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Standard Guide for Evaluating Effectiveness of Admixtures for Soil Stabilization[1]

This standard is issued under the fixed designation D 4609; 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 guide describes laboratory techniques for evaluating the effectiveness of admixtures for improving the engineering properties of fine-grained soils.

1.2 Effectiveness is assessed by comparing the unconfined compressive strength (UCS), moisture susceptibility, and moisture-density relationships (MD) of treated and untreated soils.

1.3 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

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

1.5 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 421 Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants[2]

D 422 Test Method for Particle-Size Analysis of Soils[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,4000 ft-lbf/ft^3(600 kN-m/m^3))[2]

D 2166 Test Method for Unconfined Compressive Strength of Cohesive Soil[2]

D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass[2]

D 2217 Practice for Wet Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction[2]

D 3877 Test Methods for One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures[2]

D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[2]

2.2 *AASHTO Documents:*

SPEL Special Products Evaluation List[3]

T 99 Moisture-Density Relations of Soils, Using a 5.5-lb (2.5-kg) Rammer and a 12-in. (305-mm) Drop[3]

3. Terminology

3.1 *Definitions*—For common definitions of soil and rock terms in this standard, refer to Terminology D 653.

4. Summary of Guide

4.1 Soil stabilizers are screened by comparing the results of a suite of engineering soil tests conducted on untreated soil and the same soil treated at appropriate amounts of the material being evaluated. Effectiveness is assessed by comparing the Atterberg limits, MD, USC, and resistance to moisture of treated and untreated soil samples.

5. Significance and Use

5.1 This guide is intended to assist users and producers of soil modifiers, and stabilizers in the evaluation of a product's

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[2] *Annual Book of ASTM Standards,* Vol 04.08.

[3] Available from American Association of State Highway and Transportation Officials, 444 N. Capitol St., NW, Suite 225, Washington, DC 20001.

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

potential for improving a soil's engineering properties (such as, deformation under load, shear strength, and volume stability).

5.2 The results of these tests can be used to make a decision to continue experimentation to assess longevity, durability, and practical value, and establish appropriate rates of application for field trials.

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 D 3740 are generally considered capable of competent and objective testingsampling/inspection, and the like. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors. Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Harvard Miniature Compaction Apparatus*, or apparatus for preparing remolded specimens for UCS as described in the Significance and Use section of Test Method D 2166. For instructions on calibration, see Annex A1.

7. Sampling and Test Specimens

7.1 Obtain a 150-kg (300-lb) supply or have easy access to four or five soil and soil-aggregate materials as reference materials for stabilizer evaluations. These samples should represent two or more fine-grained soils of different clay mineralogy that are widely distributed and would be likely candidates for stabilization. One or two of the samples could represent the minus No. 10 fraction of plentiful marginal aggregates in need of beneficiation.

7.2 Review literature and test results provided by the material manufacturer or supplier.

7.3 Consult publications such as Special Products Evaluation List (SPEL) or other product evaluation or qualified products lists maintained by state highway agencies.[4]

7.4 If background search demonstrates that the subject material has promise, proceed with testing program.

8. Procedure

8.1 Obtain 20-kg (45-lb) portions of two or more soil samples selected in 7.1 for an evaluation program. This quantity of soil will provide sufficient material for tests on the treated and untreated soil mixtures at three rates of application: the amount recommended by the supplier, and amounts more and less than recommended.

NOTE 2—All the tests recommended in 8.2 do not need to be conducted at all four rates of application (raw soil or zero rate, recommended rate, a rate more than recommended, a rate less than recommended.)

NOTE 3—The 20-kg recommended sample size is from the following scenario:

Two compaction tests (untreated and optimum rate)	6 kg
Calibration of Harvard Apparatus	1 kg
Atterberg limits (untreated and of optimum rate)	1 kg
Expansion (untreated and optimum rates)	2 kg
Unconfined Compressive Strength (untreated and three rates of treatment)	4 kg
Reserve for rerun of any test	6 kg
	20 kg

8.2 Test each untreated soil by the several test methods listed in 8.2.1 through 8.2.6. Perform the same tests on the treated mixtures. For each rate of admixture, five batches of the treated mixture are required. Prepare a batch by combining in a mechanical mixer carefully weighed portions of soil, admixture, and water. Blend thoroughly (normally for about 5 min) to produce a high degree of homogeneity. Prepare each batch and test separately as follows:

8.2.1 *Moisture Content*—Test Method D 2216 .

8.2.2 *Particle-Size Analysis of Soils*—Test Method D 422.

8.2.3 *Liquid Limit, Plastic Limit, and Plasticity Index*—Test Method D 4318 .

8.2.4 *Moisture-Density Relations*—Test Methods D 698 (Method A) or T 99 (Method A) (see Note 4).

8.2.5 *Volume Change*—Test Methods D 3877 (see Note 5).

8.2.6 *Unconfined Compressive Strength* (see Note 6)—Test Method D 2166 .

NOTE 4—The sample may be reused and water added for successive points on the moisture-density curve if the soil material is not fragile and will not reduce in particle size due to repeated compaction or is not a heavy-textured clay into which it is difficult to incorporate water.

NOTE 5—Although this test method is for soil-lime mixtures, other stabilizing admixtures may be used.

NOTE 6—Specimen preparation and determination of moisture absorption are described in Annex A2. The moisture absorption specimens are also used for determining unconfined compressive strength, which is determined in accordance with the methods indicated in 8.2.1-8.2.6.

8.3 On approximately 3 kg (7 lb), determine optimum moisture and maximum density in accordance with Test Method D 698.

8.4 On approximately 1 kg (2.2 lb), as described in the calibration procedure given in Annex A1, determine with the Harvard apparatus the number of tamps and the spring pressure required to duplicate the standard density obtained by Test Method D 698.

8.5 Prepare a 500-g (1-lb) batch at optimum moisture content. As soon as the mixing is completed, divide the mixture into three approximately equal portions. Perform liquid and plastic limit tests on one portion after air-drying overnight, on another after overnight storage at high-humidity, and on the other after 7 days of curing at high humidity.

8.6 On approximately 3600 g, determine expansion in accordance with Test Methods D 3877.

8.7 On approximately 1 kg (2.2 lb), with the Harvard apparatus, prepare six five-layer specimens (required for acceptable homogeneity) compacted to Test Methods D 698 density, and determine moisture absorption and unconfined compressive strength as described in Annex A2.

9. Interpretations of Results

9.1 The recommendations in 9.1.1-9.1.5 are provided to evaluate whether an admixture has improved the engineering properties of fine-grained soils. Changes in one or more, but not necessarily all, of the properties in 9.1.1-9.1.5 may be used to judge effectiveness. The results of these tests may or may not be useful for determining the cost-effectiveness or practical value of the treatment; that decision will most probably need to be made after additional testing and data analysis.

[4] Illinois, Louisiana, and New Jersey are three states that publish such lists.