Designation: D8459 – 23

Standard Test Methods for Detecting Water Soluble Sulfates in Construction Soils[1]

This standard is issued under the fixed designation D8459; 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 These methods determine the water soluble sulfate content of cohesive soils used in construction by using the colorimetric technique. Two methods are presented in this standard. Method A is for use in the field and Method B is for use in the laboratory. The colorimetric technique involves measuring the scattering of a light beam through a solution that contains suspended particulate matter. Measurements of sulfate concentrations in construction soils can be used to guide professionals in the selection of appropriate stabilization methods and to assist in assessment of potential deterioration in concrete structures.

NOTE 1—These test methods are partially based on the research conducted by Texas A & M University.

1.2 The field method, Method A, is used as a screening test for the presence of sulfates and their concentration. The laboratory method, Method B, provides better resolution than the field method.

1.3 Ion chromatography is also an acceptable alternative method that can be used to evaluate results, however, it is outside the scope of this standard.

1.4 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this test method.

1.5.1 The procedures used to specify how data are collected/recorded and calculated in the standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering data.

1.6 *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.*

1.7 *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:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D1193 Specification for Reagent Water

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4220/D4220M Practices for Preserving and Transporting Soil Samples (Withdrawn 2023)[3]

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.06 on Physical-Chemical Interactions of Soil and Rock.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

3. Terminology

3.1 *Definitions:*

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *colorimetric technique, n*—the process of measuring the light transmission of a liquid and translating it into concentration using a reagent (in this standard, barium chloride) combined with a specimen.

3.2.1.1 *Discussion*—Colorimetry is the measurement of the wavelength and the intensity of electromagnetic radiation in the visible region of the spectrum. Colorimetry can help find the concentration of substances, since the amount and color of the light that is absorbed or transmitted depends on properties of the solution, including the concentration of particles in it.

3.2.2 *filtrate, n*—a substance, usually a solution, that has been passed through a filter.

4. Summary of Test Method

4.1 These test methods are used to determine the average water soluble sulfate concentration in cohesive soils using the colorimetric technique. Method A is performed in the field using a hand-held device, whereas Method B is performed in the laboratory using a benchtop/desktop device under controlled conditions.

4.2 In both methods a sample is dried and processed over specific sieves to obtain three representative specimens. Each specimen is then diluted with distilled or demineralized water to an initial ratio of 1:20 and then vigorously shaken prior to a conditioning period. After conditioning, the soil suspension is filtered and the filtrate is transferred to a cuvette where the barium chloride reagent is added. A minimum of three readings per specimen are obtained and the results are corrected and averaged to yield the average water soluble sulfate concentration in ppm of the sample.

5. Significance and Use

5.1 Where sulfates are suspected, subgrade soils should be tested as an integral part of a geotechnical evaluation because the possibility that sulfate induced heave may occur if calcium containing stabilizers are used to improve the soils and sulfate reactions may also cause deterioration in concrete structures. When planning to treat a soil used in construction with lime, testing the soil for water soluble sulfates prior to treatment becomes very important (Note 2).

5.2 When sulfate containing cohesive soils are treated with calcium-based stabilizers for foundation improvements, sulfates and free alumina in natural soils react with calcium and free hydroxide to form crystalline minerals, such as ettringite and thaumasite.[4] Thaumasite forms when ettringite undergoes changes in the presence of carbonates at low temperatures.[5] The sulfate minerals expand considerably when they are hydrated.

NOTE 2—For more information on the effect of treating soils containing water soluble sulfates, refer to the following publication: Little, D.N., Stabilization of Pavement Subgrades and Base Course with Lime, Kendal/Hunt Publishing Co., Dubuque, IA, 1995.

NOTE 3—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.

6. Interferences

6.1 The readings from the device can be affected if the cuvette is scratched or has dirty or smeared surfaces. Care should be taken to make sure the cuvette surfaces are clean and free of debris and that the filtration has sufficiently removed the larger particulates.

6.2 The presence of aggressive sulfate reducing bacteria could lead to an under reporting of the sulfate content.

7. Apparatus

7.1 *Colorimeter*—A hand held or benchtop/desktop device capable of measuring up to 8,000 ppm.

NOTE 4—A colorimeter is an instrument that compares the amount of light passing through a solution with the amount that can pass through a sample of pure solvent. A colorimeter contains a photocell that is able to detect the amount of light which passes through the solution under evaluation. The more light that hits the photocell, the larger the current it produces, hence showing the absorbance of light. A colorimeter takes 3 wideband readings along the visible light spectrum to obtain a rough estimate of a color sample.

7.2 *Balance*—Balances shall conform to the requirements of Guide D4753.

7.2.1 The balance shall have readability without estimation of 0.01 g or better. The capacity of this balance will need to exceed the mass of the representative soil and its container.

7.3 *Drying Oven*—Vented, thermostatically controlled oven capable of maintaining a uniform temperature of 60 ± 5°C throughout the drying chamber. These requirements typically require the use of a forced-draft oven.

7.4 *Sieves*—4.75-mm (No. 4) and 425-µm (No. 40) sieves used to split and separate the sample, respectively. These sieves are subjected to rough operation and shall not be used for quantitative grain size analysis.

7.5 *Desiccator*—A desiccant containing device of suitable size used to prevent moisture gain during cooling of the oven-dried specimen.

7.6 *Cuvette*—A 10-mL glass vial with alignment markings to hold the filtrate and reagent.

7.7 *Mortar and Rubber-Tipped Pestle*—Apparatus suitable for breaking up aggregations of air-dried soil particles without breaking individual particles.

7.8 *Sample Splitter*—A device capable of adequately splitting the sample.

7.9 *Beakers*—Two, glass or plastic; with a minimum capacity of 500 mL.

[4] Mitchell, J.K., "Practical Problems from Surprising Soil Behavior," ASCE Journal of Geotechnical Engineering, Vol. 112, No. 3, 1986, pp. 259-289.

[5] Hunter, D., "Lime Induced Heave in Sulfate Bearing Clays," ASCE Journal of Geotechnical Engineering, Vol. 114, No. 2, 1988, pp. 150-167.