Designation: C87/C87M – 17

Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar[1]

This standard is issued under the fixed designation C87/C87M; 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 the effect on mortar strength of the organic impurities in fine aggregate, whose presence is indicated using Test Method C40/C40M. Comparison is made between compressive strengths of mortar made with washed and unwashed fine aggregate.

1.2 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. Some values have only SI units because the inch-pound equivalents are not used in the practice.

NOTE 1—Sieve size is identified by its standard designation in Specification E11. The alternative designation given in parentheses is for information only and does not represent a different standard sieve size

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 cementitous mixtures are caustic and may cause chemical burns to exposed skin and tissue upon prolonged exposure.)[2]

1.4 *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]

C33/C33M Specification for Concrete Aggregates

C40/C40M Test Method for Organic Impurities in Fine Aggregates for Concrete

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

C125 Terminology Relating to Concrete and Concrete Aggregates

C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate

C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates

C150/C150M Specification for Portland Cement

C230/C230M Specification for Flow Table for Use in Tests of Hydraulic Cement

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

C702/C702M Practice for Reducing Samples of Aggregate to Testing Size

D75/D75M Practice for Sampling Aggregates

D3665 Practice for Random Sampling of Construction Materials

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 *Definitions:*

[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.

Current edition approved May 1, 2017. Published July 2017. Originally approved in 1931. Last previous edition approved in 2010 as C87/C87M–10. DOI: 10.1520/C0087_C0087M-17.

[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

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

4. Summary of Test Method

4.1 A portion of the fine aggregate that produced a color darker than the standard in Test Method C40/C40M 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 C40/C40M, and that washed fine aggregate is used to prepare another set of mortar cube specimens.

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

5. Significance and Use

5.1 This test method is of significance in making a final determination of the acceptability of fine aggregates with respect to the requirements of Specification C33/C33M concerning organic impurities.

5.2 This test method is applicable to those samples which, when tested in accordance with Test Method C40/C40M, have produced a supernatant liquid with a color darker than standard color plate No. 3 or color solution.

5.3 Many specifications provide for the acceptance of fine aggregate producing a darker color in the Test Method C40/C40M test, if 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.

6. Apparatus

6.1 *Flow Table, Flow Mold, and Caliper,* as described in Specification C230/C230M.

6.2 *Tamper, Trowel, Cube Molds, and Testing Machine,* as described in Test Method C109/C109M.

6.3 *Mixer, Bowl, and Paddle,* as described in Practice C305.

6.4 *Curing Apparatus,* as described in Specification C511.

6.5 *pH Paper,* 0–14.

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

7. Reagents and Materials

7.1 Portland cement shall be Type I or Type II, meeting the requirements of Specification C150/C150M.

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

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

8. Sampling and Sample Preparation

8.1 If sufficient material remains from the sample used for testing in accordance with Test Method C40/C40M, 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 D75/D75M and Practice D3665.

NOTE 2—At least 20 kg of fine aggregate should be available for the testing described herein.

8.2 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 C305 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. A clearance of approximately 4.0 mm is required in Practice C305; a clearance of approximately 5 mm [3⁄16 in.] 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.)

8.3 Split the fine aggregate to be used for these tests into two approximately equal portions, using the procedure described in Practice C702/C702M. Set one portion aside to be used in the unwashed condition. The second portion is to be washed before use.

8.4 *Preparing Washed Fine Aggregate:*

8.4.1 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.

8.4.2 *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.

8.4.3 *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, spatula, 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.

8.4.4 *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 8.4.2.

8.4.5 *Verifying Removal of Organic Impurities*—Repeat the Test Method C40/C40M 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 8.4.3 and 8.4.4) as many times as necessary until a satisfactory result is obtained by Test Method C40/C40M.

8.4.6 Once the washed materials produce a satisfactory test result (color lighter than the standard), sieve the dried sample in accordance with Test Method C136/C136M to verify compliance with 8.4.1.

9. Procedure

9.1 *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.

9.2 *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 C128. 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 (see Note 3). Record the net mass of the fine aggregate specimen to the nearest 1 g.

9.2.1 *Optionally,* if the absorption has been determined in accordance with Test Method C128, 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.

9.3 *Preparation of Mortar*—Prepare the mortar in a mechanical mixer in accordance with the procedure for mixing mortars described in Practice C305, as modified below.

9.3.1 Use water and cement in quantities that will yield a water-cement ratio of 0.6 by mass (see Note 3). 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 that will result in a flow of 100 ± 5 % as determined by the flow test (see 9.4).

NOTE 3—It has been found that 400 g of cement, 240 mL of water, and approximately 1100 g of sand will usually be adequate for a 3-cube batch. Note that it will be necessary to adjust the actual sand content to obtain the required flow of 100 ± 5%.

9.3.2 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 4—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.

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

9.3.4 Stop the mixer and let the mortar stand for 1.5 min. During the first 15 s of this interval, 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.

9.3.5 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.

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

9.3.7 Make a determination of the flow.

9.4 *Flow Test:*

9.4.1 Wipe the flow table clean. Dry the surface and place the flow mold at the center. 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 overfill 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. 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.

9.4.2 Should the flow be too great, return the mortar to the mixing bowl, 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 in accordance with 9.3.

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

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

9.5 *Molding Mortar Cubes*—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 C109/C109M.

9.6 *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 C109/C109M.

10. Calculation and Report

10.1 Determine the average 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.

10.2 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.

10.3 If the fine aggregate was sieved to remove particles coarser than the 4.75 mm (No. 4) sieve (as described in 8.2), so state in the report and indicate the quantity of material removed as a percentage of the original sample mass.

11. Precision and Bias

11.1 *Precision*—An interlaboratory study of this test method has not been performed. A single-operator precision was obtained in one laboratory using one material. As defined in this test method, a strength ratio is obtained by dividing the average compressive strength of three cubes made from a mortar batch containing the unwashed fine aggregate by the average strength of three cubes from a mortar batch containing the washed fine aggregate. The coefficient of variation of the strength ratio was determined to be 5.4 %.

11.2 *Bias*—There is no accepted reference material suitable for determining the bias in this test method, therefore, no statement on bias is made.

12. Keywords

12.1 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, C87/C87M–10, that may impact the use of this test method. (Approved May 1, 2017)

(1) Added Terminology C125 and Test Method C136/C136M to Section 2.
(2) Added a terminology section.
(3) Revised 5.3.
(4) Added 8.4.6.
(5) Removed subjective words throughout Section 9.
(6) Revised 9.2.
(7) Revised Note 3.
(8) Revised 10.1
(9) Revised 11.1
(10) Added bias statement 11.2.