



# Standard Specification for Packaged, Pre-Blended, Dry, Combined Materials for Use in Wet or Dry Shotcrete Application<sup>1</sup>

This standard is issued under the fixed designation C 1480; 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 specification covers laboratory performance standards for pre-blended, dry, packaged, combined materials for use in wet or dry shotcrete applications that are delivered to a purchaser with the ingredients uniformly mixed. The use of supplemental materials, placement, curing, or protection of the shotcrete after delivery to the purchaser is not addressed by this specification.

1.2 The values stated in SI units shall be regarded as the standard. The inch-pound values in parentheses are for information only.

1.3 The following safety hazards caveat pertains only to the test method portion 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 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)<sup>2</sup>
- C 150 Specification for Portland Cement<sup>3</sup>
- C 387 Specification for Packaged, Dry, Combined Materials for Mortar and Concrete<sup>2</sup>
- C 595 Specification for Blended Hydraulic Cements<sup>3</sup>
- C 1012 Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution<sup>3</sup>
- C 1140 Practice for Preparing and Testing Specimens from Shotcrete Test Panels<sup>2</sup>
- C 1157 Performance Specification for Blended Hydraulic Cement<sup>3</sup>
- C 1202 Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration<sup>2</sup>
- C 1385 Practice for Sampling Materials for Shotcrete<sup>2</sup>
- C 1399 Test Method for Obtaining Average Residual-

Strength of Fiber-Reinforced Concrete<sup>2</sup>

C 1436 Specification for Materials for Shotcrete<sup>2</sup>

E 96 Test Methods for Water Vapor Transmission of Materials<sup>4</sup>

2.2 *American Concrete Institute Standards Manual of Concrete Practice:*

506.2 Specification for Materials Proportioning and Application of Shotcrete<sup>5</sup>

2.3 *National Institute of Standards and Technology:*

Handbook 44 Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing Devices<sup>6</sup>

## 3. Terminology

### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *Packaged, pre-blended, dry, combined materials*—for use in wet or dry shotcrete applications consist primarily of hydraulic cement and concrete aggregates blended, in a dry state, with other ingredients to enhance one or more properties of the mixture.

## 4. Classification

4.1 Dry packaged shotcrete materials are categorized as to type and grade.

4.1.1 Shotcrete type is based on aggregate size.

4.1.2 Type FA shotcrete shall contain aggregate in accordance with the requirements of Specification C 1436 Grading #1. Aggregates failing to comply with Grading #1 can be used only if preconstruction testing proves that they give satisfactory results or if acceptable service records are available.

4.1.3 Type CA shotcrete shall contain coarse and fine aggregates in accordance with the requirements of Specification C 1436, Grading No. 2. Aggregates failing to comply with Grading #2 can be used only if preconstruction testing proves that they give satisfactory results or if acceptable service records are available.

4.2 Shotcrete grade is based on the desired physical properties of the material.

<sup>1</sup> 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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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.02

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.01

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 04.06

<sup>5</sup> Available from American Concrete Institute, P.O. Box 9094, Farmington Hills, Michigan 48333

<sup>6</sup> Available from National Institute of Standards and Technology (NIST), Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

4.2.1 Grade GU shotcrete is a general use product.

4.2.2 Grade SR shotcrete has sulfate resistance in accordance with the requirements of 7.4

4.2.3 Grade LP shotcrete has permeability values in accordance with the requirements of 7.5

4.2.4 Grade FR shotcrete has average residual strength values in accordance with the requirements of 7.6, Type I or II.

4.2.4.1 Class I shotcrete has average residual strength values in accordance with the requirements of 7.6.1.

4.2.4.2 Class II shotcrete has flexural strength and average residual strength values in accordance with the requirements of 7.6.2.

NOTE 1—Grade FR Class I shotcrete is intended to minimize plastic shrinkage cracking. Grade FR Class 2 shotcrete is intended to provide a minimum level of post-crack flexural load capacity for hardened shotcrete.

**5. Ordering Information**

5.1 The purchaser shall specify the type, grade, and class (if applicable) of shotcrete required.

NOTE 2—A single material may meet more than one grade. Other properties may be specified by the purchaser, but are beyond the scope of this specification.

5.2 At the request of the purchaser, the producer shall, prior to delivery, furnish laboratory performance data satisfactory to the purchaser that the product meets the specified type and grades.

**6. Materials and Manufacture**

6.1 Basic materials shall meet the requirements of Specification C 1436.

6.2 Additional materials shall be permitted only if adequate test data are available to insure that the ingredient has no deleterious effects on the specified properties.

6.3 Aggregates shall be dried, without disintegration, to a moisture content of less than 0.2 mass percent, computed on material dried substantially to constant mass at 105 to 110°C (210° to 230° F).

6.4 *Measurement of Materials*—Measure materials in accordance with 6.4.1-6.4.4.

6.4.1 Cementitious materials and aggregates shall be measured by mass (or by volume). Volumetric measurement shall be calibrated by mass.

6.4.2 Scales for batching ingredients shall conform to the applicable section of the current edition of the National Institute of Standards and Technology Handbook 44 Specifications, Tolerance, and Other Technical Requirements for Commercial Weighing Devices.

6.4.3 Measure fibers by mass.

6.4.4 Measure admixtures by mass or volume.

6.5 Shotcrete ingredients shall be thoroughly blended at a central location. Mixer performance tests shall be performed to establish the mixing time suitable for uniformity of mixing. Representative samples shall be obtained in accordance with Practice C 1385.

6.6 *Delivery*—Unless otherwise specified, delivery of the shotcrete materials shall conform to 6.6.1-6.6.3.

6.6.1 Thoroughly mix and deliver to the construction site materials without segregation or lumps of ingredients.

6.6.2 Temperature of pre-blended, dry, combined materials for shotcrete at time of delivery shall not exceed 65°C (149°F).

6.6.3 Delivery shall be in any size package as agreed between the purchaser and producer.

**7. Physical Requirements**

7.1 Type FA shotcrete shall meet the requirements of Table 1 when mixed and tested in accordance with the procedure for mixing and testing high strength mortar in accordance with Specification C 387.

7.2 Type CA shotcrete shall meet the requirements of Table 1 when mixed and tested in accordance with the procedures for mixing and testing normal strength concrete in accordance with Specification C 387.

7.3 Grade GU shotcrete shall meet the general requirements for type FA or type CA shotcrete.

7.4 Grade SR shotcrete shall have sulfate resistance as determined in one of the following ways:

7.4.1 Product shall be prepared with a cement meeting Specification C 150 types II or V, Specification C 595 cements with an MS designation or Specification C 1157 types MS or HS

7.4.2 Product shall exhibit an expansion of less than 0.1 % at 180 days when tested in accordance with applicable portions of Test Method C 1012. Samples for testing shall be mixed and placed in accordance with this specification.

7.4.3 In Test Method C 1012 the samples are normally prepared at a fixed water content using standard sand. Those portions of the method will not apply in this case

7.5 Grade LP shotcrete shall have a chloride penetrability rating of “very low” (< 1000 coulombs) when tested at an age of 28 days in accordance with Test Method C 1202. Specimens for the test shall be either from laboratory prepared samples mixed and placed in accordance with this specification or from field samples obtained in accordance with method Practice C 1140 and Test Method C 1202.

NOTE 3—Due to the potential differences between laboratory and field conditions it may be necessary to test field samples in order to verify performance with the applied material specifications. See appendix for a discussion of expected field performance vs. laboratory performance for wet mix vs. dry mix shotcrete.

7.6 Grade FR shotcrete shall have fiber reinforcement with the following minimum requirements:

7.6.1 Grade FR Class I shotcrete shall have a minimum 28-day average residual strength of 275 kPa (40 psi) when tested in accordance with Test Method C 1399.

7.6.2 Grade FR Class II shotcrete shall have a minimum 28-day flexural strength of 4MPa (580 psi) when 100 by 100 by 350 mm specimens are tested in accordance with Test Method

**TABLE 1 Physical Requirements**

Property	Requirement for Type FA	Requirement for Type CA
Flow	105 to 115	- - -
Slump	- - -	50 to 75 mm (2 to 3 in.)
7 day Compressive strength (min)	21.0 MPa (3050 psi)	21.0 MPa (3050 psi)
28 day Compressive Strength (min)	35.0 MPa (5075 psi)	35.0 MPa (5075 psi)

C 78 and a minimum 28-day average residual strength of 2 MPa (290 psi) when tested in accordance with Test Method C 1399.

## 8. Sampling and Specimen Preparation

8.1 Samples of the finished product for testing shall be provided by the manufacturer or obtained in the field prior to the addition of water in accordance with Practice C 1385.

8.2 Specimens for testing for compliance with this specification shall be cast and tested in accordance with the applicable portions of Specification C 387 unless otherwise specified within this specification.

NOTE 4—Specimens for testing mixtures for compliance with this specification are laboratory mixtures cast in accordance to applicable portions of Specification C 387, not mixtures that have been shotcreted. The values of test results may be higher or lower than the values of test results from nominally similar mixtures that have been shotcreted.

## 9. Rejection

9.1 The purchaser has the right to reject material that fails to conform to the requirements of this specification. Rejection shall be reported to the producer of supplier promptly and in writing.

9.2 The seller has no control over the application of the shotcrete material; therefore unsatisfactory field performance of the material shall not be used as a basis for rejection of the product.

NOTE 5—For instructions on the proper application of shotcrete refer to ACI 506.2 Specification for Materials Proportioning and Application of Shotcrete.

## 10. Packaging and Package Marking

10.1 All packages shall be identified as conforming to Specification C 1480, and as to type, grade(s), and class (if applicable) of shotcrete material and the net mass in each package printed thereon.

10.2 The yield in cubic metres (cubic feet) and the approximate amount of water recommended for mixing shall be marked on the package.

NOTE 6—The amount of water recommended shall be the amount required to produce a 50 to 75-mm (2 to 3-in.) slump for Type CA or a flow of 105-115 for Type FA.

10.3 *Container Construction*—The material from which the containers are made shall have water vapor transmission not greater than 100 g/m<sup>2</sup> in 24 hours as determined in accordance with Procedure B of Test Method E 96. The strength of the container shall be adequate for the mass of the mixture it is intended to contain.

## 11. Keywords

11.1 average residual strength; compressive strength; dry mix shotcrete; flexural strength; packaged shotcrete materials; pre-blended shotcrete materials; shotcrete; wet mix shotcrete

# APPENDIXES

## (Nonmandatory Information)

### X1. DIFFERENCE BETWEEN DRY-MIX AND WET-MIX SHOTCRETE

X1.1 Dry mix shotcrete (also known as guniting) is typically placed in the field at a water content that is 10 to 15 % lower than that required for laboratory testing. Therefore field performance of dry mix shotcrete under ideal conditions will provide substantially higher strengths than in the laboratory.

X1.2 Wet mix shotcrete will be more likely to be placed with a water content similar to that used in the laboratory. Wet mix shotcrete is sometimes modified at the nozzle by the addition of a shotcrete accelerator. This can affect the in-place results.


### X2. FIELD TESTING

X2.1 It is recommended that job mock-ups be prepared by the contractor and tested prior to beginning a project to establish the expected in-place performance that will be achieved with the specified product. ACI Committee 506 provides extensive recommendations as to proper surface

preparation and equipment as well as nozzlemen certification and proper shotcrete placement and curing procedures. See reference ACI 506R, 506.2, and 506.3R, as well as Practice C 1140.

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