



Designation: C1697 – 21

Standard Specification for Blended Supplementary Cementitious Materials¹

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1. Scope*

1.1 This specification covers blended supplementary cementitious materials that result from the blending or intergrinding of two or three ASTM compliant supplementary cementitious materials, for use in concrete or mortar where hydraulic or pozzolanic action, or both, is desired. The supplementary cementitious materials include slag cement conforming to Specification C989/C989M, natural pozzolans and coal fly ash conforming to Specification C618 and silica fume conforming to Specification C1240.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

NOTE 1—The incorporation of supplementary cementitious materials as separate additions or as a manufactured blend may significantly alter the properties of fresh and hardened concrete. The user should be aware of these changes and is referred to the *ACI Manual of Concrete Practice*² for information and guidelines. Specific reference is made to:

ACI 232.1R	Use of Natural Pozzolans in Concrete
ACI 232.2R	Use of Fly Ash in Concrete
ACI 233R	Slag Cement in Concrete and Mortar
ACI 234R	Guide for the Use of Silica Fume in Concrete

1.3 *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.*

1.4 *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.*

¹ This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.24 on Supplementary Cementitious Materials.

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² Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.concrete.org>.

2. Referenced Documents

2.1 ASTM Standards:³

- C114 Test Methods for Chemical Analysis of Hydraulic Cement
- C125 Terminology Relating to Concrete and Concrete Aggregates
- C150/C150M Specification for Portland Cement
- C151/C151M Test Method for Autoclave Expansion of Hydraulic Cement
- C183/C183M Practice for Sampling and the Amount of Testing of Hydraulic Cement
- C311/C311M Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
- C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
- C1240 Specification for Silica Fume Used in Cementitious Mixtures
- C1778 Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete

3. Terminology

3.1 Definitions:

3.1.1 For definitions of other terms used in this specification, refer to Terminology C125.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *slag cement, n*—granulated blast furnace slag that is ground to cement fineness with or without additions and meets Specification C989/C989M.

3.2.2 *supplementary cementitious material, n*—a slag cement or pozzolan that contributes to the properties of concrete or mortar through hydraulic or pozzolanic activity, or both.

3.2.3 *silica fume, n*—as defined in Specification C1240.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

4. Classification

4.1 This specification applies to a hydraulic or pozzolanic material composed of a blend of multiple supplementary cementitious materials as defined in **Table 1**. The supplementary cementitious materials of the blend are identified in accordance with the Type listed in the first column of **Table 1**. For the purpose of conformance to the requirements of this specification, the blend is classified according to the predominant supplementary cementitious material. For blended supplementary cementitious materials that have no predominant constituent, the manufacturer selects the blend type.

4.2 The naming practice for reporting blended supplementary cementitious materials is as follows:

$$SCMb - Axx/Byy/Czz$$

where:

- SCMb* = designation of the product as a blended supplementary cementitious material,
- A* = targeted mass % of the predominant supplementary cementitious material in the blended supplementary cementitious material expressed by mass of the final blended supplementary cementitious material,
- xx* = predominant supplementary cementitious material—use Type designation in accordance with **Table 1**,
- B* = targeted mass % of the secondary supplementary cementitious material in the blended supplementary cementitious material expressed by mass of the final blended supplementary cementitious material,
- yy* = secondary supplementary cementitious material—use Type designation in accordance with **Table 1**,
- C* = targeted mass % of the tertiary supplementary cementitious material in the blended supplementary cementitious material expressed by mass of the final blended supplementary cementitious material. This would be required only for ternary mixtures, and
- zz* = tertiary supplementary cementitious material—use Type designation in accordance with **Table 1**

NOTE 2—Examples of the naming practice are as follows:

A binary mixture of 65 % Class C fly ash and 35 % slag cement would be:

$$SCMb - 65C/35S$$

A ternary mixture of 60 % Class F fly ash, 35 % slag cement and 5 % silica fume would be:

$$SCMb - 60F/35S/5SF$$

5. Ordering Information

5.1 Orders for material under this specification shall include the following:

5.1.1 Specification number,

5.1.2 The composition of the blend using the naming convention in 4.2.

5.1.3 Any optional requirements as delineated in **Table 2**.

NOTE 3—In advance of ordering, it is important to check for market availability of blended supplementary cementitious materials.

6. Materials and Manufacture

6.1 All individual constituents used in the manufacture of the blended supplementary cementitious material shall conform to their applicable specification.

6.2 All blended supplementary cementitious materials shall consist of a uniform mixture of constituents within the limits specified in Section 9.

7. Chemical Composition

7.1 The individual constituents and the blended supplementary cementitious material shall be chemically analyzed using applicable analytical methods of Test Methods **C311/C311M** or Test Methods **C114**. Analyze for major and minor oxides present in greatest quantity that together, including loss-on-ignition constitutes at least 98 % of the total mass of the material.

7.2 There are no chemical requirements for the blended supplementary cementitious material but the chemical composition of the constituents and of the blended supplementary cementitious material are necessary to verify blend proportions.

8. Physical and Optional Properties

8.1 Blended supplementary cementitious materials shall conform to the physical requirements in **Table 3**, where the blend type is in accordance with Section 4.

8.2 Blended supplementary cementitious materials shall conform to the optional requirements in **Table 2**, only when specifically requested by the purchaser. The blend type is in accordance with Section 4.

9. Permissible Variations in Blending Accuracy

9.1 The amount of pozzolan or slag cement in the finished blended supplementary cementitious material shall not vary from the target value by more than ± 2.5 percentage points for silica fume and not more than ± 5 percentage points for other supplementary cementitious materials, with a 99 % probability of compliance.

NOTE 4—To satisfy the 99 % probability of compliance, the blending process must be capable of producing a blend containing silica fume such that the standard deviation of the measured mass percentage of silica fume in the blend is less than 1 %. For constituents other than silica fume, the standard deviations of their measured mass percentages have to be less than 1.9 %.

9.2 The chemical composition of the individual constituents and of the finished blended supplementary cementitious material shall be determined in accordance with Section 7. The composition of the blend in terms of mass percentage of the constituents shall be calculated.

NOTE 5—**Appendix X1** provides an example to illustrate how the composition of the blend can be calculated from the various measured chemical compositions.

TABLE 1 Classification of Supplementary Cementitious Materials

Type	Name
N	Class N Pozzolan meeting Specification C618
F	Class F fly ash meeting Specification C618
C	Class C fly ash meeting Specification C618
SF	Silica Fume meeting Specification C1240
S	Slag cement meeting Specification C989/C989M

TABLE 2 Optional Requirements

	Blend Type				
	N	F	C	S	SF
Increase of drying shrinkage of mortar bars at 28 days, max, difference, in %, over control ^A	0.03	0.03	0.03	...	...
Uniformity Requirements: ^B					
The density and fineness of individual samples shall not vary from the average established by the ten preceding tests, or by all preceding tests if the number is less than ten, by more than:					
Density - max variation from average, %	5	5	5	...	...
% retained on 45 µm (No. 325) sieve, max variation from average, %	5	5	5	5	5
When air-entraining concrete is specified, the quantity of air-entraining agent required to produce an air content of 18.0 vol % of mortar shall not vary from the average established by the ten preceding tests or by all preceding tests if less than ten, by more than, %	20	20	20	...	20
Effectiveness in Contributing to Sulfate Resistance: Procedure A: ^E					
Expansion of test mixture:					
For moderate sulfate exposure after 6 months exposure, max, %	0.10 ^F	0.10 ^F	0.10 ^F	0.10 ^C	0.10 ^D
For high sulfate exposure after 6 months exposure, max, %	0.05 ^F	0.05 ^F	0.05 ^F	0.05 ^C	0.05 ^D
For very high sulfate exposure after 12 months exposure, max, %	...	...	...	...	0.05 ^C
Procedure B:					
Expansion of test mixture as a percentage of sulfate resistance cement control after at least 6 months exposure, max, % ^F	100	100	100	...	...

^A Determination of compliance or noncompliance with the requirement relating to increase in drying shrinkage will be made only at the request of the purchaser. Test method in accordance with Test Methods **C311/C311M**.

^B Test in accordance with Test Methods **C311/C311M** or Specification **C1240** as appropriate.

^C Refer to the Appendix of Specification **C989/C989M**.

^D As delineated in Specification **C1240**.

^E Only one limit shall be specified.

^F Blended supplementary cementitious materials shall be considered effective only when the blended supplementary cementitious material is used at percentages, by mass, of the total cementitious material within 2 % of those that are successful in the test mixtures or between two percentages that are successful, and when the C₃A content of the project cement is less than, or equal to, that which was used in the test mixtures. See Appendix X2 of Test Methods **C311/C311M**. Test method in accordance with Test Methods **C311/C311M**.

TABLE 3 Physical Requirements

	Blend Type				
	N	F	C	S	SF
% retained when wet sieved on 45 µm (No. 325) sieve ^A	Report only	Report only	Report only	Report only	Report only
Activity Index, min, % of control ^B					
7 day Index	75 ^C	75 ^C	75 ^C	Report only	105
28 day Index	75 ^C	75 ^C	75 ^C	75 ^D	...
Water Requirement, % of control ^E	Report only	Report only	Report only	Report only	...
Autoclave, expansion or contraction, max, % ^F	0.8	0.8	0.8	...	...

^A Refer to Test Methods **C311/C311M**.

^B The activity index with portland cement is not to be considered a measure of the compressive strength of concrete containing the pozzolan or slag. The tests are conducted as follows - for N, F, C refer to Specification **C618**; for S refer to Specification **C989/C989M**; for SF refer to Specification **C1240**.

^C Meeting the 7 day or 28 day activity index will indicate specification compliance.

^D Requirement is for the average of last 5 consecutive samples; no individual sample shall be more than 5 % less than the average requirement.

^E Refer to test method in Test Methods **C311/C311M**. Refer to the applicable activity index procedure for determining the water requirement of the test mixture compared with the control.

^F In accordance with Test Method **C151/C151M**, except the specimens shall be molded from a paste composed of 25 parts by mass of blended supplementary cementitious material and 100 parts by mass of a portland cement conforming to Specification **C150/C150M**.

10. Sampling

10.1 The manufacturer shall sample and test the finished blended supplementary cementitious material in order to verify compliance with this specification.

10.1.1 Upon request of the purchaser, the manufacturer shall furnish the sampling procedure used to certify compliance with this specification.