



Designation: **C618—22** C618 – 23

## Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete<sup>1</sup>

This standard is issued under the fixed designation C618; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

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

### 1. Scope\*

1.1 This specification covers coal fly ash resulting from the combustion of coal, and raw or calcined natural pozzolan, for use in concrete where cementitious or pozzolanic action, or both, is desired, or where other properties normally attributed to fly coal ash or natural pozzolans may be desired, or where both objectives are to be achieved.

NOTE 1—Finely divided materials may tend to reduce the entrained air content of concrete. Hence, if a fly coal ash or natural pozzolan is added to any concrete for which entrainment of air is specified, provision should be made to ensure that the specified air content is maintained by air content tests and by use of additional air-entraining admixture or use of an air-entraining admixture in combination with air-entraining hydraulic cement.

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

1.3 The text of this standard references notes and footnotes, which provide explanatory information. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

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.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

[C125 Terminology Relating to Concrete and Concrete Aggregates](#)

[C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates](#)

[C311/C311M Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete](#)

[C1778 Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete](#)

### 3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this specification refer to Terminology [C125](#).

<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 C09.24 on Supplementary Cementitious Materials.

Current edition approved Aug. 1, 2022 March 1, 2023. Published August 2022 March 2023. Originally approved in 1968. Last previous edition approved in 2019 2022 as C618-19. DOI: 10.1520/C0618-22-22. DOI: 10.1520/C0618-23.

<sup>2</sup> 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

**TABLE 1 Chemical Requirements**

	Class		
	N	F	C
Silicon dioxide (SiO <sub>2</sub> ) plus aluminum oxide (Al <sub>2</sub> O <sub>3</sub> ) plus iron oxide (Fe <sub>2</sub> O <sub>3</sub> ), min, %	70.0	50.0	50.0
Calcium oxide (CaO), %	report only	18.0 max.	>18.0
Sulfur trioxide (SO <sub>3</sub> ), max, %	4.0	5.0	5.0
Moisture content, max, %	3.0	3.0	3.0
Loss on ignition, max, %	10.0	6.0 <sup>A</sup>	6.0

<sup>A</sup>The use of Class F pozzolan-coal ash containing up to 12.0 % loss on ignition may be approved by the user if either acceptable performance records or laboratory test results are made available.

**TABLE 2 Physical Requirements**

	Class		
	N	F	C
<i>Fineness:</i>			
Amount retained when wet-sieved on 45 µm (No. 325) sieve, max, %	34	34	34
Amount retained on 150-µm (No. 100) sieve, max, % <sup>A</sup>			
<i>Strength activity index:</i> <sup>A</sup>			
<i>Strength activity index:</i> <sup>B</sup>			
With portland cement, at 7 days, min, percent of control	75 <sup>B</sup>	75 <sup>B</sup>	75 <sup>B</sup>
With portland cement, at 7 days, min, percent of control	75 <sup>C</sup>	75 <sup>C</sup>	75 <sup>C</sup>
With portland cement, at 28 days, min, percent of control	75 <sup>B</sup>	75 <sup>B</sup>	75 <sup>B</sup>
With portland cement, at 28 days, min, percent of control	75 <sup>C</sup>	75 <sup>C</sup>	75 <sup>C</sup>
Water requirement, max, percent of control	115	105	105
<i>Uniformity requirements:</i>			
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
Percent retained on 45-µm (No. 325), max variation, percentage points from average	5	5	5

<sup>A</sup> Limit only applies to coal ash that is harvested or coal ash containing bottom ash. Determine the amount retained in accordance with Test Method C136/C136M using a sample size of 15 g ± 5 g

<sup>B</sup> The *strength* activity index with portland cement is not to be considered a measure of the compressive strength of concrete containing the flycoal ash or natural pozzolan. The mass of flycoal ash or natural pozzolan specified for the test to determine the *strength* activity index with portland cement is not considered to be the proportion recommended for the concrete to be used in the work. The optimum amount of flycoal ash or natural pozzolan for any specific project is determined by the required properties of the concrete and other constituents of the concrete and is to be established by testing. *Strength* activity index with portland cement is a measure of reactivity with a given cement and is subject to variation depending on the source of both the flycoal ash or natural pozzolan and the cement.

<sup>C</sup> Meeting the 7 day or 28 day *strength* activity index will indicate specification compliance.

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

**3.2.1 coal ash, n**—fly ash and bottom ash resulting from the process of combustion of ground or powdered coal obtained either from current power plant production or harvested from landfills or impoundments.

**3.2.2 bottom ash, n**—ash that results from the process of combustion of ground or powdered coal that is not transported by flue gases.

#### 3.2.2.1 Discussion—

This definition of bottom ash does not include the residue resulting from: (1) fluidized bed combustion, (2) the burning of municipal solid waste or any other refuse with coal, or (3) the burning of industrial or municipal solid waste in incinerators.

## 4. Classification

**4.1 Class N**—Raw or calcined natural pozzolans that comply with the applicable requirements for the class as given herein, such as some diatomaceous earths; opaline cherts and shales; tuffs and volcanic ashes or pumicites, calcined or uncalcined; and various materials requiring calcination to induce satisfactory properties, such as some clays and shales.

**TABLE 3 Supplementary Optional Physical Requirements**

NOTE 1—These optional requirements apply only when specifically requested.

	Class		
	N	F	C
Increase of drying shrinkage of mortar bars at 28 days, max, difference, in %, over control <sup>A</sup>	0.03	0.03	0.03
Uniformity Requirements: In addition, 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
Effectiveness in Contributing to Sulfate Resistance: <sup>B</sup> Procedure A: Expansion of test mixture: For moderate sulfate exposure after 6 months exposure, max, %	0.10	0.10	0.10
For high sulfate exposure after 6 months exposure, max, %	0.05	0.05	0.05
Procedure B: Expansion of test mixture as a percentage of sulfate resistance cement control after at least 6 months exposure, max,%	100	100	100

<sup>A</sup> Determination of compliance or noncompliance with the requirement relating to increase in drying shrinkage will be made only at the request of the purchaser.

<sup>B</sup> Fly Coal ash or natural pozzolan shall be considered effective only when the flycoal ash or natural pozzolan 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 C<sub>3</sub>A content of the project cement is less than, or equal to, that which was used in the test mixtures. See Appendix X2 of Test Method C311/C311M.

4.2 **Class F—FlyCoal** ash that meets the applicable requirements for this class as given herein. This class of flycoal ash has pozzolanic properties.

4.3 **Class C—FlyCoal** ash that meets the applicable requirements for this class as given herein. This class of flycoal ash, in addition to having pozzolanic properties, also has some cementitious properties.

NOTE 2—Class F flycoal ash is typically produced from burning anthracite or bituminous coal, but may also be produced from subbituminous coal and from lignite. Class C flycoal ash is typically produced from burning lignite or subbituminous coal, and may also be produced from anthracite or bituminous coal.

## 5. Materials and Manufacture

5.1 It is permitted to process coal ash and natural pozzolans in order to meet the requirements of this specification.

NOTE 3—Processing may include but is not limited to one or more of the following unit operations: grinding, drying, sieving, de-agglomeration, sizing, and carbon removal.

## 6. Ordering Information

6.1 The purchaser shall specify any supplementary optional physical requirements.

6.2 The purchaser shall indicate which procedure, A or B, shall be used when specifying requirements for effectiveness in contribution to sulfate resistance under Table 3.

## 7. Chemical Composition

7.1 FlyCoal ash and natural pozzolans shall conform to the requirements as to chemical composition prescribed in Table 1.

NOTE 4—The chemical component determinations and the limits placed on each do not predict the performance of the flycoal ash or natural pozzolan with hydraulic cement in concrete, but collectively help describe composition and uniformity of the material.

## 8. Physical Properties

8.1 FlyCoal ash and natural pozzolans shall conform to the physical requirements prescribed in Table 2. Supplementary optional physical requirements are shown in Table 3.

## 9. Methods of Sampling and Testing

9.1 Sample and test the flycoal ash or natural pozzolan in accordance with the requirements of Test Methods C311/C311M.

9.2 Use cement of the type proposed for use in the work and, if available, from the mill proposed as the source of the cement, in all tests requiring the use of hydraulic cement.

## 10. Storage and Inspection

10.1 The flycoal ash or natural pozzolan shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment.

10.2 Inspection of the material shall be made as agreed upon by the purchaser and the seller as part of the purchase contract.

## 11. Rejection

11.1 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 or supplier promptly and in writing.

11.2 The purchaser has the right to reject packages varying more than 5 % from the stated weight. The purchaser also has the right to reject the entire shipment if the average weight of the packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified.

11.3 The purchaser has the right to require that material in storage prior to shipment for a period longer than 6 months after testing be retested. The purchaser has the right to reject such material if it fails to meet the fineness requirements.

## 12. Packaging and Package Marking

12.1 When the flycoal ash or natural pozzolan is delivered in packages, the class, name, and brand of the producer, and the weight of the material contained therein, shall be plainly marked on each package. Similar information shall be provided in the shipping invoices accompanying the shipment of packaged or bulk material.

## 13. Supplier's Certification

13.1 Upon request of the purchaser, in the contract or the order, a supplier's report shall be furnished stating the results of tests made on samples of the material and certifying the product conforms to all applicable requirements of this specification. In addition, the report shall include the percentages of magnesium oxide (MgO), sodium oxide (Na<sub>2</sub>O), potassium oxide (K<sub>2</sub>O), and calcium oxide (CaO), all determined as described in Test Methods C311/C311M. The report shall also include the total alkali content of the material, expressed as equivalent percentage of sodium oxide (Na<sub>2</sub>Oe).

NOTE 5—Guidance on preparing the supplier's report is provided in Appendix X1.

13.2 The supplier's report shall disclose whether the source of the material represented in the certificate is fly ash, bottom ash, or commingled fly ash and bottom ash, and if the material is harvested coal ash.

## 14. Keywords

14.1 bottom ash; coal ash; fly ash; natural pozzolan; harvested coal ash; pozzolan; natural pozzolan