Designation: C156 – 11

Standard Test Method for Water Loss [from a Mortar Specimen] Through Liquid Membrane-Forming Curing Compounds for Concrete[1]

This standard is issued under the fixed designation C156; 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 laboratory determination of the efficiency of liquid membrane-forming compounds for curing concrete, as measured by their ability to reduce moisture loss from mortar specimens during the early hardening period.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

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.)[2]

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C87 Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
C150 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
C778 Specification for Sand
D1475 Test Method For Density of Liquid Coatings, Inks, and Related Products
D1653 Test Methods for Water Vapor Transmission of Organic Coating Films
D2369 Test Method for Volatile Content of Coatings
E178 Practice for Dealing With Outlying Observations

3. Significance and Use

3.1 The moisture retaining ability of a product as determined by this test method is used to assess the suitability of materials for contributing to an appropriate curing environment for concrete. The laboratory test method is used both in formulating and in specifying or qualifying curing products. This test method gives the user a measure of the ability of tested curing materials to impede the escape of moisture from a hydraulic cement mortar. Since it is desirable to retain moisture in fresh concrete to promote the hydration process, failure of the product to minimize the escape of moisture may lead to loss of strength, cracking, shrinkage, or low abrasion resistance of the hardened concrete, or a combination thereof.

3.2 Many factors affect the laboratory test results. Test results obtained may be highly variable as indicated by the precision statement. Critical factors include the precision of the control of the temperature, humidity and air circulation in the curing cabinet, preparation and sealing of the mortar specimens, the age and surface condition of the mortar specimen when the curing product is applied, and the uniformity and quantity of application of the curing membrane.

4. Apparatus

4.1 *Mechanical Mortar Mixer,* as described in Practice C305, or a larger size mixture operating on the same principle.

4.2 *Flow Table,* as described in Specification C230/C230M.

4.3 *Molds* shall be made of metal, glass, hard rubber, or plastic, and shall be watertight and rigidly constructed to prevent distortion during molding of the specimens or handling of the mold containing fresh mortar. They shall have a minimum surface area of 12000 mm^2 (18.6 $in.^2$), and a minimum depth of 19 mm (¾ in.). The top surface shall be round, square, or rectangular with length not more than twice the width. The top of the mold shall have a rim to provide a firm level surface to support the wood float and to facilitate the

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.22 on Materials Applied to New Concrete Surfaces.

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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**

grooving and sealing steps of the procedure. The rim shall be parallel with the bottom surface of the mold.

NOTE 1—Take care to avoid use of an excessive amount of oil, grease, or mold release compound on molds, particularly along the top rim where sealing compound will be applied. Use of masking tape on the top rim during application of release compound to prevent contamination has been found expedient.

4.4 *Spoon*—A stainless steel serving spoon having a bowl 75 to 100 mm (3 to 4 in.) long and 50 to 75 mm (2 to 3 in.) wide for transferring the mortar from the mixing bowl to the mold.

4.5 *Gloves,* of rubber or plastic, to be worn while molding the specimens.

4.6 *Tamper,* of a nonabsorptive, nonabrasive material such as medium-hard rubber or seasoned oak rendered non-absorptive by immersion for 15 min in paraffin at approximately 200 °C. The tamper shall be rectangular with a 25 by 50-mm (1 by 2-in.) cross section and it shall be a convenient length (150 to 300 mm (6 to 12 in.)).

4.7 *Wood Float,* approximately 75 by 280 by 20 mm thick (3 by 11 by ¾ in.).

NOTE 2—A commercial wood float equipped with a substantial handle can be readily reduced to these dimensions. The float shall be resurfaced or replaced when there is noticeable wear to the floating surface.

4.8 *Brush,* medium-soft bristle 50-mm (2-in.) paint brush to brush the surface of the specimens prior to sealing.

4.9 *Curing Cabinet,* maintained at a temperature of 37.8 ± 1.1°C (100± 2 °F) and a relative humidity of 32 ± 2 %. The curing cabinet shall be of a design that allows movement of conditioned air such that the solvent from the curing compound will be readily evaporated and eliminated from the system. Air flow over the specimens shall be adjusted to provide an evaporation rate of 2.0 to 3.4 g/h as measured by the procedure of Annex A1. The evaporation rate shall initially be measured for each position in the cabinet in which a specimen will be placed, and shall be verified annually and whenever any changes are made to the cabinet. The range of evaporation rates for all specimen positions in the test cabinet shall be reported.

4.10 *Balance,* having the capacity to determine the mass of a filled specimen mold to the nearest 0.1 g or less.

4.11 *Applicator*—For spray application, any apparatus that can be used to apply the curing compound uniformly and with minimum overspray is acceptable. For brush or roller application, use the equipment recommended by the curing compound manufacturer.

5. Materials

5.1 *Portland Cement,* conforming to the requirements for Type I of Specification C150.

5.2 *Graded Standard Sand,* conforming to the requirements of Specification C778.

5.3 *Sealing Compound,* that will not be affected by the curing material and which effectively seals against moisture loss between the boundary of the specimen and the edge of the mold.

NOTE 3—Tissue embedding wax, readily available from scientific supply houses, is a convenient and reliable sealant.

6. Conditioning

6.1 The temperature of the room and of all materials when used in this test shall be 23 ± 2 °C (73 ± 4 °F) unless otherwise specified, and the room humidity shall be 50 ± 10 %.

7. Number of Specimens

7.1 A set of three or more test specimens shall be made in order to constitute a test of a given curing material.

NOTE 4—When more than one set of specimens is to be prepared, each set should be handled as a group throughout the preparation to make the elapsed time between molding and application of the curing product as uniform as possible. This may require mixing the mortar for each set separately.

7.2 For determining the quantity of curing compound to be applied (MA) calculate the total top surface area of the specimen, including the seal and the rim of the mold in square millimetres using appropriate geometric formulae.

NOTE 5—The area (A) used in calculating the mass loss per unit area (L) is calculated in 14.2 from the surface dimensions measured inside the seal of the specimen.

8. Proportioning and Mixing Mortar

8.1 *Proportioning*—Determine the sand content of the mortar by adding dry sand to a cement paste having a water-cement ratio of 0.40 by weight, to produce a flow of 35 ± 5 in 10 drops of the flow table, following the procedure described in Test Method C87. Discard the mix used to determine the proportion of sand to cement.

NOTE 6—The sand:cement ratio required varies with the source of the cement. A ratio of 2.5:1 is suggested as a starting point. Flow may be determined on a 3 to 4 kg batch of mortar which is conveniently mixed in the mixer described in Practice C305. The mixture used to establish the sand:cement ratio is discarded because it is thought that the age and mixing history of the mortar affect the final moisture loss results and must be controlled.

8.2 *Mixing*—Combine the components of the mortar in a mortar-mixing machine to produce a homogeneous mortar not more than 6 min from the time the water and the cement are combined.

NOTE 7—A generally effective sequence is to add the cement to all of the water in the mixing bowl and allow it to stand for 30 s. Then, mix at low speed for 30 s and, without stopping the mixer, add the sand within 30 s and continue mixing for 1 min. Stop the mixer for 1 min. During the first 15 s, scrape down the sides of the bowl. Finish by mixing for an additional 1 min, and promptly begin molding the specimens.

9. Preparing Specimens

9.1 Thoroughly clean the molds before each use. Use of a mold release is acceptable provided that care is taken to avoid its application to the top rim of the mold to prevent interference with sealing of the edge.

9.2 Half fill the mold and spread the mortar with the back of the spoon to create a layer of approximately uniform thickness. Tamp over the entire surface with one stroke of the 25 by 50 mm (1 by 2 in.) face of the tamper per 1000 mm^2 of surface area rounded to the nearest integer. Place a second layer of

mortar, sufficient in amount to slightly overfill the mold and tamp in a similar manner. Using the 25-mm (1-in.) wide by 150 to 300-mm (6 to 12-in.) long edge of the tamper, fill the indentations made by the tamping and level the surface by pressing down firmly with a series of contacts across the entire surface. Strike off the specimen level with the top of the mold using a wood float with one pass only, in the direction of the long axis of the specimen for rectangular molds, using a sawing motion of the float. Keep the 75-mm (3-in.) face of the float firmly in contact with the mortar and edges of the mold so that the float creates a uniformly dense surface free of voids and cracks.

9.3 Immediately after molding, wipe the outside surfaces of the molds clean, and place the specimens in the curing cabinet maintained at the conditions specified in 4.9. The specimens shall be level and not subject to vibration. The spacing between the individual specimens and between the specimens and the side walls of the cabinet shall be between 50 and 175 mm (2 to 7 in.). Within these limits the spacing shall be the same for all specimens. Use dummy specimens to fill any empty spaces in the cabinet.

10. Surface Preparation and Edge Sealing

10.1 Remove the specimens from the cabinet immediately upon disappearance of the surface water and lightly brush the surface using just sufficient force to remove the laitance and glaze without scarifying the mortar surface. If surface water appears after brushing, return the specimen to the cabinet but immediately remove the specimen upon the disappearance of the surface water brought to the surface by the brushing operation, and brush again. The mortar shall be free of surface water but shall not be dry below the surface. The proper surface condition will be attained when brushing does not bring free water to the surface, or produce smearing, and can be determined by gently rubbing an area with the finger tip.

NOTE 8—The exposure time in the cabinet and the initial moisture loss that will result in the proper surface condition is characteristic of the curing cabinet used and other testing conditions related to the laboratory performing the test. Uniformity of test surface conditions may be maintained by setting an expected exposure time or initial moisture loss. When any test condition is changed (sand, cement, and so forth), a new exposure time or initial moisture loss, or both, shall be determined.

10.2 Form a V-shaped groove approximately 3 mm (⅛ in.) deep and not more than 3 mm (⅛ in.) wide between the edge of the mortar specimen and the mold. Fill the groove with the sealing compound. The sealing compound shall not extend more than 6 mm (¼ in.) from the edge of the mold onto the surface of the specimen.

NOTE 9—To cut out the groove for sealing, the tip of a pointed trowel, a pointed spatula, a pointed triangular can opener, or a "hawksbill point" ground on the end of a spatula or knife blade have all been reported to be effective.

11. Application of Curing Materials

11.1 Determine the density of the curing compound, Dm, in accordance with Test Method D1475.

11.2 Calculate the mass of the curing compound to be applied, *MA*, to the nearest 0.1 g based on the specified application rate, the total surface area calculated per 7.2, and the density of the curing compound, Dm. If no rate is specified, apply the curing compound at the rate of 5.0 m^2/L (200 ft^2/gal). The method of application shall be in accordance with the manufacturer's recommendations.

11.3 Immediately after sealing, weigh the specimen to the nearest 0.1 g (M_1); then uniformly apply the curing compound at the specified rate of application. Application shall be made expeditiously to only one specimen at a time.

NOTE 10—It is desirable to use a spray booth or a laboratory hood to control overspray and solvent fumes especially for curing compounds that are sprayed. However, the velocity of air movement in the vicinity of the specimen must be kept at a minimum so as to prevent, as much as possible, significant loss of volatiles during spraying and before the final weighing. Spraying shall be accomplished with the minimum pressure and flow rate of air with which an acceptable spray pattern can be attained.

11.4 Determine the proper coverage by comparing the initial mass of the specimen (M_1), before applying the curing compound, to the mass after coating. The final mass shall equal the initial mass of the specimen plus the predetermined mass of the curing compound to be applied. This will necessitate frequent weighing of the specimen during application as full coverage is approached. In the case of brush application, proper coverage may be determined by weighing the container, brush, and curing compound before and after application of the compound to the specimen. Total time for application shall not exceed 2 min. Weigh to the nearest 0.1 g (M_2). If the final amount of curing compound applied differs from the calculated amount for the specified coverage by more than 10 %, the specimen shall be discarded.

NOTE 11—In previous versions of this test method, coverage was determined by weighing the application equipment and the curing compound before and after application to the specimen. Which method is more precise has not been established.

11.5 Return the specimens to the cabinet without delay.

NOTE 12—Unusual loss caused by a leaking mold or a faulty seal may be detected by weighing the specimens 3 to 4 h after application of the curing material. If one specimen has lost considerably more than the others, this specimen is probably faulty. If only three specimens are being tested, consider the test invalid (see 14.4).

12. Determination of Non-Volatile Content of Curing Compounds

12.1 Determine the proportion of non-volatile matter in the curing compound (*NV*) in accordance with Test Method D2369.

13. Duration of Test

13.1 Specimens shall be stored in the test cabinet for 72 h, then removed, and immediately weighed (M_3). Other test times may be specified by the purchaser.

14. Calculation

14.1 *Loss of Mass:*

14.1.1 Calculate the loss of mass from each specimen in grams as follows:

$$ML = M_1 + (NV \times MA) - M_3 \quad (1)$$

where:

ML = mass loss of the specimen, g,
M_1 = mass of the sealed specimen, g,
NV = proportion of non-volatile matter in the curing compound, g,
MA = mass of the curing compound applied, g, = $M_2 - M_1$,
M_2 = mass of the specimen immediately after applying curing compound, g, and
M_3 = mass of specimen at the conclusion of the test, g.

14.2 *Specimen Area:*

14.2.1 Calculate the area of the specimen (A) in square millimetres by measuring the dimensions of the surface from the inner edges of the seal to the nearest millimetre and applying the appropriate geometric formula.

14.3 For each specimen, calculate the mass loss per unit area (L) in kg/m^2 as:

$$L = 1000 \times ML/A \quad (2)$$

14.4 *Rejection of Results:*

14.4.1 In a set of three or more specimens, if the difference in moisture loss between the specimen having the greatest loss and that with the least loss exceeds 0.15 kg/m^2, the test shall be repeated and the average taken as that of all specimens in the original and repeat tests. If, after the repeat test, it is determined that the result on a single specimen, whether from the original or repeat test, meets the criteria for rejection as an outlier as given in Practice E178, such value shall be disregarded and a new average calculated that does not include such outlying value.

15. Report

15.1 Report the following information for the materials tested:

15.1.1 Manufacturer's name, address, and brand designation,

15.1.2 Type of curing material,

15.1.3 Manufacturer's batch number,

15.1.4 Quantity of material represented by the sample,

15.1.5 Date sampled, and

15.1.6 Source of the sample.

15.2 Report the following information regarding the test:

15.2.1 Laboratory sample identification,

15.2.2 Surface area inside the seal and depth of mortar specimens,

15.2.3 Brand of cement used,

15.2.4 Proportions of mortar by weight,

15.2.5 Method of application,

15.2.6 Duration of the test,

15.2.7 Range of evaporation rates of test cabinet,

15.2.8 Rate of application, and

15.2.9 Average loss of water per unit area.

16. Precision and Bias

16.1 *Precision*—Efforts to establish a more meaningful measure of the precision of this test method continue. The previous version of this test method, containing some differences in testing technique, contained a precision statement. The single-operator standard deviation was reported as 0.13 kg/m^2 and the multilaboratory standard deviation as 0.30 kg/m^2.[4]

16.2 *Bias*—Since there is no accepted reference material suitable for determining the bias of this test method, no statement on bias is being made.

17. Keywords

17.1 concrete curing materials; liquid membrane-forming curing compounds; moisture retention by concrete curing materials

[4] See Test Method C156 – 80a, *1987 Annual Book of ASTM Standards*, Vol 04.02.

ANNEX

(Mandatory Information)

A1. STANDARDIZATION OF EVAPORATION RATE IN TEST CABINETS

A1.1 This procedure provides a means for measuring the rate of evaporation of water from a standard surface in order to characterize a controlled set of environmental conditions (temperature, humidity, air circulation) by providing a system which will lose water at a nearly constant rate for a period of time long enough to establish a characteristic rate. Comparison of results from different positions in the same cabinet can establish whether or not conditions are uniform throughout the cabinet. Comparisons between labs may help to rationalize differing results.

A1.2 *Apparatus:*

A1.2.1 *Cup*—A permeability cup, conforming to the specifications of Test Method D1653.

A1.2.2 *Filter Paper*—7 cm disks.

A1.2.3 *Absorbent Filler*—Absorbent cotton balls.

A1.2.4 *Mold Cover*—Stiff cardboard or sheet metal plate having the same dimensions as the top of the specimen mold, and having a 63 mm (2½ in.) diameter hole in its center.

A1.2.5 *Balance*—Any balance having a capacity of 200 g or more and a sensitivity and accuracy of 0.01 g or less.

A1.3 *Procedure:*

A1.3.1 Fill the permeability cup with the absorbent filler using three cotton balls pulled together to make a uniform sponge. Fill the cup with distilled water, lay a disk of filter paper over the cup, and complete assembly of the cup. Place the mold cover on top of an empty specimen mold and fasten it in place with masking tape. Put the cup in the hole in the center of the mold. Place the mold and cup in the test cabinet in the position to be tested and allow 1 h for it to reach temperature equilibrium. Determine the mass of the cup to the nearest 0.01 g and immediately return it to the cabinet. Reweigh at approximately 1 h intervals for 5 to 7 h. Record the mass and the total elapsed time to the nearest 2 min for each interval.

A1.4 *Calculation:*

A1.4.1 Calculate the total mass loss at each time interval as follows:

$$L = m_i - m_t \quad \text{(A1.1)}$$

where:

L = cumulative mass loss,
m_i = initial mass, and
m_t = mass at time, t.

A1.4.2 Plot the cumulative mass loss (L) versus elapsed time (t) and determine the slope for the test period. Report as loss rate in grams per hour. Alternatively, the slope may be calculated by a "least squares" method. (The rate of loss should be nearly constant throughout the test period.)

A1.5 : *Precision and Bias:*

A1.5.1 *Precision*—Data for a precision statement is being collected.

A1.5.2 *Bias*—This test method has no bias because the evaporation rate is defined only in terms of this test method.

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this test method since the last issue, C156–09a, that may impact the use of this test method. (Approved June 1, 2011)

(*1*) Revised 1.1.

(*2*) Added new 11.1 and renumbered subsequent paragraphs. Revised 11.2.

Committee C09 has identified the location of selected changes to this test method since the last issue, C156–09, that may impact the use of this test method. (Approved December 15, 2009)

(*1*) Revised the title of the standard.