



Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar¹

This standard is issued under the fixed designation C 87; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers the determination of the effect on mortar strength of the organic impurities in fine aggregate, whose presence is indicated using Test Method C 40. Comparison is made between compressive strengths of mortar made with washed and unwashed fine aggregate.

1.2 The SI values shown are to be regarded as the standard. The inch-pound values shown in parentheses are provided for information purposes 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 exposed skin and tissue upon prolonged exposure.)²

2. Referenced Documents

2.1 ASTM Standards:³

- C 33 Specification for Concrete Aggregates
- C 40 Test Method for Organic Impurities in Fine Aggregates for Concrete
- C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
- C 128 Test Method for Density, Relative Density, (Specific Gravity), and Absorption of Fine Aggregate
- C 150 Specification for Portland Cement
- C 230 Specification for Flow Table for Use in Tests of Hydraulic Cement

- C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
- C 511 Specification for Mixing Rooms, 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 702 Practice for Reducing Samples of Aggregate to Testing Size
- D 75 Practice for Sampling Aggregates
- D 3665 Practice for Random Sampling of Construction Materials

3. Summary of Test Method

3.1 A portion of the fine aggregate that produced a color darker than the standard in Test Method C 40 is used to prepare mortar cube specimens. A separate portion of the same fine aggregate is washed in sodium hydroxide solution to remove the organic impurities that caused the failing result when tested in accordance with Test Method C 40, and that washed fine aggregate is used to prepare another set of mortar cube specimens.

3.2 After curing for a stated period, the compressive strengths of the two sets of cube specimens are determined and compared.

4. Significance and Use

4.1 This test method is of significance in making a final determination of the acceptability of fine aggregates with respect to the requirements of Specification C 33 concerning organic impurities.

4.2 This test method is applicable to those samples which, when tested in accordance with Test Method C 40, have produced a supernatant liquid with a color darker than standard color plate No. 3 or color solution.

4.3 Many specifications provide for the acceptance of fine aggregate producing a darker color in the Test Method C 40 test, when testing by this test method indicates the strength of the mortar cubes prepared with the unwashed fine aggregate is comparable to the strength of mortar cubes made with the washed fine aggregate.

¹ This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.20 on Normal Weight Aggregates.

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² See 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.

5. Apparatus

5.1 *Flow Table, Flow Mold, and Caliper*, as described in Specification **C 230**.

5.2 *Tamper, Trowel, Cube Molds, and Testing Machine*, as described in Test Method **C 109/C 109M**.

5.3 *Mixer, Bowl, and Paddle*, as described in Practice **C 305**.

5.4 *Curing Apparatus*, as described in Specification **C 511**.

5.5 *pH Paper*, 0–14.

5.6 *pH Meter*, capable of reading to 0.1 pH units or better.

6. Reagents and Materials

6.1 Portland cement shall be Type I or Type II, meeting the requirements of Specification **C 150**.

6.2 *Sodium Hydroxide Solution (3 %)*—Dissolve 3 parts by mass of sodium hydroxide (NaOH) in 97 parts water.

6.3 *Phenolphthalein*—Dissolve 1 g of reagent grade phenolphthalein in 1 L of 95 % reagent grade ethyl alcohol.

7. Sampling and Sample Preparation

7.1 If sufficient material remains from the sample used for testing in accordance with Test Method **C 40**, use this material for the tests described in this test method. If there is insufficient material remaining, obtain another field sample from the same source in accordance with Practice **D 75** and Practice **D 3665**.

NOTE 1—At least 20 kg of fine aggregate should be available for the testing described herein.

7.2 If the fine aggregate contains particles coarser than the 4.75-mm (No.4) sieve, remove the coarser particles by sieving on the 4.75-mm (No.4) sieve, so that when the particles are mixed in the designated mixer, there will be no damage to the mixer or crushing of the fine aggregate particles. Determine the percentage of the sample removed. (**Warning**—The clearances between the paddle and the bowl specified in Practice **C 305** are suitable when using the mortar made with graded standard sand. To permit the mixer to operate freely and to avoid serious damage to the paddle and bowl when coarser aggregates are used, it may be necessary to set the clearance adjustment bracket to provide greater clearances than specified. A clearance of approximately 4.0 mm is required in Practice **C 305**; a clearance of approximately 5.0 mm has been found to be satisfactory for this method when used with fine aggregate from which the material retained on the 4.75-mm (No. 4) sieve has been removed.)

7.3 Split the fine aggregate to be used for these tests into two approximately equal portions, using the procedure described in Practice **C 702**. Set one portion aside to be used in the unwashed condition. The second portion is to be washed before use.

7.4 *Preparing Washed Fine Aggregate:*

7.4.1 Perform the washing and rinsing of the fine aggregate with care to minimize the loss of fines, so that the aggregate after washing and rinsing has a fineness modulus within 0.10 of that of the unwashed aggregate.

7.4.2 *Establishing a Standard for Thoroughness of Rinsing*—Place a small amount of the water to be used for washing and rinsing in a clean, clear container, and determine

the pH of the water by use of pH paper, pH meter, or add a drop of phenolphthalein to the wash water and retain for later comparison.

7.4.3 *Washing the Aggregate*—Place sufficient quantity of fine aggregate for three batches in a suitable container, flood with the sodium hydroxide solution, and agitate thoroughly with a spoon or trowel. At the end of the washing and after allowing to stand for fines to settle, siphon off as much of the sodium hydroxide solution as possible, without removing any of the aggregate fines.

7.4.4 *Rinsing the Aggregate*—Add a large quantity of water to the washed aggregate, agitate, allow to stand for fines to settle, and then siphon off the rinse water. Repeat this operation several times, until the water used for rinsing has a pH equal to or lower than the pH of the water prior to contact with the fine aggregate. If phenolphthalein was used as an indicator, the color of the wash water is to be equal or lighter in color than the solution prepared in **7.4.2**.

7.4.5 *Verifying Removal of Organic Impurities*—Repeat the Test Method **C 40** procedure to determine if the washing has removed sufficient organic impurities to produce a satisfactory result (color lighter than the standard). If the fine aggregate continues to produce an unsatisfactory result (color darker than the standard), repeat the washing and rinsing procedure (described in **7.4.3** and **7.4.4**) as many times as necessary until a satisfactory result is obtained by Test Method **C 40**.

8. Procedure

8.1 *Number of Test Batches*—Prepare three batches of mortar using the washed aggregate and three batches of mortar using the unwashed aggregate, on the same day. Mix the batches, alternating between the washed and unwashed aggregate.

8.2 *Fine Aggregate*—For both the washed and the unwashed fine aggregates, bring the portions of fine aggregate to the saturated surface dry condition as described in Test Method **C 128**. Prepare a quantity of aggregate of known mass (*the aggregate specimen*) that is slightly more than needed to produce a single batch of the desired consistency.

8.2.1 *Optionally*, if the absorption has been determined in accordance with Test Method **C 128**, prepare the aggregate for test by adding to a known mass of dry aggregate the amount of water it will absorb, mixing thoroughly, and permitting the aggregate to stand in a covered pan for 30 min before use.

8.3 *Preparation of Mortar*—Prepare the mortar in a mechanical mixer in accordance with the procedure for mixing mortars described in Practice **C 305**, as modified below.

8.3.1 Use water and cement in quantities that will yield a water-cement ratio of 0.6 by mass (See **Note 2**). The mixing water shall be at a temperature of 23.0 ± 2.0 °C (73.5 ± 3.5 °F). The mortar shall be proportioned to produce a consistency of 100 ± 5 % as determined by the Section on Flow Test (see **8.4.1**).

NOTE 2—It has been found that 600 g of cement and 360 mL of water will usually be adequate for a 6-cube batch. The flow is adjusted by the quantity of fine aggregate added to the mixture.

8.3.2 After placing all the mixing water in the bowl, add the cement to the water. Start the mixer and mix at the slow speed

(140 ± 5 r/min) for 30 s. While still mixing at slow speed over a 30-s period, add a measured quantity of aggregate estimated to provide the proper consistency.

NOTE 3—The quantity of aggregate used may be determined by subtracting from a known quantity of prepared aggregate the mass of the portion remaining after mixing.

8.3.3 Stop the mixer, change to medium speed (285 ± 10 r/min), and mix for 30 s.

8.3.4 Stop the mixer and let the mortar stand for 1.5 min. During the first 15 s of this interval, quickly scrape down into the batch any mortar that may have collected on the side of the bowl, then for the remainder of this interval, cover the bowl with the lid.

8.3.5 Finish by mixing for 1 min at medium speed. If the flow appears to be too high during the first 30 s of this period, stop the mixer briefly, add additional fine aggregate, and then complete the final 30 s of mixing.

8.3.6 In any case requiring a remixing interval, any mortar adhering to the side of the bowl shall be quickly scraped down into the batch with the scraper prior to remixing.

8.3.7 Make a determination of the flow.

8.4 Flow Test:

8.4.1 Carefully wipe the flow table clean. Dry the surface and place the flow mold at the center. Immediately after completing the mixing operation, place a layer of mortar approximately 25 mm (1 in.) in thickness in the mold and tamp 20 times with the tamper. The tamping pressure shall be just sufficient to ensure uniform filling of the mold. Slightly overflow the mold with mortar and tamp as specified for the first layer. Cut off the mortar to a plane surface, 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. Wipe the table top clean and dry, being especially careful to remove any water from around the edge of the flow mold. Lift the mold away from the mortar 1 min after completing the mixing operation. Immediately drop the table through a height of 12.7 mm (0.5 in.) ten times in 6 s. The flow is the resulting increase in average diameter of the mortar specimen, measured on at least four diameters at approximately equal angles, expressed as a percentage of the original diameter.

8.4.2 Should the flow be too great, return the mortar to the mixing vessel, add additional fine aggregate, mix for 30 s at medium speed, and make another determination of the flow. If more than two trials must be made to obtain a flow of 100 ± 5 %, consider the mortar as a trial mortar, and prepare a new batch.

8.4.3 If the mortar is too dry, discard the batch and prepare a new batch starting with a smaller quantity of fine aggregate.

8.4.4 Determine the quantity of fine aggregate used by subtracting the mass of the portion remaining from the original mass of the aggregate specimen.

8.5 *Molding Mortar Cubes*—Immediately following completion of a flow test that indicates acceptable consistency, return the mortar from the flow table to the mixing bowl, scrape down the bowl, and then remix the entire batch for 15 s at medium speed. Upon completion of mixing, shake the excess mortar from the paddle into the bowl. Mold one set (three cubes) from each batch, in accordance with Test Method **C 109/C 109M**.

8.6 *Curing and Testing Mortar Cubes*—Store the test specimens in a moist cabinet or moist room maintained at a temperature of 23.0 ± 2.0 °C (73.5 ± 3.5 °F) and relative humidity not less than 95 % for 24 ± ½ h. Additional curing shall be by immersion in saturated lime water maintained at a temperature of 23.0 ± 2.0 °C (73.5 ± 3.5 °F). Determine the compressive strength of the cubes at 7 days in accordance with Test Method **C 109/C 109M**.

9. Calculation and Report

9.1 Calculate the compressive strength of each specimen by dividing the maximum load it carried during the test by the cross-sectional area. Average the strengths of the three specimens from each batch. Calculate three strength ratios by dividing the average strength for a batch containing unwashed fine aggregate by the average strength for the corresponding (in respective order of mixing) batch containing washed fine aggregate.

9.2 Report the average of the three ratios, expressed as a percentage (to the nearest 1 %), as the relative strength for the fine aggregate under test.

9.3 If the fine aggregate was sieved to remove particles coarser than the 4.75 mm (No. 4) sieve (as described in 7.2), so state in the report and indicate the quantity of material removed as a percentage of the original sample mass.

10. Precision and Bias

10.1 The following precision statement is applicable when a test result is the average ratio, as defined by this test method, of three pairs of mortar batch strength tests with all the batches mixed on the same day and tested at the same age.

10.2 The single laboratory coefficient of variation has been determined to be 5.4 % (See Note 4). Therefore, strength ratios of two properly conducted tests in the same laboratory are not expected to differ from each other by more than 15.3 % (See Note 4) of their average. The maximum range (difference between highest and lowest) of the three individual ratios used in calculating the average are not expected to exceed 17 % (See Note 4).

NOTE 4—These numbers represent respectively the (1s %) and (d2s %) limits as described in Practice **C 670**, calculated as described in the section on *Form of Statement for Which a Test Result is Defined as the Average of a Specified Number of Measurements* in Practice **C 670**.

11. Keywords

11.1 aggregate; fine aggregate; organic impurities; mortar strength

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this test method since the last issue, C 87 – 04, that may impact the use of this test method. (Approved July 1, 2005)

(I) Moved old Note 3 into 8.2.1 and revised 8.3.1.

Committee C09 has identified the location of selected changes to this test method since the last issue, C 87 – 03, that may impact the use of this test method. (Approved August 1, 2004)

(I) Revised Sections 4-10.

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