Designation: C1646/C1646M – 16

Standard Practice for Making and Curing Test Specimens for Evaluating Resistance of Coarse Aggregate to Freezing and Thawing in Air-Entrained Concrete[1]

This standard is issued under the fixed designation C1646/C1646M; 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 practice covers procedures for making and curing test specimens for evaluating resistance of normal-weight coarse aggregates to freezing and thawing in air-entrained concrete in accordance with Test Method C666/C666M, Procedure A or B.

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.

1.3 *This practice does not purport to address all 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 use.[2])

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C33 Specification for Concrete Aggregates

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C125 Terminology Relating to Concrete and Concrete Aggregates

C143/C143M Test Method for Slump of Hydraulic-Cement Concrete

C150 Specification for Portland Cement

C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

C490 Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete

C494/C494M Specification for Chemical Admixtures for Concrete

C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing

D75 Practice for Sampling Aggregates

2.2 *ACI Standard:*[4]

211.1 Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this specification, refer to Terminology C125.

4. Significance and Use

4.1 This practice provides standard requirements for proportioning concrete, and for preparing and conditioning test specimens suitable for evaluating the durability of coarse aggregate in air-entrained concrete subjected to freezing and thawing in accordance with Test Method C666/C666M.

4.2 Concrete having an adequate air-void system may not be resistant to freezing and thawing if it contains coarse aggregate that becomes critically saturated. An aggregate particle is considered to be critically saturated when there is insufficient unfilled pore space to accommodate the expansion of water that accompanies the freezing.

[1] This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.67 on Resistance to the Environment.

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[2] Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Volume 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.

[4] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.aci-int.org.

***A Summary of Changes section appears at the end of this standard**

5. Apparatus

5.1 Equipment for mixing concrete and procedures for making and curing test specimens shall be in accordance with Practice C192/C192M.

6. Coarse Aggregate Preparation

6.1 *Sampling*—Sample in accordance with Practice D75.

6.2 *Grading*—When coarse aggregates are to be compared using this practice, standardize the coarse aggregate gradings by recombining individual size fractions in accordance with Table 1 for the appropriate size aggregate being tested. Bring the as-received sample to a saturated-surface-dry (SSD) condition or drier prior to sieving. Do not oven-dry the coarse aggregate sample. If necessary, air drying of the sample to achieve this condition is permitted. The nominal-maximum-aggregate size shall not exceed one-third the least dimension of the test specimen to be used. Fine aggregate shall meet the requirements of Specification C33 and the grading shall conform to Table 1.

6.3 *Conditioning*—Condition fine and coarse aggregates as follows:

6.3.1 *Fine Aggregate*—Uniformly wet the fine aggregate 24 h prior to mixing of concrete so that the moisture content exceeds the saturated-surface-dry condition but there is no tendency for loss of surface water by draining. Keep the fine aggregate covered to prevent evaporation prior to use.

6.3.2 *Coarse Aggregate*—Immerse the coarse aggregate in water 24 h prior to mixing of concrete. On the day of mixing, decant the water from the coarse aggregate.

7. Concrete Mixture

7.1 *Ingredients*—The portland cement shall meet the requirements of Specification C150, Type I or Type II. Batches for a particular test series shall use cement, fine aggregate, and air-entraining admixture taken from the same lot.

7.2 *Air-entraining admixture*—As described in Specification C494/C494M, section on Air-Entraining Admixture (See Note 1).

NOTE 1—As stated in Specification C494/C494M, note that "neutralized Vinsol resin" is required if no material is designated by the person or agency for whom the testing is being performed.

7.3 *Proportions*—Except when tests are being made where mixture proportions are those proposed for the work, proportion all concrete using ACI 211.1 conforming to the following requirements:

7.3.1 The cement content shall be 307 ± 3 kg/m^3 [517 ± 5 lb/yd^3]

7.3.2 The air content used in the computation of mixture proportions shall be in accordance with Table 2. The amount of air-entraining admixture used shall be such as to give an air content as prescribed in Table 2, ± 1 %, when tested according to Test Method C231 or Test Method C173/C173M.

7.3.3 The mixture shall contain the amount of coarse aggregate shown in the "Volume of Coarse Aggregate Per Unit of Volume of Concrete" table of ACI 211.1 for the nominal-maximum size of aggregate and for the fineness modulus of the fine aggregate being used.

7.3.4 Adjust the water content and fine aggregate content to obtain a slump of 75 ± 25 mm [3 ± 1 in.] when tested in accordance with Test Method C143/C143M.

7.4 *Mixing*—Machine mix the concrete as prescribed in Practice C192/C192M.

8. Specimen Preparation and Conditioning

8.1 *Specimen Preparation*—The type and size of the test specimen and the method for molding shall be in accordance with the Test Specimen section of Test Method C666/C666M, unless otherwise specified. If length change testing is to be performed as a permitted option in Test Method C666/C666M, fit the specimens with axially centered stainless steel gauge studs in accordance with Practice C490.

8.2 *Number of Specimens*—Make at least three freezing-and-thawing test specimens from each batch. In addition, make at least three cylindrical specimens from each batch for strength verification. The cylindrical specimens shall be made in accordance with Practice C192/C192M and tested in accordance with Test Method C39/C39M.

TABLE 1 Grading Requirements

		Amounts Finer Than Each Laboratory Sieve, Mass Percent									
Size No.	Nominal Max. Size	37.5 mm [1 ½ in.]	25.0 mm [1 in.]	19.0 mm [¾ in.]	12.5 mm [½ in.]	9.5 mm [⅜ in.]	4.75 mm [No. 4]	2.36 mm [No. 8]	1.18 mm [No. 16]	300 µm [No. 50]	150 µm [No. 100]
467	37.5 mm [1 ½ in.]	100	70	50	30	20	0				
56	25.0 mm [1 in.]		100	60	25	0					
57	25.0 mm [1 in.]		100	75	40		0				
6	19.0 mm [¾ in.]			100	35	0					
67	19.0 mm [¾ in.]			100	60	35	0				
7	12.5 mm [½ in.]				100	55	0				
8	9.5 mm [⅜ in.]					100	20	0			
89	9.5 mm [⅜ in.]					100	35	15	0		
Fine Aggregate	4.75 mm [No. 4]						100		65-75	12-20	2-5

TABLE 2 Target Total Air Content

	Nominal Maximum Size of Aggregate, mm [in.]				
	9.5 [⅜]	12.5 [½]	19.0[¾]	25.0 [1]	37.5 [1 ½]
Total Air Content, %	7.5	7.0	6.0	6.0	5.5

8.3 *Curing*—Complete initial storage and remove from molds in accordance with Practice C192/C192M. After removal from the molds, inspect for defects and store in saturated limewater at 23.0 ± 2.0 °C [73.5 ± 3.5 °F] to an age of 14 days.

9. Method of Test

9.1 After the specimens have cured, test in accordance with Procedure A or Procedure B of Test Method C666/C666M.

10. Keywords

10.1 aggregate; coarse aggregate; freezing and thawing

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this practice since the last issue, C1646/C1646M – 08a, that may impact the use of this practice. (Approved June 1, 2016.)

(1) Revised Section 4: Significance and Use.