



Designation: D5239 – 12<sup>ε</sup><sup>1</sup>

## Standard Practice for Characterizing Fly Ash for Use in Soil Stabilization<sup>1</sup>

This standard is issued under the fixed designation D5239; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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<sup>ε</sup><sup>1</sup> NOTE—Editorially updated units of measurement statement in April 2018.

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### 1. Scope\*

1.1 This practice covers procedures for characterizing fly ash to be used in soil stabilization. This practice lists representative test methods for determining the chemical, physical, and cementitious properties of fly ash. A broad guideline is provided in [Appendix X1](#) that explains the significance of these properties in soil stabilization.

1.2 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice [D6026](#).

1.2.1 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.4 *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.*

1.5 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

1.6 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.

1.7 *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>

- [C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime](#)
- [C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars \(Using 2-in. or \[50-mm\] Cube Specimens\)](#)
- [C191 Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle](#)
- [C265 Test Method for Water-Extractable Sulfate in Hydrated Hydraulic Cement Mortar \(Withdrawn 2017\)](#)<sup>3</sup>
- [C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency](#)
- [C311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete](#)
- [C593 Specification for Fly Ash and Other Pozzolans for Use With Lime for Soil Stabilization](#)
- [C821 Specification for Lime for Use with Pozzolans](#)
- [D653 Terminology Relating to Soil, Rock, and Contained Fluids](#)
- [D1293 Test Methods for pH of Water](#)
- [D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction](#)

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<sup>1</sup> This practice is under the jurisdiction of ASTM Committee [D18](#) on Soil and Rock and is the direct responsibility of Subcommittee [D18.15](#) on Stabilization With Admixtures.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

**D5370** Specification for Pozzolanic Blended Materials in Construction Applications

**D6026** Practice for Using Significant Digits in Geotechnical Data

### 3. Terminology

#### 3.1 Definitions:

3.1.1 For common definitions of terms in this standard, refer to Terminology **D653**.

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

3.2.1 *non self-cementing fly ash, n*—fly ash produced from the combustion of pulverized or crushed coal. This fly ash has pozzolanic properties and no self-cementing properties.

3.2.2 *self-cementing fly ash, n*—fly ash produced from the combustion of pulverized or crushed coal. This fly ash, in addition to having pozzolanic properties, sets and hardens by chemical interaction with water and is capable of doing so under water.

3.2.3 *stabilizing admixtures, n*—admixtures used to improve soil properties such as increased soil freeze-thaw durability, stiffness, and strength; reduction of permeability, plasticity, and swelling; increased control of soil compressibility and moisture.

### 4. Significance and Use

4.1 This practice is intended for use with fly ash that can be used separately or along with other stabilizing admixtures to improve soil properties.

4.2 The characterization of the physical and chemical properties of the fly ash shall assist in the evaluation of the fly ash for soil stabilization.

4.3 This practice is not intended to limit the flexibility of design in soil stabilization. The degree of success attained in soil stabilization is highly dependent on the particular combination of soil, fly ash, and other additives and the construction procedure used. Demonstrated sound engineering procedures that result in appropriate physical characteristics are acceptable. The selection of appropriate materials, applicable tests, acceptance criteria, and specification is the responsibility of the design engineer.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice **D3740** are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice **D3740** does not in itself assure reliable results. Reliable results depend on many factors; Practice **D3740** provides a means of evaluating some of those factors.

### 5. Fly Ash Quality Assurance Program

5.1 *Pre-Qualification*—A fly ash is pre-qualified if it is sampled in accordance with Method **C311** and a quality history is made available consisting of six months of recent test results. The type of tests performed and their frequency shall be acceptable to the purchaser.

NOTE 2—The intent of the quality history is not to accept or reject the fly ash with regard to specified limits but to provide an evaluation of the fly ash and its uniformity.

5.2 *Project*—During the project, spot-checking of a pre-qualified fly ash shall occur at the sampling and testing frequency established by the purchaser. A fly ash that is not pre-qualified shall be sampled at the source at a minimum frequency of one sample for each (91 mg) 100 tons made available for sale and be sampled at the job site at a minimum frequency of one sample for every (23 mg) 25 tons. The type of tests performed and their frequency shall be acceptable to the purchaser.

### 6. Determination of Fly Ash Characteristics

6.1 Determine loss on ignition, moisture, and major oxides in accordance with Method **C311**.

6.2 *Free Lime*—Determine the free lime content in fly ash in accordance with available Lime Index Method of Test Method **C25** (Hydrated Lime Procedure).

6.3 *Fineness*—Determine the amount retained when wet sieved on a 45  $\mu\text{m}$  (No. 325) sieve in accordance with the procedure described in Method **C311**.

6.4 *Self-Cementing Properties*—Determine the self-cementing properties of fly ash by the compressive strength method given in Test Method **C109/C109M** except use no sand nor Portland cement and mixtures shall contain fly ash plus tap water at water-to-fly ash weight ratio of 0.35. Test compressive strength at one and seven days. Mix the paste in accordance with Method **C305**. Mixing time may have to be modified for quick-setting fly ashes.

6.4.1 *Very Self-Cementing Fly Ash*—Compressive strengths greater than (345 MPa) 500 psi at seven days.

6.4.2 *Moderately Self-Cementing Fly Ash*—Compressive strengths greater than or equal to (70 MPa) 100 psi but less than or equal to (345 MPa) 500 psi at seven days.

6.4.3 *Non Self-Cementing Fly Ash*—Compressive strengths less than (70 MPa) 100 psi at seven days.

6.5 *Lime-Pozzolanic Activity*—Determine the lime-pozzolan strength development in accordance with Specification **C593**. For purposes of standardization, the lime must meet Specification **C821**.

6.6 *Strength Activity Index with Portland Cement*—Determine the strength activity index with Portland Cement in accordance with Method **C311**.

6.7 *Setting Time*—Determine the set of fly ash-water pastes at water-to-fly ash weight ratio of 0.35 by vicat needle in accordance with Test Method **C191**.

6.8 *pH*—Determine the pH of the fly ash by adding 20 g fly ash to 80 mL distilled water. Stir the mixture to disperse the fly ash. Leave the covered beaker undisturbed for 2 h and then determine pH in accordance with Test Method **D1293**.

6.9 *Sulfates*—Determine water-soluble sulfates in accordance with Test Method **C265** except stir 1 g fly ash into 100 mL distilled water for 2 min and filter and wash the residue thoroughly with 3 to 10 mL aliquots of room temperature water using a rapid-filtering, acid-washed filter paper folded inside a fine-textured acid-washed filter paper.

6.9.1 Determine total sulfate in accordance with Method **C311**.