



Standard Specification for Admixtures for Shotcrete¹

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1. Scope

1.1 This specification covers materials proposed for use as admixtures to be added to a portland-cement shotcrete mixture for the purpose of altering the properties of the mixture.

1.2 *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.*

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 ASTM Standards:

- C 125 Terminology Relating to Concrete and Concrete Aggregates²
- 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 173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method²
- C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement³
- 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 311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete²
- C 494 Specification for Chemical Admixtures for Concrete²
- C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete²
- C 979 Specification for Pigments for Integrally Colored Concrete²
- C 989 Specification for Ground Granulated Blast Furnace

- Slag for Use in Concrete and Mortars²
- C 1240 Specification for Silica Fume for Use in Hydraulic-Cement Concrete and Mortar²
- C 1438 Specification for Latex and Powder Polymer Modifiers for Hydraulic Cement Concrete and Mortar²
- D 98 Specification for Calcium Chloride⁴
- 2.2 *ACI Documents:*
- 318 Building Code Requirements for Reinforced Concrete⁵

3. Terminology

3.1 The terms used in this standard are defined in Terminology C 125.

3.2 Definitions of Terms Specific to This Standard:

- 3.2.1 *dry-mix shotcrete*—Shotcrete in which most of the mixing water is added at the nozzle.
- 3.2.2 *shotcrete*—Mortar or concrete pneumatically projected at high velocity onto a surface.
- 3.2.3 *wet-mix shotcrete*—Shotcrete in which most of the ingredients, including the water, are mixed prior to introduction into the delivery hose.

4. Classification

4.1 This specification recognizes grades of admixtures, used in shotcrete made by either of two processes, as follows:

- 4.1.1 *Type I*—Dry mix shotcrete.
 - 4.1.1.1 *Grade 1*—Accelerating admixture, conventional.
 - 4.1.1.2 *Grade 2*—Retarding admixture.
 - 4.1.1.3 *Grade 3*—Pozzolan admixture.
 - 4.1.1.4 *Grade 4*—Metallic iron admixture.
 - 4.1.1.5 *Grade 5*—Coloring admixture.
 - 4.1.1.6 *Grade 6*—Organic polymer admixture.
 - 4.1.1.7 *Grade 7*—Not applicable.
 - 4.1.1.8 *Grade 8*—Not applicable.
 - 4.1.1.9 *Grade 9*—Accelerating admixture, quick-setting.
- 4.1.2 *Type II*—Wet-mix shotcrete.
 - 4.1.2.1 *Grade 1*—Accelerating admixture, conventional.
 - 4.1.2.2 *Grade 2*—Retarding admixture.
 - 4.1.2.3 *Grade 3*—Pozzolan admixture.
 - 4.1.2.4 *Grade 4*—Metallic iron admixture.
 - 4.1.2.5 *Grade 5*—Coloring admixture.
 - 4.1.2.6 *Grade 6*—Organic polymer admixture.
 - 4.1.2.7 *Grade 7*—Water reducing admixture.

¹ This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.46 on Shotcrete.

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

³ *Annual Book of ASTM Standards*, Vol 04.01.

⁴ *Annual Book of ASTM Standards*, Vol 04.03.

⁵ Available from American Concrete Institute, P.O. Box 19150, Detroit, MI 48219.

4.1.2.8 *Grade 8*—Air-entraining admixture.

4.1.2.9 *Grade 9*—Accelerating admixture, quick-setting.

4.1.3 Each of the above grades is further classified by identifying it according to the following classes:

4.1.3.1 *Class A*—Liquid.

4.1.3.2 *Class B*—Non-liquid.

5. Ordering Information

5.1 The purchaser shall include the following information in the contract or purchase order, if applicable:

5.1.1 The specification designation and date of issue,

5.1.2 Type of shotcrete, grade and class of admixture,

5.1.3 Quantity of admixture required,

5.1.4 Special packaging and package marking requirements,

5.1.5 Special sampling for inspection requirements, and

5.1.6 Any supplementary requirements.

6. Requirements

6.1 Shotcrete admixtures shall conform to the requirements for the applicable type and grade as given in Table 1.

6.2 At the request of the purchaser, the manufacturer shall state in writing that the admixture supplied is essentially identical in concentration, composition, and performance to the admixture previously tested under this specification and found to comply with the applicable requirements thereof.

6.3 Requirements for establishing compositional or chemical equivalence of a lot or of a subsequent lot relative to a previous lot that was subjected to quality tests and found to comply with the applicable requirements may be determined by agreement between the purchaser and the manufacturer. At

the request of the purchaser, the manufacturer shall recommend appropriate test procedures, such as infrared spectrophotometry, pH value, and solids content, for establishing the equivalence of material from different lots or different portions of the same lot.

6.4 At the request of the purchaser, the manufacturer shall state in writing the chloride content of the admixture.

NOTE 1—Ultraviolet absorption of solutions and infrared spectroscopy of dried residues have been found to be valuable for these purposes. The specific procedures to be employed and the criteria to establish equivalence should be stipulated with due regard to the composition and properties of the sample.

NOTE 2—Admixtures containing relatively large amounts of chloride ions may make embedded metals susceptible to corrosion when moisture and oxygen are present in hardened shotcrete.

7. Sampling

7.1 Access shall be provided to the purchaser for careful sampling, either at the point of manufacture, or at the site of the work, as may be specified by the purchaser.

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

7.3 The sample size for each class of admixture shall be as follows:

7.3.1 *Class A Liquid Admixtures:*

7.3.1.1 Liquid admixtures shall be agitated thoroughly immediately prior to sampling. Individual grab samples shall represent not more than 2500 gal (9500 L) of admixture and

TABLE 1 Shotcrete Admixture Requirements

Type I—Dry-Mix Shotcrete																	
Grade	Admixture	ASTM Standard	Other Limits														
1	Accelerating, conventional	D 98, C 494 Type C or E	The metallic particles shall be ground iron free from rust, oil, foreign materials, and nonferrous metal particles. The grading of the metallic aggregates shall be as follows when tested according to C 136: <table><tr><td>U.S. Sieve No.</td><td>% Passing</td></tr><tr><td>4.75 mm (No. 4)</td><td>100</td></tr><tr><td>2.36 mm (No. 8)</td><td>90–100</td></tr><tr><td>1.18 mm (No. 16)</td><td>70–85</td></tr><tr><td>600 μm (No. 30)</td><td>20–35</td></tr><tr><td>300 μm (No. 50)</td><td>0–10</td></tr><tr><td>150 μm (No. 100)</td><td>0–5</td></tr></table> Even when using materials conforming to C 979, it may be difficult to obtain uniformity of coloring because of the placement procedures in dry-mix shotcreting. Initial time of setting 1 to 3 min and final time of setting not more than 12 min in two of every three tests and chloride limits of ACI 318 shall not be exceeded.	U.S. Sieve No.	% Passing	4.75 mm (No. 4)	100	2.36 mm (No. 8)	90–100	1.18 mm (No. 16)	70–85	600 μm (No. 30)	20–35	300 μm (No. 50)	0–10	150 μm (No. 100)	0–5
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600 μm (No. 30)	20–35																
300 μm (No. 50)	0–10																
150 μm (No. 100)	0–5																
2	Retarding	C 494 Type B or D															
3	Pozzolanic	C 618, C 989, C 1240															
4	Metallic iron	Not established															
5	Coloring	C 979															
6	Organic Polymer	C 1438															
9	Accelerating, quick-setting	C 1102															
Type II—Wet-Mix Shotcrete																	
Grade	Admixture	ASTM Standard	Other Limits														
1	Accelerating, conventional	D 98, C 494 Types C or E	See Type I, Grade 4														
2	Retarding	C 494, Type B, D or G															
3	Pozzolanic	C 618, C 989, C 1240															
4	Metallic iron	Not established															
5	Coloring	C 979	See Type I, Grade 9														
6	Organic Polymer	C 1438															
7	Water reducing	C 494, Types A, D, E, F, or G															
8	Air-entraining	C 260															
9	Accelerating, quick-setting	C 1102															

shall have a volume of at least 1 qt (1 L). A minimum of four grab samples shall be taken from different locations well distributed throughout the quantity to be represented. Composite samples shall be prepared by thoroughly mixing the selected grab samples, and the resultant mixture sampled to provide at least 1 gal (4 L) for testing.

7.3.1.2 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.

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

7.3.2 *Class B Non-liquid Admixtures:*

7.3.2.1 Individual grab samples (except pozzolanic) shall not represent more than 2 tons (2 Mg) of admixture and shall weigh at least 2 lb (1 Kg). A minimum of four grab samples shall be taken from different locations well distributed throughout the quantity to be represented. Composite samples shall be prepared by thoroughly mixing the selected grab samples, and the resultant mixture sampled to provide at least 5 lb (2.1 Kg) for testing. Grading of composite samples shall be determined for each 2 tons (2 Mg) of Grade 4 metallic iron admixtures shipped.

7.3.2.2 Pozzolanic admixtures shall be sampled and tested in accordance with the requirements established in Test Methods C 311.

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

7.3.2.4 When recommended by the manufacturer, the entire sample of an admixture shall be dissolved in water prior to testing.

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

8. Number of Tests and Retests

8.1 The number of tests and retests to be performed on specified materials shall be the number stipulated in the referenced ASTM standard.

9. Specimen Preparation

9.1 The specimens for tests shall be prepared as required by the particular test method referenced by the ASTM specification relating to the particular admixture.

NOTE 3—It is recommended that, whenever practicable, tests with the admixture be made using all of the ingredients of the shotcrete proposed for the specified work, because the effect produced by the admixture may vary with the properties of the other ingredients of the concrete.

10. Inspection

10.1 Inspection of the material shall be agreed upon between the purchaser and supplier as part of the purchase contract.

11. Rejection

11.1 The shotcrete admixture may be rejected if it fails to meet any of the applicable requirements of this specification. See Table 1.

11.2 An admixture stored at the point of manufacturer for more than six months prior to shipment or an admixture in local storage by a vendor for more than six 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.

11.3 Packages or containers varying more than 2 % from the specified weight or volume shall be rejected. If the average weight or volume of 50 packages taken at random is less than that specified, the entire shipment shall be rejected.

11.4 When the admixture is to be used in non-air-entrained wet-mix shotcrete, it shall be rejected if the tested shotcrete containing the admixture has an air content greater than 5 %. When the admixture is to be used in air-entrained wet-mix shotcrete, it shall be rejected if the tested shotcrete containing the admixture has an air content greater than 12 % or less than 5 %. The air content shall be determined on a sample taken prior to shooting in accordance with either of Test Methods C 138, C 173 or C 231.

11.5 Rejection and reason(s) for rejection shall be reported to the producer or supplier promptly in writing.

12. Certification

12.1 When specified in the purchase order or contract, a certificate shall be furnished to the purchaser that the material has been tested in accordance with this specification and found to meet the requirements. When specified in the purchase order or contract, a report of test results on samples taken from material shipped shall be furnished. The test report requested in accordance with the purchase order shall be furnished within 60 days after shipment of the order.

13. Product Marking

13.1 When the admixture is delivered in packages or containers, the proprietary name of the admixture, the type, grade, and class under this specification, and the net weight or volume shall be plainly marked thereon. Similar information shall be provided in the shipping paper accompanying packaged or bulk materials.

14. Supplementary Requirements

14.1 Supplementary requirements may be specified by the purchaser and apply only when they appear separately on the purchase contract or order.

14.2 Quality assurance requirements shall be specified in the purchase contract or order with a reference to a pertinent document agreed upon by the supplier and purchaser.

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