



Designation: C233/C233M – 18

# Standard Test Method for Air-Entraining Admixtures for Concrete<sup>1</sup>

This standard is issued under the fixed designation C233/C233M; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This test method covers the testing of materials proposed for use as air-entraining admixtures in the field.

1.2 The text of this test method 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.

1.3 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 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.

1.4 *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.*

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:<sup>2</sup>

C33/C33M Specification for Concrete Aggregates

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

C78/C78M Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

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

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

C150/C150M Specification for Portland Cement

C157/C157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete

C172/C172M Practice for Sampling Freshly Mixed Concrete

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

C185 Test Method for Air Content of Hydraulic Cement Mortar

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

C231/C231M Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

C232/C232M Test Method for Bleeding of Concrete

C260/C260M Specification for Air-Entraining Admixtures for Concrete

C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

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

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

D75/D75M Practice for Sampling Aggregates

D1193 Specification for Reagent Water

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E70 Test Method for pH of Aqueous Solutions With the Glass Electrode

### 2.2 ACI Standards:

ACI 211.1 Recommended Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete<sup>3</sup>

## 3. Significance and Use

3.1 This test method is used to develop data for comparison with the requirements of Specification C260/C260M. These

<sup>3</sup> American Concrete Institute Manual of Concrete Practice, Part 1, pp. 211-1 to 211-38 (1993).

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

tests are based on arbitrary stipulations permitting highly standardized testing in the laboratory, and are not intended to simulate actual job conditions.

#### 4. Materials

4.1 *Cement*—The cement used in any series of tests shall be either the cement proposed for specific work in accordance with 4.4, a Type I or Type II cement conforming to Specification C150/C150M, or a blend of two or more cements, in equal parts. Each cement of the blend shall conform to the requirements of either Type I or Type II, Specification C150/C150M. If a blend of cements is used, it shall be a combination which produces an air content of less than 10 % when tested in accordance with Test Method C185 (Note 5).

4.2 *Aggregates*—Except when tests are made in accordance with 4.4, using the aggregates proposed for specific work, the fine and coarse aggregates used in any series of tests shall come from single lots of well-graded, sound materials that conform to the requirements of Specification C33/C33M, except that the grading of the aggregates shall conform to the following requirements:

4.2.1 *Fine Aggregate Grading*—The fine aggregate shall meet the requirements for the fine aggregate in Specification C33/C33M.

4.2.2 *Coarse Aggregate Grading*—The coarse aggregate grading shall meet the Size 57 grading requirements of Specification C33/C33M.

NOTE 2—Take care in loading and delivery to avoid segregation.

4.2.3 The coarse aggregate used for the reference concrete and test concretes shall be essentially the same. Provide sufficient coarse aggregate for the reference concrete, the test concrete, and for the grading analysis. Concrete consists of one reference concrete and as many test admixture-containing concretes as are intended to be compared.

4.2.3.1 Prepare required quantities of coarse aggregate as follows: Fill tared containers, one for sieve analysis, one for a batch of reference concrete, and one for a batch of test concrete, to the required mass from the aggregate stockpile (See Note 3). Accomplish this by placing equal quantities into each container, successively, and repeat the procedure until all the containers have their required mass (See Note 3).

NOTE 3—See the Appendix of Practice D75/D75M, Sampling from Stockpiles, and the section on Sampling Aggregates in the Manual of Aggregate and Concrete Testing<sup>4</sup> for guidance on procedures for sampling from stockpiles.

4.2.4 Perform sieve analysis on the coarse aggregate sample prepared in 4.2.3.1 by Test Method C136/C136M. Discard any set for which the sample does not comply with Size 57. Average test results for samples that comply with Size 57 for each sieve size. Discard any set for which the sample deviates from this average by more than the amount shown in column 3. Continue the process of preparation, testing and averaging until sufficient sets of aggregate within tolerance are obtained.

<sup>4</sup> Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

Sieve	Specification C33/C33M, No. 57 Percent Passing	Maximum variation from average/ passing
37.5 mm (1½ in.)	100	00
25.0 mm (1.00 in.)	95 to 100	1.0
12.5 mm (½ in.)	25 to 60	4.0
4.75 mm (No. 4)	0 to 10	4.0
2.36 mm (No. 8)	0 to 5	1.0

NOTE 4—All of the results required for demonstrating compliance under this specification are dependent on the uniformity of the aggregate samples prepared and used. Careful, skilled and well-supervised work is essential.

4.3 *Reference Admixture*—For this test method, unless otherwise requested by the purchaser, the reference admixture used in the concrete mixture specified in Section 4 shall be “neutralized Vinsol resin.”<sup>5</sup>

4.4 *Materials for Tests for Specific Uses*—When it is desired to test an air-entraining admixture for use in specific work, the cement and aggregates used shall be representative of those proposed for use in the work, and the concrete mixtures shall be designed to have the cement content specified for use in the work (Note 5). If the maximum size of coarse aggregate is greater than 25.0 mm [1 in.], the freshly mixed concrete shall be screened over a 25.0-mm (1-in.) sieve prior to fabricating the test specimens in accordance with the wet sieving procedure described in Practice C172/C172M.

4.5 *Preparation and Weighing*—All materials shall be prepared and all weighings shall be made as prescribed in Practice C192/C192M.

NOTE 5—It is recommended that whenever practicable, tests be made in accordance with 4.4 using the cement and pozzolanic or chemical admixtures, if any, proposed for specific work.

#### 5. Concrete Mixtures

5.1 *Proportions*—Using ACI 211.1, all concrete shall be proportioned to conform to the following requirements:

5.1.1 The cement content shall be  $307 \pm 3 \text{ kg/m}^3$  [ $517 \pm 5 \text{ lb/yd}^3$ ] except when tests are being made for specific uses (see 4.4).

5.1.2 The first trial mixture shall contain the amount of coarse aggregate shown in Table 6.3.6 of ACI 211.1 for the maximum size of aggregate and for the fineness modulus of the sand being used.

NOTE 6—The volumes of coarse aggregate recommended in ACI 211.1 are intended to ensure workable mixtures with the least favorable combinations of aggregate likely to be used. It is suggested, therefore, that for a closer approximation of the proportions required for this test, the recommended values in ACI 211.1 be multiplied by 1.07 for the first trial mixture.

5.1.3 The air content used in the computation of proportions for all concrete shall be 5.5 % except where the admixture

<sup>5</sup> The sole source of supply of Vinsol resin known to the committee at this time is Hercules Inc., Wilmington, DE. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,<sup>1</sup> which you may attend. Neutralization may be accomplished by treating 100 parts of the Vinsol resin with 9 to 15 parts of NaOH by weight. In an aqueous solution, the ratio of reagent water (See Specification D1193) to the resinate shall not exceed 12:1 by weight.

under test is for use in specific work (see 4.4). In this case the air content used in selecting proportions shall be the median of the range to be permitted in the work. If lightweight aggregates are to be used in specific work, the unit weight of concrete used in selecting proportions shall be the median of the range permitted in the work.

5.1.4 The water content and sand content shall be adjusted to obtain a slump of  $90 \pm 15$  mm [ $3\frac{1}{2} \pm \frac{1}{2}$  in.]. The workability of the concrete mixture shall be suitable for consolidation by hand rodding and the concrete mixture shall have the minimum water content possible. These conditions shall be achieved by final adjustments in the proportion of fine aggregate to total aggregate, in the amount of total aggregate, or both, while maintaining the yield and slump in the required ranges.

5.2 *Conditions*—Concrete mixtures shall be prepared both with the air-entraining admixture under test and with the reference admixture. For the reference mixture, the reference admixture shall be added in amounts necessary to produce an average air content of  $5.5 \pm 0.5$  %, or within the range permitted for the specific work in accordance with 5.1.3. For the test mixture, the test admixture shall be added in amounts necessary to produce an average air content within 0.5 % of the average air content of the reference mixture.

NOTE 7—As an example, if three batches of the reference mixture have air contents of 5.2, 5.3, and 5.2 %, and three batches of the test mixture have air contents of 5.6, 5.9, and 5.7 %, the reference and test mixtures would be in compliance with Section 5.2 because the average air content of the reference mixture, 5.2 %, falls between  $5.5 \pm 0.5$  %, and the average air content of the test mixture, 5.7 %, is within 0.5 % of the average air content of the reference mixture.

## 6. Mixing

6.1 Machine mix the concrete as prescribed in Practice C192/C192M.

## 7. Tests and Properties of Freshly Mixed Concrete

7.1 Test samples of freshly mixed concrete from at least three separate batches for each condition of concrete in accordance with the following methods and the minimum number of tests shall be as prescribed in Table 1.

7.1.1 *Slump*—Test Method C143/C143M.

7.1.2 *Air Content*—Test Method C231/C231M. When lightweight aggregates, air-cooled blast furnace slag, or aggregates of high porosity, for which the aggregate correction factor defined in Test Method C231/C231M exceeds 0.5 %, are used under the provisions of 4.4, use Test Method C173/C173M.

7.1.3 *Bleeding*—Test Methods C232/C232M.

7.1.4 *Time of Setting*—Test Method C403/C403M, except that the temperature of each of the ingredients of the concrete mixtures, just prior to mixing, and the temperature at which the time of setting specimens are stored during the test period shall be  $23.0 \pm 2$  °C [ $73.5 \pm 3.5$  °F].

## 8. Preparation of Test Specimens

8.1 Specimens for test of hardened concrete, representing each test and age of test and each condition of concrete being compared, shall be made from at least three separate batches, and the minimum number of specimens shall be as prescribed in Table 1. On a given day at least one specimen shall be made for each test and age of test from each condition of concrete except that at least two specimens for the freezing and thawing test shall be made from each condition of concrete. The preparation of all specimens shall be completed in three days of mixing.

8.2 *Manifestly Faulty Specimens*—Each group of specimens representing a given test or a given age of test, including tests of freshly mixed concrete, shall be examined visually before or during the test, or both, whichever is appropriate. Discard any specimen found to be manifestly faulty by such examination without testing. Visually examine all specimens representing a given test at a given age after testing, and should any specimen be found to be manifestly faulty, the test results thereof shall be disregarded. Should more than one specimen representing a given test at a given age be found manifestly faulty, either before or after testing, the entire test shall be disregarded and repeated. The test result reported shall be the average of the individual test results of the specimens tested or, in the event that one specimen or one result has been discarded, it shall be the average of the test results of the remaining specimens.

## 9. Test Specimens of Hardened Concrete

9.1 *Number of Specimens*—Make six or more test specimens for the freezing and thawing test and three or more test

**TABLE 1 Types and Minimum Number of Specimens and Tests**

Test	Number of Types of Specimens <sup>A</sup>	Number of Test Ages	Number of Conditions of Concrete <sup>B</sup>	Minimum Number of Specimens
Slump	1	1	2	<sup>C</sup>
Air content	1	1	2	<sup>C</sup>
Bleeding	1	1	2	6
Time of setting	1	<sup>D</sup>	2	6
Compressive strength	1	3	2	18
Flexural strength <sup>E</sup>	1	3	2	18
Freezing and thawing	1	1	2	12 <sup>F</sup>
Length change <sup>E</sup>	1	1	2	6

<sup>A</sup> See Section 7 and 9.2.

<sup>B</sup> See 4.2.

<sup>C</sup> Determined on each batch of concrete mixed.

<sup>D</sup> See 7.1.4.

<sup>E</sup> Optional tests, see 10.1.5.

<sup>F</sup> Specimens for duplicate tests from each batch.