust the temperature of either the mix water, cement, sand or a combination in order to obtain a specified mortar temperature range. Starting the test with the initial dry material and water temperatures within the mixing room temperature range is recommended.

10. Procedure

10.1 *Batch*—Mix at one time 600 g of cement, 300 g of graded standard sand, 300 g of 20-30 standard sand, and an amount of water that produces a mortar with an initial penetration of 46 ± 3 mm.

10.2 *Mixing of Mortar*—Mix in the mechanical mixer as follows:

10.2.1 Place the sand and cement in the dry bowl, and mix the dry materials for a few seconds with the spoon.

10.2.2 Place the bowl in the mixer, set the paddle in place, and mix the dry materials for 10 s at a slow speed (140 ± 5 r/min).

10.2.3 With the mixer operating at a slow speed (140 ± 5 r/min), add the entire quantity of mixing water within 5 s. Stop the mixer, quickly change to a medium speed (285 ± 10 r/min), and continue the mixing for 1 min, timing from the first addition of water.

10.2.4 Stop the mixer, scrape the sides of the mixing bowl with the rubber scraper, and quickly place the thermometer in the mortar. Allow it to stand undisturbed for the remainder of a 45-s interval from the time of stopping the mixer.