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Standard Specification for Ground Calcium Carbonate and Aggregate Mineral Fillers for use in Hydraulic Cement Concrete[1]

This standard is issued under the fixed designation C1797; 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 applies to ground calcium carbonate (GCC is a type of ground limestone) and other finely divided aggregate mineral filler (AMF) materials for use in concrete mixtures. The specification defines the types of GCC and AMF materials for use in concrete.

1.2 If concrete in service is subject to sulfate exposure, fillers derived from ground limestone should not be used unless mitigation methods are used.

NOTE 1—American Concrete Institute (ACI) technical documents 201.2R, 318, 332, and 350 contain useful information and code requirements dealing with sulfate exposure in service. Soluble sulfate in water can be determined in accordance with Test Method D516 or Test Method D4130. Percent sulfate by mass in soil can be determined by Test Method C1580.

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

NOTE 2—Sieve size is identified by its standard designation in Specification E11. The alternative designation given in parentheses is for information only and does not represent a different standard sieve size.

1.4 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.

1.5 *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.*

1.6 *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:*[2]

C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime

C50/C50M Practice for Sampling, Sample Preparation, Packaging, and Marking of Lime and Limestone Products

[1] This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.20 on Aggregates.

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[2] 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**

C51 Terminology Relating to Lime and Limestone (as Used by the Industry)
C110 Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone
C117 Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
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
C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
C566 Test Method for Total Evaporable Moisture Content of Aggregate by Drying
~~C595/C595M Specification for Blended Hydraulic Cements~~
C1580 Test Method for Water-Soluble Sulfate in Soil
C1777 Test Method for Rapid Determination of the Methylene Blue Value for Fine Aggregate or Mineral Filler Using a Colorimeter
D75/D75M Practice for Sampling Aggregates
D516 Test Method for Sulfate Ion in Water
D1193 Specification for Reagent Water
D4130 Test Method for Sulfate Ion in Brackish Water, Seawater, and Brines
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
E832 Specification for Laboratory Filter Papers
E1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Inert Gas Fusion Techniques

2.2 *ACI Documents:*[3]

ACI 201.2R Guide to Durable Concrete
ACI 318 Building Code Requirements for Structural Concrete and Commentary
ACI 332 Residential Code Requirements for Structural Concrete and Commentary
ACI 350 Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI ~~CT-13~~CT Concrete Terminology

2.3 *Standards of Other Organizations:*

AASHTO T 330 Method of Test for the Quantitative Detection of Harmful Clays of the Smectite Group in Aggregates Using Methylene Blue[4]
CSA A3004-D2 Determination of Total Organic Carbon in Limestone[5]

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this specification, refer to Terminology C51 and Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *aggregate mineral filler (AMF), n*—a finely divided inorganic material derived from quarried stone, for use as an ingredient in hydraulic cementitious mixtures and meeting specified chemical and physical requirements.

3.2.1.1 *Discussion*—

AMF derived from carbonate or non-carbonate quarried stone are finely divided particulate matter that have been shown to be effective in improving the particle packing and rheological characteristics of fresh concrete. In some cases, enhancement is seen in mechanical and fluid transport properties of hardened concrete. AMF for use in concrete may undergo a series of processing steps such as screening, grinding, classifying and drying as needed to meet requirements of this specification.

3.2.2 *ground calcium carbonate (GCC), n*—a finely divided inorganic material consisting predominantly of calcium carbonate or of the carbonates of calcium and magnesium and meeting specified chemical and physical requirements.

3.2.2.1 *Discussion*—

The series of processing steps like grinding and classifying that these products undergo, ensure consistent particle size distribution. Research has demonstrated that the use of GCC results in improved packing density and the GCC particles provide nucleation sites

[3] Available from American Concrete Institute (ACI), 38800 Country Club Dr., Farmington Hills, MI 48331-3439, http://www.concrete.org.
[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.
[5] Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada, http://www.csagroup.org.

that increase the rate of hydration of hydraulic cementitious materials. The effect of hydration is also influenced by the particle size distribution (PSD) and fineness of the GCC. See cited References (**1-6**).[6]

4. Classification

4.1 Types A and B, which are derived from calcium carbonates, are ground products from quarried stone. The chemical and physical properties shall comply with the requirements in Table 1.

4.2 Type C is typically a byproduct from the crushing of quarried stone, with mineral composition that depend on the stone from which it is derived. The chemical and physical properties shall comply with the requirements of Table 1.

4.3 The Type classification shall be stated by the supplier of the product.

NOTE 3—ACI ~~CT-13~~CT defines mineral filler as a finely divided mineral product at least 65 % of which passes the 75 µm (No. 200) sieve. This specification establishes requirements for GCC and AMF materials that meet this definition.

5. General Requirements

5.1 The chemical and physical requirements for Type A, Type B, and Type C shall conform to the requirements in Table 1.

5.2 The purchaser has the authority to request measurement by a specified method of the chloride ion content of the material.

6. Sampling

6.1 Obtain a sample from each lot for testing in accordance with Practice C50/C50M or Practice D75/D75M.

7. Test Methods

7.1 Calcium carbonate and magnesium carbonate content – Test Methods C25 or Annex A1.

7.2 Methylene Blue Value – AASHTO T330 or Test Method C1777.

TABLE 1 Chemical and Physical Requirements

Parameter	Type A	Type B	Type C
$CaCO_3$, % by mass	≥ 92	≥ 70	NA
Sum of $CaCO_3$ + $MgCO_3$, % by mass	≥ 95	≥ 90	NA
Methylene blue value (mg/g)	≤ 3	≤ 5	≤ 5
Total Organic Carbon Content % by mass	≤ 0.5	≤ 0.5	≤ 0.5
Particle size distribution, minimum % by mass passing			
300-µm (No. 50) sieve	100	100	100
150-µm (No.100) sieve	100	85	
75-µm (No. 200) sieve	95	70	65
45-µm (No. 325) sieve	90	65	
Fineness (m^2/kg)[D]	Report[A]	Report[A]	Report[A]
Moisture Content (%)[B] by mass	≤ 1	≤ 1	≤ 1
Strength Activity Index, % of control at 28d[C]	≥ 75	≥ 75	≥ 75
Water Requirement, maximum % by mass of control	120	120	120

[A] The purchaser has the authority to approve a change in the fineness or to add a range if needed.
[B] The moisture content is listed for materials that can be pneumatically transferred. If material is not pneumatically transferred, then the purchaser can waive the moisture content requirement.
[C] The purpose of testing the Strength Activity Index is to evaluate whether the material has any detrimental effect when used in concrete.
[D] There is no specification limit but the value is reported to provide information to the purchaser. The proportioning of a concrete mixture may be dependent on the fineness of the material to be used. If there is a change in fineness, the purchaser should be notified so that appropriate adjustments can be made to the concrete mixtures.

[6] The boldface numbers in parentheses refer to the list of references at the end of this standard.

7.3 Total Organic Carbon (TOC) Content – Annex A2~~Specification .C595/C595M-15 Annex A3.~~

7.4 Particle Size Distribution (PSD) – Test Method C110 for Types A and B. Test Method C136/C136M and Test Method C117 for Type C.

7.5 Strength Activity Index – Test Methods C311/C311M replacing the mass of pozzolan in the test mixture with GCC or AMF.

7.6 Water requirement – Test Methods C311/C311M.

7.7 Fineness – Test Methods C110.

7.8 Moisture Content – Test Methods C25 or Test Method C566.

8. Storage and Inspection

8.1 Store the product in such a manner as to permit easy access for proper inspection and identification of each shipment.

8.2 Inspection of the material shall be made as agreed upon by the purchaser and the supplier as part of the purchase order or contract.

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 or supplier in writing.

10. Packaging and Package Marking

10.1 If the product is delivered in packages, the name of the manufacturer, Type, and the mass of the material contained therein shall be plainly marked on each package. Similar information shall be provided in the shipping invoices accompanying the packaged or bulk material.

11. Certification

11.1 If specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested as directed in this specification and the specified requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

12. Manufacturer's Statement

12.1 At the request of the purchaser, the manufacturer shall state in writing the mineral origin, nature, amount, and type of any processing or other additions made to the product.

13. Keywords

13.1 aggregate mineral filler; ground calcium carbonate; hydraulic cement concrete; limestone; mineral filler

~~ANNEX~~ANNEXES

(Mandatory Information)

A1. CHEMICAL ANALYSIS OF CALCIUM AND MAGNESIUM CARBONATES IN GROUND LIMESTONE BY EDTA TITRATION

A1.1 Scope

A1.1.1 This test method covers the chemical analysis of high-calcium and dolomitic limestone.

A1.1.2 The standard test method uses classical gravimetric and volumetric analytical procedures and are typically required for referee analyses if conformance with chemical specification requirements is part of contractual agreement between purchaser and producer.

A1.1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

A1.2 Referenced Documents

A1.2.1 *ASTM Standards:*[2]
D1193 Specification for Reagent Water
E832 Specification for Laboratory Filter Papers

A1.3. Significance and Use

A1.3.1 This test method provides analytical procedures to determine the major chemical constituents of limestone (see Note 1). The percentages of specific constituents that determine a material's quality or fitness for use are of significance depending upon the purpose or end use of the material. Results obtained may be used in relation to specification requirements.

NOTE A1.1—This test method can be applied to other calcareous materials if provisions are made to compensate for known interferences.

A1.4. Apparatus

A1.4.1 *Balance*—The balance shall be of an analytical type with a capacity not to exceed 200 g. It may be of conventional design or it may be a constant-load, direct-reading type. It shall be capable of reproducing weighings within 0.0002 g with an accuracy of ±0.0002 g.

A1.4.2 *Glassware and Laboratory Containers*—Standard volumetric flasks, burets, pipets, dispensers, etc. should be of precision grade or better (Class A). Polyethylene containers are recommended for all aqueous solutions of alkalies and for standard solutions where the presence of dissolved silica or alkali from the glass would be objectionable.

A1.4.3 *Filter Paper*—Filter paper shall conform to the requirements of Specification E832, Type II, Quantitative, Class F.

A1.5. Reagents

A1.5.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society if such specifications are available.[7] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

A1.5.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined by Type I or II of Specification D1193.

A1.5.3 *Ethylenediaminetetraacetic Acid, EDTA*—Dissolve 18 g of Disodium EDTA in 1 L of water.

A1.5.4 *Potassium hydroxide, KOH*—Dissolve 56 g of KOH in 1 L of water.

A1.5.5 *Ammonia Buffer*—Dissolve 66 g of ammonium chloride, NH_4Cl, in 300 mL water in a 2 L beaker. Add 560 mL ammonium hydroxide, NH_4OH. Transfer to a 1000 mL volumetric flask and make up to volume with water.

A1.5.6 *Calcium Carbonate, $CaCO_3$*—ACS grade, 99.95 – 100.05 % purity, dry basis.

A1.5.7 *Dilute Hydrochloric Acid (dilute HCl)*—Dilute 1 part of concentrated HCl (12N) into 4 parts of water.

A1.5.8 *Hydroxy napthol blue indicator.*

A1.5.9 *Calmagite (1-(1-hydroxy-4-methyl-2-phenylazo)-2-napthol-4-sulfonic acid) indicator.*

A1.6 Standardization of the EDTA Titration Solution

A1.6.1 Weigh out two samples of ACS grade $CaCO_3$ into 600-mL beakers. Use 0.200 g. Record mass of each sample.

A1.6.2 Add 10 mL water and 5 mL dilute HCl to each beaker with $CaCO_3$. Stir solution to disperse $CaCO_3$. When $CaCO_3$ is dissolved add 285 mL water.

A1.6.3 Fill 50 mL burette with EDTA solution. To prevent precipitation of the calcium add 35 mL EDTA titrating solution. Using a graduated cylinder, add 30 mL KOH and stir. Add 0.2 g hydroxyl napthol blue indicator and stir. Complete titration to a clear blue end point by adding EDTA solution from burette with constant stirring.

A1.6.4 *Calculations:*

$$\text{Calciumcarbonatefactor},Fc,\%/\text{mL} = \frac{Mc \times P}{V} \times 500 \quad \text{(A1.1)}$$

[7] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the United States *Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.