CRD-C 661-06

Specification for Antiwashout Admixtures for Concrete

1. Scope

1.1 This specification covers materials for use as antiwashout admixtures to be added to portland cement concrete mixtures for purposes of preventing washout of cement and other fine fractions of materials from underwater concrete.

1.2 This specification stipulates tests of an antiwashout admixture either with a standard concrete, as described in 11.1 through 11.3, or with a concrete proposed for specific work (11.4). Unless specified otherwise by the purchaser, the tests shall be made using the standard concrete, as described in 11.1 through 11.3 (see Note 1).

Note 1 - It is recommended that, whenever practicable, tests be made using the cement, pozzolan, aggregates, air-entraining admixture, and the mixture proportions, batching sequence, and other physical conditions proposed for the specific work (11.4) because the specific effects produced by chemical admixtures may vary with the properties and proportions of the other ingredients of the concrete.

1.3 This specification provides for three levels of testing.

1.3.1 *Level 1*—During the initial approval stage, proof of compliance with the performance requirements defined in Section 5.1 demonstrates that the admixture meets the requirements of this specification. The basic approach of this level of testing is to compare critical properties of concrete containing the antiwashout admixture, dosed at levels required to provide a specified level of antiwashout performance, with the same properties in a control concrete.

1.3.2 *Level 2*—Limited retesting, described in 5.2, may be requested at intervals by the purchaser to insure continued compliance.

1.3.3 *Level 3*—For acceptance of a lot or for measuring uniformity within or between lots, when specified by the purchaser, the uniformity and equivalence tests of Section 6 shall be used.

1.4 The following precautionary caveat pertains only to the test method portion, Sections 11 through 18 of this Specification: *This standard does not purport to address all of the safety problems, 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*.

1.5 The values stated in SI units are to be regarded as the standard.

2. Referenced Documents

2.1 ASTM Standards:

C 33 Specification for Concrete Aggregates[1]
C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens[1]
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregate[1]
C 143 Test Method for Slump of Hydraulic Cement Concrete
C 150 Specification for Portland Cement[2]
C 157 Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete[1]
C 192 Practice for Making and Curing Concrete Test Specimens in the Laboratory[1]
C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method[1]
C 403 Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance[1]
C 494 Specification for Chemical Admixtures for Concrete
D 75 Practice for Sampling Aggregates[1]
D 1193 Specification for Reagent Water[3]
E 100 Specification for ASTM Hydrometers[4]
Manual of Aggregate and Concrete Testing[1]

2.2 *American Concrete Institute Standards:*

ACI 211.1-77 Practice for Selecting Proportions for Concrete[5]

2.3 *US Army Corps of Engineers Standards:*

CRD-C 61-89A. Test Method for Determining Resistance of Freshly-Mixed Concrete to Washout in Water.

3. Terminology

3.1 Definitions:

antiwashout – Any material or process that inhibits the effect of water in contact with concrete from washing out the fine fractions.

4. Ordering Information

4.1 The purchaser shall specify whether the admixture shall be tested with the standard concrete or with a job-specific concrete, and shall specify limits on any supplemental requirements, such as time of setting.

[1] *Annual Book of ASTM Standards*, Vol 04.02.
[2] *Annual Book of ASTM Standards*, Vol 04.01.
[3] *Annual Book of ASTM Standards*, Vol 11.01.
[4] *Annual Book of ASTM Standards*, Vol 14.03.
[5] Available from the American Concrete Institute, P.O. Box 19150, Redford Station, Detroit, MI 48219.

5. General Requirements

5.1 *Initial Compliance.* For initial compliance with this specification, test concrete in which admixture is used for conformance with the in Table 1. Test methods are in Sections 15 and 16.

Table 1. Physical Requirements[A]

Requirement	Limits
Slump Loss, % of control at 30 minutes	50
Strength, min % of Control	
3 days	90
7 days	90
28 days	90
Length Change, max shrinkage (alternative requirements)[B]	
% of control	135
increase over control, %	0.010
Air Content, max, % over control	3

[A]The values in the table include allowance for normal variation in test results. The object of the 90% strength requirementis to require a level of performance comparable to that of the reference concrete.

[B]Alternative requirements, see 16.1.3, % of control applies when shrinkage is 0.030% or greater, increase in control applies when shrinkage of control is less than 0.030%.

5.1.1 The effects of antiwashout admixture on time of setting is not a requirement, but the user should be aware that some brands of admixtures retard this property. If this is critical to the work that this be controlled, then this needs to be controlled by creating a job-specific requirement.

5.2 *Retesting*. The purchaser may require a limited retesting to confirm current compliance of the admixture to specification requirements. The limited retesting will cover physical properties and performance of the admixture (see Note 2).

Note 2—Additional performance tests currently in this standard may be required by users having special requirements.

5.2.1 The retesting for properties of the admixture shall consist of uniformity and equivalence tests for infrared analysis, residue by oven drying and specific gravity.

5.2.2 The performance-property retesting shall consist of slump loss of fresh concrete and compressive strength at 28 days.

5.3 *Manufacturer's Statements*.

5.3.1 At the request of the purchaser, the manufacturer shall state in writing that the admixture supplied for use in the work is identical in all essential respects, including concentration, to the admixture tested under this specification.

5.3.2 At the request of the purchaser, when the admixture is to be used in prestressed concrete, the manufacturer shall state in writing the chloride content of the admixture and whether or not chloride has been added during its manufacture.

5.4 *Uniformity*. Tests for uniformity and equivalance, as indicated in Section 6, shall be made on the initial sample and the results retained for reference and comparison with the results of tests of samples taken from elsewhere within the lot or subsequent lots of admixture supplied for use in the work.

6. Uniformity and Equivalence Requirements

6.1 When specified by the purchaser, the uniformity of a lot, or the equivalence of different lots from the same source shall be established by the use of the following requirements:

6.1.1 *Residue by Oven Drying*—When tested as described in 18.2, the oven-dried residues of the initial sample and of subsequent samples shall not differ by more than 5%.

6.1.2 *Specific Gravity*—When tested as specified in 18.4, the specific gravity of subsequent test samples shall not differ from the specific gravity of the initial sample by more than 10% of the difference between the specific gravity of the initial sample and that of reagent water at the same temperature. Reagent water shall conform to ASTM D 1193, Types III or IV.

6.2 In cases when it is suspected that a product might have changed, use of infrared analysis can be helpful in determining whether substantial changes in the product chemistry have occurred. ASTM C 494 contains guidance on use of this technique.

7. Packaging and Marking

7.1 When the admixture is delivered in packages or containers, the proprietary name of the admixture and the net weight or volume shall be plainly marked thereon. Similar information shall be provided with bulk shipments of admixtures.

8. Storage

8.1 The admixture shall be stored in such a manner to permit easy access for proper inspection and identification of each shipment, and in a suitable weathertight building that will protect the admixture from freezing.

9. Sampling and Inspection

9.1 Every facility shall be provided the purchaser for careful sampling and inspection, either at the point of manufacture or, on delivery at the site of the work, as may be specified by the purchaser.

9.2 Samples shall be either "grab" or "composite" samples, as specified or required by this specification. A grab sample is one obtained in a single operation. A composite sample is one obtained by combining three or more grab samples.

9.3 For the purposes of this specification, it is recognized that samples will be taken for two reasons:

9.3.1 *Quality Tests*—A sample taken for the purpose of evaluating the quality of a source or lot of admixture will be required to meet all the applicable requirements of this specification. Samples used to determine conformance with the requirements of this specification shall be composites of grab samples taken from sufficient locations to ensure that the composite sample will be representative of the lot.

9.3.2 *Uniformity and Equivalence Tests*—When specified by the purchaser, a sample taken for the purpose of evaluating the uniformity of a single lot, or equivalence of different lots from one source shall be tested as provided in Section 6. Such samples shall be composite samples from individual lots when different lots from the same source are being compared. When the uniformity within a single lot is being determined, grab samples shall be used.

9.4 The admixture shall be thoroughly mixed immediately prior to sampling. Grab samples taken for quality or uniformity tests shall represent a unit shipment or a single production lot. Each grab sample shall have a volume of at least 0.5 L (1 pt). A minimum of three grab samples shall be taken. Composite samples shall be prepared by thoroughly mixing the grab samples selected and the resultant mixture sampled to provide at least 4 L (1 gal) for quality tests. Grab samples shall be taken from different locations well distributed throughout the quantity to be represented.

9.4.1 Admixtures in bulk storage tanks shall be sampled equally from the upper, intermediate, and lower levels by means of drain cocks in the sides of the tanks or a weighted sampling bottle fitted with a stopper that can be removed after the bottle is lowered to the desired depth.

9.4.2 Samples shall be packaged in impermeable, airtight containers which are resistant to attack by the admixture.

10. Rejection

10.1 For initial compliance testing, the admixture may be rejected if it fails to meet any of the applicable requirements for this specification.

10.2 For limited retesting, the admixture may be rejected if it fails to meet any of the requirements of the Uniformity and Equivalence Section and of the applicable parts of Table 1.

10.3 An admixture stored at the point of manufacture, for more than 6 months prior to shipment, or an admixture in local storage in the hands of a vendor for more than 6 months, after completion of tests, may be retested before use and may be rejected if it fails to conform to any of the applicable requirements of this specification.

10.4 Packages or containers varying more than 5% from the specified mass or volume may be rejected. If the average mass or volume of 50% of packages taken at random is less than that specified, the entire shipment may be rejected.

TEST METHODS

11. Materials

11.1 *Cement*—The cement used in any series of tests shall be either the cement proposed for specific work in accordance with 11.4, or a Type I or Type II cement conforming to ASTM C 150, or a Type GU cement conforming to Specification C 1157, or a blend of two or more cements, in equal parts. If when using a cement other than that proposed for specific work, the air content of the concrete made without admixture, tested as prescribed in 14.3, is more than 3.0%, select a different cement, or blend, so that the air content of the concrete will be 3.0% or less.

11.2 *Aggregates*— Except when tests are made in accordance with 11.4 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 ASTM C 33, except that the grading of the aggregates shall conform to the following requirements (Note 3):

NOTE 3—All of the results required for demonstrating compliance of under this specification are dependent on the uniformity of the aggregate samples prepared and used. Careful, skilled and well-supervised work is essential.

11.2.1 *Fine Aggregate Grading:* The fine aggregate shall meet the grading requirements of ASTM C 33.

11.2.2 *Coarse Aggregate Grading*—The coarse aggregate shall meet the requirements for size number 67 of ASTM C 33.

11.2.3 The coarse aggregate used for each set of reference concrete and comparable test admixture-treated concrete shall be essentially the same. Therefore, a set of test concrete consists of one reference concrete and as many test admixture-containing concretes as are intended to be compared to that one reference. Thus, coarse aggregate for one set shall consist of enough material for one reference concrete, the test admixture-containing concrete to be compared with that reference and the sample for grading analysis testing.

11.2.3.1 Prepare coarse aggregate for a set, comprising a sample large enough for concrete trials, as follows: Fill tared containers, one each for a sample, a batch of reference concrete and one or more test concretes to the required mass from the aggregate stockpile. Accomplish this by starting with a scoopful into the first container and repeat this procedure until all containers have their required mass. Repeat the process for each of the three or more sets needed. One or more spare sets may be needed. See the Appendix of ASTM D 75, Sampling from Stockpiles, and the Manual of Aggregate and Concrete Testing for guidance for conditions and procedures.

11.2.4 Test coarse aggregate samples representing each set by ASTM C 136 requirements for the sieves shown below. Discard any set for which the sample does not comply with size 67. Average test results for samples which comply with size 67 for each sieve size. Discard any set for which the sample deviates from this average by more than the amount shown in column 3 of Table 2. Continue the process of preparation, testing and averaging until sufficient sets of aggregate within tolerance are obtained.

Table 2. Among-batch grading tolerances.

Sieve	ASTM C 33, No. 67 Percent Passing	Maximum variation from average passing
19 mm (0.75 in)	90 to 100	1.0
9.5 mm (0.5 in)	20 to 55	4.0
4.75 mm (No. 4)	0 to 10	4.0
2.36 mm (No. 8)	0 to 5	1.0

11.3 *Materials for Tests for Specific Uses*—The effects of an antiwashout admixture on washout and time of setting of concrete may vary with the time of its addition during the batching and mixing sequence. To test an admixture for use in specific work, the cement, pozzolan, aggregates, and air-entraining admixture used shall be representative of those proposed for use in the work. Add to the admixture in the same manner and at the same time during the batching and mixing sequence as it will be added on the job. Proportion the concrete mixtures to have the cement content specified for use in the work. If the maximum size of coarse aggregate

is greater than 1 in. (25.4-mm), screen the concrete over a 1-in. (25.0-mm) sieve prior to fabricating the test specimens.

11.3.1 *Other Use Conditions*—Other conditions may affect the overall suitability of the concrete mixture for specific intended uses. These include the temperature of the materials or the surroundings, the humidity, the length of time between mixing and placing, the amount of mixing activity and other factors. These physical conditions may be incorporated into the tests with intention for indicating the potential interactions. These tests would be only for guidance. After incorporation of such test conditions it would not be suitable to expect compliance with this specification requirement.

11.4 *Preparation and Determining Mass*—Prepare all material and make mass determinations as prescribed in ASTM C 192.

12. Proportioning of Concrete Mixtures

12.1 *Proportions*—Except when tests are being made for specific uses (see 11.4), all concrete shall be proportioned using ACI 211.1-77 to conform to the requirements described in Table 3.

Table 3. Properties for concrete mixtures.

Property	Reference (Control) Mixtures	Test Mixtures
water-cement ratio	0.40	0.40
slump, mm	165±13	190±40
cement content, kg/m^3 (lb/yd^3)	400 ± 15 (675 ± 25)	400 ± 15 (675 ± 25)
nominal max. size aggregate, mm (inches), gradation of ASTM C 33, No. 67	19 (0.75)	19 (0.75)
sand as % of total aggregate, ASTM C 33 gradation	45 - 55 %	45 - 55 %
amount WRA or HRWRA (see footnote 1)	as needed to achieve target slump	as needed to achieve target slump
washout	10 - 20 %	50% reduction of control value
air content non air-entrained concrete, % max	4%, max	

footnote 1. Some antiwashout admixtures contain WRA or HRWRA, which may have some effects on attempts to achieve target slumps.

12.2 *Conditions*—Prepare concrete mixtures both with and without the admixture under test. Refer herein to the concrete mixture without the chemical admixture as the reference or control concrete mixture. Refer to the concrete mixture containing the admixture as the test

mixture. Add the admixture in the manner recommended by the manufacturer and in the amount necessary to comply with the applicable requirements for antiwashout performance (see Note 4). If there is no recommended time of addition for the admixture, the admixture shall be added with the first increment of mixing water that is added to the mixer.

Note 4 – The time of addition of the admixture may have affects on both washout and time of setting. If there are no manufacturers recommendations, then this should be consistent between test and control concretes.

13. Mixing

13.1 Machine mix the concrete as prescribed in ASTM C 192.

14. Preparation of Test Specimens

14.1 Make specimens for tests of hardened concrete, representing each test and age of test and each condition of concrete being compared, from at least three separate batches, and the minimum number of specimens shall be as prescribed in Table 4. On a given day make at least one specimen for each test and age of test from each condition of concrete.

14.2 *Manifestly Faulty Specimens*—Visually examine each group of specimens representing a given test or a given age of test, including tests of freshly mixed concrete, 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.

TABLE 4
Types and Minimum Number of Specimens and Tests

	Number of Types of Specimens[A]	Number of Test Ages	Number of Conditions of Concrete[B]	Number of Specimens, min
Slump	1	1	2	[C]
Air content	1	1	2	[C]
Time of setting	1		2	2
Compressive strength	1	3	2	18
Length change	1	1	2	6

[A] See Section 15 and 16.
[B] See 12.2.
[C] Determined on each batch of concrete mixed.

15. Tests and Properties of Freshly Mixed Concrete

15.1 Samples of freshly mixed concrete from at least three separate batches for each condition of concrete shall be tested in accordance with the methods described in 15.2 through 15.5.

15.2 *Slump Loss*— Determine slump according to ASTM C 143. Calculate slump loss as follows:

$$SlumpLoss = \frac{Si - Sf}{Si} x100$$

where *Si* and *Sf* are the initial and final slumps, respectively.

15.3 *Air Content* – ASTM C 231.

15.4 *Time of Setting*—ASTM C 403, 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 73 ± 3 °F (23.0 ± 1.7 °C).

16. Test Method For Determining The Resistance Of Freshly Mixed Concrete To Washing Out In Water

16.1 Apparatus

16.1.1 Washout tube - A cylindrical clear plastic tube (Fig. 1) of the following dimensions:

Inside diameter = 190 mm ± 2 mm
Outside diameter = 200 mm ± 2 mm
Height = 2,000 mm ± 2 mm

16.1.2 Receiving Container - A cylindrical receiving container with cover, shown in the tube in Fig. 1, both made out of perforated sheet steel having a nominal thickness of 1.4 mm. The perforations shall be circular and shall have a nominal diameter of 3 mm and a nominal distance between the centers of adjacent perforations of 5 mm. The diameter shall be 130 mm ± 2 mm and the height should be 120 mm ± 2 mm.

16.1.3 Rope - A rope with a length of about 2-1/2 m attached to the receiving container.

16.1.4 Scale - A scale allowing determination of the mass of the sample with a precision of 0.05 percent of the mass of the sample.

16.1.5 Rod - A 10-mm (3/8-in.) diameter round, straight steel rod with at least the tamping end rounded to a hemispherical tip of the same diameter as the rod, approximately 300 mm (12-in.) long.

16.2. Sample

16.2.1 Obtain a representative sample of concrete in accordance with Method C 172. If the concrete contains coarse aggregate particles that would be retained on a 37.5-mm (1-1/2-in.) sieve, wet sieve a representative sample over a 37.5-mm (1-1/2-in.) sieve to yield somewhat more than enough to fill the receiving container to the desired level. The wet sieving procedure is described in Method C 172.

16.3 Procedure

16.3.1 Level the washout tube base and fill the tube with water to a height of 1,700 ± 5 mm.

16.3.2 Determine the mass of the receiving container and cover. Put a sample of fresh concrete, having a mass slightly in excess of 2,000 g, into the receiving container.

16.3.3 Rod the sample 10 times with a 10-mm diameter rod. Tap the side of the container with the rod 10 to 15 times. Clean the extruded concrete from the outside of the container. Determine and record the mass of the concrete as M_i, M_i shall be 2,000 ± 20 g.

16.3.4 Attach the rope to the receiving container. Put the receiving container holding the sample with its cover in place into the washout tube and lower until the bottom of the container is in contact with the water.

16.3.5 Let the receiving container fall freely through the water to the bottom of the tube. After waiting 15 sec, bring the receiving container up in 5 ± 1 sec. Let the receiving container drain for 2 min, tilting slightly to allow water to run off the top of the sample. Determine the mass of the concrete remaining in the receiving container and record as M_f. The loss in mass of the concrete in the receiving container is equal to M_i - M_f.

16.3.6 Perform the sequence three times on the same sample, determining M_f each time. The M_f after the final sequence is the cumulative loss in mass.

16.4 Calculations

16.4.1 Washout, or loss of mass of the sample, expressed as a percentage of the initial mass of the sample is given by the following formula:

$$D = \frac{M_i - M_f}{M_i} \times 100$$

where:

D = washout, %
M_i = mass of sample before initial test
M_f = mass of sample after each test

16.5 Report

The report shall include the following:

16.5.1 Values of D after each drop, expressed as D_1, D_2, and D_3, i.e., the percentage of the original mass of the sample lost after each of the three drops.

16.5.2 The mixture proportions of the concrete and other information necessary to describe the properties of the freshly mixed concrete when tested.

16.6 Precision and Bias

16.6.1 Precision - The precision of this test method has not been determined.

16.6.2 Bias - The bias of this test method cannot be determined since no standard reference material is available.

17. Tests on Hardened Concrete

17.1 Test specimens of hardened concrete in accordance with the following methods (see Table 1):

17.1.1 *Compressive Strength*—ASTM C 39. Test specimens at ages of 3, 7, and 28 days. Calculate the compressive strength of the concrete containing the admixture under test as a percentage of the compressive strength of the reference concrete as follows:

17.1.1.1 Calculate strength, as a percentage of control, as follows:

$$Strength, \% Control = \frac{CS_{test}}{CS_{control}} x100$$

where CS_{test} and $CS_{control}$ are the compressive strengths of the test and control mixtures, respectively.

17.1.3 *Length Change*—Test specimens shall consist of molded prisms made and tested in accordance with ASTM C 157 except that the moist curing period, including the period in the molds, shall be 14 days. Then store the specimens in air, as specified in the relevant section of C 157 for a period of 14 days, at which time determine the length change of the specimen. Consider the drying shrinkage to be the length change during the drying period, based on an initial measurement at the time of removal of the specimen from the mold, and express it as percent to the nearest 0.001% based on the specimen gage length. If the shrinkage of the reference concrete after 14 days of drying is 0.030% or greater, the shrinkage on drying of concrete containing the admixture under test, expressed as percent of the shrinkage of the reference concrete, shall not exceed the maximum specified in Table 1, as calculated in the following equation:

$$Shrinkage, \% Control = \frac{Lc - Lt}{Lc} x100$$

where *Lc* and *Lt* are the shrinkages of the control and the test concretes, respectively. If the shrinkage of the reference concrete after 14 days of drying is less than 0.030%, the shrinkage on drying of concrete containing the admixture under test shall be not more than 0.010% greater than that of the reference concrete (Note 5), as calculated using the following equation.

$$Shrinkage, \% \ Over Control = Lt - Lc$$

where *Lt* and *Lc* are the shrinkages of the test and the control concrete, respectively.

NOTE 5—Since the specific effects produced by chemical admixtures may vary with the properties of the other ingredients of the concrete, results of length change tests using aggregates of such a nature that the length change on drying is low may not accurately indicate relative performance to be expected with other aggregates having properties such as to produce concrete of high length change on drying.

18. Uniformity and Equivalence Tests

18.1 *Residue by Oven Drying.* The following was taken from ASTM C 494-98a.

18.1.1 Place 25 to 30 g of standard Ottawa sand (20 to 30 mesh) in a wide-mouth, low-form (about 60 mm inside diameter and 30 mm in height) glass weighing bottle provided with a ground-glass stopper. Place the weighing bottle and stopper, with stopper removed, in a drying oven (18.2.1.1) and dry for 17 ± ¼ h at 105 ± 3 °C. Insert the stopper in the weighing bottle, transfer to a desiccator, cool to room temperature, and weigh to the nearest 0.001 g. Remove the stopper and, using a pipet, evenly distribute 4 ml of the liquid admixture over the sand. Immediately insert the stopper to avoid loss by evaporation and weigh to the nearest 0.001 g. Remove the stopper and place both the bottle and stopper in a drying oven (18.2.1.1). Dry for 17 ± ¼ h at 105 ± 3 °C. At the end of the drying period, stopper the weighing bottle, transfer to a desiccator, cool to room temperature, and weigh to the nearest 0.001 g.

18.1.1.1 The drying oven shall be either a forced circulation type or one with provision for free access of air. There shall be precise control of temperature and time of drying so that the degree of volatilization of the material other than water from sample to sample will not vary.

18.1.2 *Calculation:*

18.1.2.1 Record the following weights:

w_1 = weight of stoppered bottle with sand and sample,
w_2 = weight of stoppered bottle with sand,
w_3 = w_1 - w_2 = weight of sample,
w_4 = weight of stoppered bottle with sand and dried residue, and
w_5 = w_4 - w_2 = weight of dried residue.

18.1.2.2 Calculate the residue by using the following equation:

Residue by oven drying (percent by weight) = $(w_5 \times 100)/w_3$

18.1.3 *Precision Statement*—The maximum multi-laboratory coefficient of variation for residue by oven drying (liquid admixtures) has been found to be 1.25%. Therefore, results of tests by two different laboratories on identical samples of an admixture should not differ from each other by more than 3.5% of their average (Note 6). The maximum single-operator coefficient of variation has been found to be 0.6%. Therefore, results of two properly conducted tests by the same operator on the same material should not differ by more than 1.7%.

NOTE 6—The precision statements are based on the maximum variation of tests made in 18 laboratories on sets of three duplicate samples of two different admixtures.

18.2 *Specific Gravity.* The following was taken from ASTM C 494-98a.

18.2.1 Determine the specific gravity at 25 ± 1 °C of a liquid admixture using hydrometers complying with ASTM E 100. Hydrometers No. 112H through 117H will cover the range for most determinations. A 250-mL graduated cylinder, and a water bath capable of maintaining 25 °C will also be required.

18.2.2 Place a sample in the 250-mL graduated cylinder and put in the hydrometer in such a manner that it floats free and does not touch the side of the cylinder. Place the cylinder with sample and hydrometer in the constant temperature bath until the temperature of the cylinder, hydrometer, and sample is uniform at 25 ± 1 °C. If all are at proper temperature prior to insertion of the hydrometer, approximately 10 min should be allowed for equilibrium. If the sample shows evidence of foaming, hydrometer reading should be continued until constant readings are obtained. Read the hydrometer at the base of the meniscus to the nearest 0.005.

18.2.2.1 If foaming is encountered during transfer of the admixture to the cylinder, sufficient time shall be allowed for the foam to dissipate or rise to the surface, where it shall be removed before inserting, the hydrometer. Crusting of the admixture on the hydrometer stem due to evaporation during temperature adjustment shall be avoided.

18.2.3 *Precision Statement*—The maximum multi-laboratory coefficient of variation for specific gravity (liquid admixtures) has been found to be 0.316%. Therefore, results of two different laboratories on identical samples of an admixture should not differ from each other by more than 0.9% of their average (Note 14). The maximum single operator coefficient of variation has been found to 0.09%. Therefore, results of two properly conducted tests by the same operator on the same material should not differ by more than 0.275%.

19. Report

19.1 Report the following:

19.1.1 Results of the tests specified in Sections 6, 15, and 16, and the relevant specification requirements with which they are compared,

19.1.2 Brand name, manufacturer's name, and lot number, and quantity represented by the sample of the admixture under test,

19.1.3 Brand name, manufacture's name, and other pertinent data on other admixtures as part of the testing procedure,

19.1.4 Brand name, manufacturers name, type, and test data on the portland cement or cements used,

19.1.5 Description of, and test data on the fine and coarse aggregates used,

19.1.6 Detailed data on the concrete mixtures used, including amounts and proportions of admixtures used, actual cement factors, water-cement ratios, unit water contents, ratios of fine to total aggregate, slump, and air content, time of addition of AWA, and

19.1.7 In the event that, in accordance with the provisions of 17.1.1.2, some of the tests have been waived, the circumstances under which such action was taken shall be stated.