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Standard Specification for Chemical Admixtures for Concrete¹

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This standard has been approved for use by agencies of the Department of Defense.

^{e1} NOTE—Range value in 12.2.2 was editorially corrected July 2001.

1. Scope

1.1 This specification covers materials for use as chemical admixtures to be added to hydraulic-cement concrete mixtures in the field for the purpose or purposes indicated for the seven types as follows:

- 1.1.1 *Type A*—Water-reducing admixtures,
- 1.1.2 *Type B*—Retarding admixtures,
- 1.1.3 *Type C*—Accelerating admixtures,
- 1.1.4 *Type D*—Water-reducing and retarding admixtures,
- 1.1.5 *Type E*—Water-reducing and accelerating admixtures,
- 1.1.6 *Type F*—Water-reducing, high range admixtures, and
- 1.1.7 *Type G*—Water-reducing, high range, and retarding admixtures.

1.2 This specification stipulates tests of an admixture with suitable concreting materials as described in 11.1-11.3 or with cement, pozzolan, aggregates, and an air-entraining admixture proposed for specific work (11.4). Unless specified otherwise by the purchaser, the tests shall be made using concreting materials as described in 11.1-11.3.

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. For instance, Types F and G admixtures may exhibit much higher water reduction in concrete mixtures having higher cement factors than that listed in 12.1.1.

Mixtures having a high range water reduction generally display a higher rate of slump loss. When high-range admixtures are used to impart increased workability (6 to 8-in. slump [150 to 200-mm]), the effect may be of limited duration, reverting to the original slump in 30 to 60 min depending on factors normally affecting rate of slump loss. The use of chemical admixtures to produce high-slump (flowing) concrete is covered by Specification C 1017.

NOTE 2—The purchaser should ensure that the admixture supplied for use in the work is equivalent in composition to the admixture subjected to test under this specification (see Section 6, Uniformity and Equivalence).

¹ This specification is under the jurisdiction of ASTM Committee C09 on Concrete Aggregates and is the direct responsibility of Subcommittee C9.23 on Chemical Admixtures.

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NOTE 3—Admixtures that contain relatively large amounts of chloride may accelerate corrosion of prestressing steel. Compliance with the requirements of this specification does not constitute assurance of acceptability of the admixture for use in prestressed 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 Table 1 demonstrates that the admixture meets the requirements of this specification. Uniformity and equivalence tests of Section 6 shall be carried out to provide results against which later comparisons can be made.

1.3.2 *Level 2*—Limited retesting is described in 5.2, 5.2.1 and 5.2.2. Proof of compliance with the requirements of Table 1 demonstrates continued conformity of the admixture with the requirements of the specification.

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 values stated in either inch-pound or SI units shall be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining values in any way.

1.5 The text of this standard 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.

1.6 The following precautionary caveat pertains only to the test method sections, Sections 11-18 of this Specification: *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.*

2. Referenced Documents

- 2.1 *ASTM Standards:*
C 33 Specification for Concrete Aggregates²

² *Annual Book of ASTM Standards*, Vol 04.02.

TABLE 1 Physical Requirements^A

| | Type A, Water Reducing | Type B, Retarding | Type C, Accelerating | Type D, Water Reducing and Retarding | Type E, Water Reducing and Accelerating | Type F, Water Reducing, High Range | Type G, Water Reducing, High Range and Retarding |
|---|-----------------------------------|----------------------|-------------------------|--|---|---|---|
| Water content, max, % of control | 95 | ... | ... | 95 | 95 | 88 | 88 |
| Time of setting, allowable deviation from control, h:min: | | | | | | | |
| Initial: at least | ... | 1:00 later | 1:00 earlier | 1:00 later | 1:00 earlier | ... | 1:00 later |
| not more than | 1:00 earlier nor 1:30 later | 3:30 later | 3:30 earlier | 3:30 later | 3:30 earlier | 1:00 earlier nor 1:30 later | 3:30 later |
| Final: at least | ... | ... | 1:00 earlier | ... | 1:00 earlier | ... | ... |
| not more than | 1:00 earlier nor 1:30 later | 3:30 later | ... | 3:30 later | ... | 1:00 earlier nor 1:30 later | 3:30 later |
| Compressive strength, min, % of control: ^B | | | | | | | |
| 1 day | ... | ... | ... | ... | ... | 140 | 125 |
| 3 days | 110 | 90 | 125 | 110 | 125 | 125 | 125 |
| 7 days | 110 | 90 | 100 | 110 | 110 | 115 | 115 |
| 28 days | 110 | 90 | 100 | 110 | 110 | 110 | 110 |
| 6 months | 100 | 90 | 90 | 100 | 100 | 100 | 100 |
| 1 year | 100 | 90 | 90 | 100 | 100 | 100 | 100 |
| Flexural strength, min, % control: ^B | | | | | | | |
| 3 days | 100 | 90 | 110 | 100 | 110 | 110 | 110 |
| 7 days | 100 | 90 | 100 | 100 | 100 | 100 | 100 |
| 28 days | 100 | 90 | 90 | 100 | 100 | 100 | 100 |
| Length change, max shrinkage (alternative requirements): ^C | | | | | | | |
| Percent of control | 135 | 135 | 135 | 135 | 135 | 135 | 135 |
| Increase over control | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| Relative durability factor, min: ^D | 80 | 80 | 80 | 80 | 80 | 80 | 80 |

^A The values in the table include allowance for normal variation in test results. The object of the 90 % compressive strength requirement for a Type-B admixture is to require a level of performance comparable to that of the reference concrete.

^B The compressive and flexural strength of the concrete containing the admixture under test at any test age shall be not less than 90 % of that attained at any previous test age. The objective of this limit is to require that the compressive or flexural strength of the concrete containing the admixture under test shall not decrease with age.

^C Alternative requirements, see 17.1.4, % of control limit applies when length change of control is 0.030 % or greater; increase over control limit applies when length change of control is less than 0.030 %.

^D This requirement is applicable only when the admixture is to be used in air-entrained concrete which may be exposed to freezing and thawing while wet.

C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens²

C 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)²

C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates²

C 138 Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete²

C 143/C 143M Test Method for Slump of Hydraulic-Cement Concrete²

C 150 Specification for Portland Cement³

C 157/C 157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete²

C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement³

C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory²

C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method²

C 260 Specification for Air-Entraining Admixtures for Concrete²

C 403/C 403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance²

C 666 Test Method for Resistance of Concrete to Rapid Freezing and Thawing²

C 1017 Specification for Chemical Admixtures for Use in Producing Flowing Concrete²

D 75 Practice for Sampling Aggregates²

D 1193 Specification for Reagent Water⁴

E 100 Specification for ASTM Hydrometers⁵
Manual of Aggregate and Concrete Testing²

2.2 American Concrete Institute Standard:

ACI 211.1-91 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete⁶

⁴ Annual Book of ASTM Standards, Vol 11.01.

⁵ Annual Book of ASTM Standards, Vol 14.03.

⁶ Available from the American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331.

³ Annual Book of ASTM Standards, Vol 04.01.

3. Terminology

3.1 Definitions:

3.1.1 *accelerating admixture*—an admixture that accelerates the setting and early strength development of concrete.

3.1.2 *retarding admixture*—an admixture that retards the setting of concrete.

3.1.3 *water-reducing admixture*—an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency.

3.1.4 *water-reducing admixture, high range*—an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency by 12 % or greater.

3.1.5 *water-reducing and accelerating admixture*—an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and accelerates the setting and early strength development of concrete.

3.1.6 *water-reducing and retarding admixture*—an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency and retards the setting of concrete.

3.1.7 *water-reducing, high range, and retarding admixture*—an admixture that reduces the quantity of mixing water required to produce concrete of a given consistency by 12 % or greater and retards the setting of concrete.

4. Ordering Information

4.1 The purchaser shall specify the type of chemical admixture desired.

5. General Requirements

5.1 For initial compliance with this specification, test concrete in which each type of admixture shown in 1.1 is used shall conform to the respective requirements prescribed in Table 1.

5.2 The purchaser is allowed to 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.

5.2.1 The physical properties retesting 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 water content of fresh concrete, setting time and compressive strength at 3, 7 and 28 days. Purchasers having special requirements are allowed to require additional tests currently in this standard.

5.3 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.

5.4 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.

5.5 Tests for uniformity and equivalence, 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

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 *Infrared Analysis*—The absorption spectra of the initial sample and the test sample, obtained as specified in 18.1, shall be essentially similar.

6.1.2 *Residue by Oven Drying (Liquid Admixtures)*—When dried as specified in 18.2, the oven-dried residues of the initial sample and of subsequent samples shall be within a range of variation of not greater than 5 percentage points.

6.1.3 *Residue by Oven Drying (Nonliquid Admixtures)*—When dried as specified in 18.3, the oven-dried residues of the initial sample and of the subsequent samples shall be within a range of variation not greater than 4 percentage points.

6.1.4 *Specific Gravity (Liquid Admixtures)*—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 conforming to Specification D 1193, Types III or IV, and prepared by distillation ion exchange, reverse osmosis, electro dialysis, or a combination of these procedures is adequate.

6.2 When the nature of the admixture or the analytical capability of the purchaser make some or all of these procedures unsuitable, other requirements for uniformity and equivalence from lot to lot or within a lot shall be established by agreement between the purchaser and the manufacturer.

7. Packaging and Marking

7.1 When the admixture is delivered in packages or containers, the proprietary name of the admixture, the type under this specification, and the net weight or volume shall be plainly marked thereon. Similar information shall be provided in the shipping advices accompanying packaged or bulk shipments of admixtures.

8. Storage

8.1 The admixture shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weathertight building that will protect the admixture from dampness and 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 at the site of the work, as 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 of a single lot is being determined, grab samples shall be used.

9.4 *Liquid Admixtures*—Liquid admixtures shall be agitated thoroughly 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 1 pt [0.5 L]. 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 1 gal [4 L] 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.

9.5 *Nonliquid Admixtures*—Grab samples taken for quality or uniformity tests shall represent not more than 2 tons [2 Mg] of admixture and shall weigh at least 2 lb [have a mass of at least 1 kg]. A minimum of four 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 5 lb [2.5 kg] for the composite sample. Grab samples shall be taken from different locations well distributed throughout the quantity to be represented.

9.5.1 Samples of packaged admixtures shall be obtained by means of a tube sampler as described in Practice C 183.

9.5.2 Samples shall be packaged in moisture-proof, airtight containers.

9.6 Samples shall be thoroughly mixed before testing to ensure uniformity. When recommended by the manufacturer, the entire sample of a nonliquid admixture shall be dissolved in water prior to testing.

10. Rejection

10.1 For initial compliance testing, the purchaser is allowed to reject the admixture if it fails to meet any of the applicable requirements for this specification.

10.2 For limited retesting, the purchaser is allowed to reject the admixture 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, shall be retested before use when requested

by the purchaser and is allowed to 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 weight or volume are allowed to be rejected. If the average weight or volume of 50 packages taken at random is less than that specified, the entire shipment is allowed to be rejected.

10.5 When the admixture is to be used in non-air-entrained concrete, it shall be rejected when the purchaser desires if the test concrete containing it has an air content greater than 3.5 %; when the admixture is to be used in air-entrained concrete, it can be rejected if the test concrete containing it has an air content greater than 7.0 %.

TEST METHODS

NOTE 4—These tests are based on arbitrary stipulations which make possible highly standardized testing in the laboratory and are not intended to simulate actual job conditions.

11. Materials

TESTS NOT FOR A SPECIFIC USE

11.1 *Cement*—The cement used in any series of tests shall be either the cement proposed for a specific use in accordance with 11.4, a Type I or Type II cement conforming to Specification C 150, 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 C 150. 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 3.5 %, select a different cement, or blend, so that the air content of the concrete will be 3.5 % or less.

11.2 *Aggregates*—Except when tests are made in accordance with 11.4 using the aggregates proposed for a specific use, 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 C 33, except that the grading of the aggregates shall conform to the following requirements:

11.2.1 *Fine Aggregate Grading:*

| Sieve | Weight Percent Passing |
|------------------|------------------------|
| No. 4 [4.75-mm] | 100 |
| No. 16 [1.18-mm] | 65 to 75 |
| No. 50 [300 μm] | 12 to 20 |
| No. 100 [150 μm] | 2 to 5 |

11.2.2 *Coarse Aggregate Grading*— The coarse aggregate shall meet the requirements for size number 57 of Specification C 33. Take care in loading and delivery to avoid segregation.

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.