Designation: D 6276 – 99a (Reapproved 2006)

Standard Test Method for Using pH to Estimate the Soil-Lime Proportion Requirement for Soil Stabilization[1]

This standard is issued under the fixed designation D 6276; 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 test method provides a means for estimating the soil-lime proportion requirement for stabilization of a soil. This test method is performed on soil passing the −425-μm (No. 40) sieve. The optimum soil-lime proportion for soil stabilization is determined by tests of specific characteristics of stabilized soil such as unconfined compressive strength or plasticity index.

1.2 Some highly alkaline by-products (lime kiln dust, cement kiln dust, and so forth) have been successfully used to stabilize soil. This test method is not intended for these materials and any such product would need to be tested for specific characteristics as indicated in 1.1.

1.3 This test method is used to determine the lowest percentage of lime that results in a soil-lime pH of 12.4.

1.4 Lime is not an effective stabilizing agent for all soils. Some soil components such as sulfates, phosphates, organics, and so forth can adversely affect soil-lime reactions and may produce erroneous results using this test method.

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.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 51 Terminology Relating to Lime and Limestone (as used by the Industry)

C 977 Specification for Quicklime and Hydrated Lime for Soil Stabilization

D 421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 1193 Specification for Reagent Water

D 1293 Test Methods for pH of Water

D 2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

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

D 4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

E 11 Specification for Wire Cloth and Sieves for Testing Purposes

E 145 Specification for Gravity-Convection And Forced-Ventilation Ovens

3. Terminology

3.1 *Definitions*:

3.2 Refer to Terminology C 51 for definitions of terms relating to lime.

3.3 Refer to Terminology D 653 for terms relating to soil.

3.4 *Definitions of Terms Specific to This Standard:*

3.4.1 *buffer solution*—a solution of specific pH value used to calibrate the pH meter.

3.4.2 *free lime*—lime in a soil-lime mixture that has not dissociated into calcium and hydroxyl ions.

3.4.3 *hydrated lime*—lime that is predominately calcium hydroxide ($Ca(OH)_2$) or a mixture of calcium hydroxide and magnesium oxide (MgO) or magnesium hydroxide ($Mg(OH)_2$).

3.4.4 *lime*—a general term which, for the purpose of this test method, includes hydrated lime and quicklime.

3.4.5 *lime content*—the ratio expressed as a percentage of the mass of lime to the dry mass of soil.

3.4.6 *lime stabilization*—addition of lime to a soil in sufficient quantities to promote long-term pozzolanic reactions that result in strength gain and permanent improvement in stability.

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.15 on Stabilization and Admixtures.

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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.**

Textural improvement alone, such as reduced plasticity, is often referred to as "modification." Modification can be effected by lime addition rates less than those required for stabilization and may not be permanent.

3.4.7 *pH*—the negative logarithm of the effective hydrogen-ion concentration or hydrogen-ion activity, in gram equivalents per litre. The pH values range from 0 to 14; where pH 7 represents neutrality, pH values less than 7 indicate increasing acidity, and pH values greater than 7 indicate increasing alkalinity.

3.4.8 *quicklime*—lime that is predominately calcium oxide (CaO) or calcium oxide in association with magnesium oxide (MgO).

3.4.9 *stabilization*—a process to improve the engineering properties of soils at a site.

4. Summary of Test Method

4.1 A series of specimens is prepared containing a range of percentages of lime content in soil. Measurements of pH are made on slurries of the specimens to determine the minimum lime content of the soil-lime mixture to obtain a pH of at least 12.4.

4.2 The pH of at least 12.4 achieved in this test method results from free lime remaining in the soil-lime mixture. Normally, the pH of the specific lime being used for soil stabilization should be determined and used as the indicator pH.

5. Significance and Use

5.1 The soil-lime pH test is performed as a test to indicate the soil-lime proportion needed to maintain the elevated pH necessary for sustaining the reactions required to stabilize a soil. The test derives from Eades and Grim.[3]

5.2 Performance tests are normally conducted in a laboratory to verify the results of this test method.

5.3 This test method will not provide reliable information relative to the potential reactivity of a particular soil, nor will it provide information on the magnitude of increased strength to be realized upon treatment of this soil with the indicated percentage of lime.

5.4 This test method can be used to estimate the percentage of lime as hydrated lime or quicklime needed to stabilize soil.

5.5 Agricultural lime (crushed limestone) will not stabilize soil.

NOTE 1—Notwithstanding the statements on precision and bias contained in this test method: The precision of this test method 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 testing. Users of this test method are cautioned that compliance with Practice D 3740 does not itself ensure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Balance or Scale*:

6.1.1 A balance or scale for determining the mass of soil and lime having a minimum capacity of 600 g and meeting the requirements of Specification D 4753 for a balance or scale of 0.01 g readability.

6.2 *Sieve*—A 425-µm (No. 40) sieve, conforming to the requirements of Specification E 11.

6.3 *Plastic Bottles*—Six 150-mL (or larger) plastic bottles with tight-fitting screw caps.

6.4 *A pH Meter*—A pH meter equipped with reference electrode and low-sodium error glass pH-sensitive electrodes (or combination electrode) and a meter capable of displaying 0.01 units pH at 0.2 pH accuracy over a range from 0 to 14.

6.5 *Drying Oven*—Oven conforming to requirements of Specification E 145.

6.6 *Miscellaneous Equipment*—An airtight, moisture-proof container for preserving the moisture content of the soil; mixing tools and scoops for use in preparing test specimens.

7. Reagents and Materials

7.1 *Water*—Reference to water shall be understood to mean Type II reagent water conforming to Specification D 1193. Store the water in a tightly capped container; boil and cool the water immediately before use.

NOTE 2—If the pH of the site water to be used is highly acidic (<6) or highly basic (>9) test results should be checked against a specimen made up with site water rather than Type II water.

7.2 *Buffer Solution*—Use a buffer solution having a pH of 12, either commercially available or prepared in accordance with Test Methods D 1293.

7.3 *Hydrated Lime*—Only fresh lime meeting the requirements of Specification C 977 may be used.

7.4 *Quicklime*—Only fresh lime meeting the requirements of Specification C 977 may be used.

8. Safety Hazards

8.1 Quicklime becomes hot when mixed with water. Use protective gloves when handling containers of soil-quicklime-water mixtures.

8.2 Hydrated lime and quicklime are strong caustics and may cause severe irritation of skin, eyes, and mucous membranes. Appropriate safety equipment such as heavy rubber gloves, protective eye wear, and a plastic apron should be worn when handling lime. Ensure that adequate ventilation (or a respirator) is provided.

9. Technical Hazards

9.1 Lime readily absorbs water and carbon dioxide from the air, therefore, store lime in tightly closed containers.

9.2 The soil-lime-water mixture is alkaline and will react with metal and glass; therefore, use plastic bottles and beakers.

10. Specimens

10.1 Prepare a representative sample of air-dried soil in accordance with Practice D 421. Soil may be oven-dried at a temperature ≤ 60°C.

10.2 Pass 350 g of material through the 425-µm (No. 40) sieve.

10.3 Thoroughly mix the material passing the 425-µm (No. 40) sieve.

[3] Eades, J.L., and Grim, R.E., A Quick Test to Determine Lime Requirements for Lime Stabilization,*Highway Research Record No. 3*, 1996, National Academy of Sciences, National Research Council, Highway Research Board, Washington, DC.