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# **Standard Method of Test for Determination of the Strength of Soil–Lime Mixtures**

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**AASHTO Designation: T 220-22**

**Technically Revised: 2022**

**Technical Subcommittee: 1a, Soil and Unbound Recycled Materials**



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## 1. SCOPE

- 1.1. This method provides for the determination of the unconfined compressive strength of soil–lime stabilization mixtures.
- Note 1**—Generally, an unconfined compressive strength of 690 kPa (100 psi) is satisfactory for the final course of base construction, and it is desirable that materials for such courses contain a minimum of 50 percent plus 0.425-mm (No. 40) material before treatment. Various soil materials may be treated for subbase, and, in such cases, the minimum suggested unconfined compressive strength is 345 kPa (50 psi).
- 1.2. The values stated in SI units are to be regarded as the standard.
- 1.3. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*
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## 2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 216, Quicklime and Hydrated Lime for Soil Stabilization
  - M 339M/M 339, Thermometers Used in the Testing of Construction Materials
  - R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
  - R 74, Wet Preparation of Disturbed Soil Samples for Test
  - T 88, Particle Size Analysis of Soils
  - T 89, Determining the Liquid Limit of Soils
  - T 90, Determining the Plastic Limit and Plasticity Index of Soils
- 2.2. *ASTM Standards:*
- D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
  - E1, Standard Specification for ASTM Liquid-in-Glass Thermometers

- E4, Standard Practices for Force Verification of Testing Machines
- E11, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
- E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- E2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standard:*

- IEC 60584-1: 2013 Thermocouples - Part 1: EMF Specifications and Tolerances

### 3. APPARATUS

- 3.1. *Automatic Tamper*—A compaction device with base plate to hold 152 mm (6 in.) ID forming molds, equipped with 4.54-kg (10-lb) ram and adjustable height of fall. Ram fall is 457 mm (18 in.). The striking face of the ram is a 40-degree segment of a circle of 76-mm (3-in.) radius. Automatic tamper shall be furnished an extra base plate to hold the forming mold during specimen top finishing.
- 3.2. *Compaction Mold with Removable Collar*—Mold is 152 mm (6 in.) ID and 215 mm (8½ in.) high.
- 3.3. *Measuring Device for Specimen Height*—A micrometer dial assembly with a standard set of spacer blocks.
- 3.4. *Scale*, rated 18.1-kg (40-lb) capacity, sensitive to 0.0005 kg (0.001 lb).
- 3.5. *Press*, hydraulic, to extrude specimens from mold.
- 3.6. *Drying Oven*, controlled from  $60 \pm 5^\circ\text{C}$  ( $140 \pm 9^\circ\text{F}$ ) to  $110 \pm 5^\circ\text{C}$  ( $230 \pm 9^\circ\text{F}$ ). Oven(s) for heating and drying shall be capable of operation at the temperatures required, between 25 to  $120^\circ\text{C}$  (77 to  $248^\circ\text{F}$ ), within  $\pm 5^\circ\text{C}$  ( $\pm 9^\circ\text{F}$ ), as corrected, if necessary, by standardization. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer used for monitoring the temperature of the oven, or for measuring the temperature of materials shall meet the requirements of M 339M/M 339 with a temperature range of at least 0 to  $130^\circ\text{C}$  (32 to  $266^\circ\text{F}$ ), and an accuracy of  $\pm 1.25^\circ\text{C}$  ( $\pm 2.25^\circ\text{F}$ ) (see Note 2).
- Note 2**—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E2877 digital metal stem thermometer; ASTM E230/E230M thermocouple thermometer, Type J or K, Special Class, Type T any Class; IEC 60584 thermocouple thermometer, Type J or K, Class 1, Type T any Class; or dial gauge metal stem (bi-metal) thermometer.
- 3.7. *A Supply of Metal Pans*, wide and shallow, for mixing and drying materials, and a supply of rectangular stainless steel pans approximately 230 by 400 by 60 mm (9 by 16 by 2¼ in.) deep, equipped with porous spacer plates.
- 3.8. *Circular Porous Stones*, slightly less than 152 mm (6 in.) in diameter and 51 mm (2 in.) high.
- 3.9. *Axial Cells*, lightweight stainless steel cylinders, 171 mm (6¾ in.) ID and 305 mm (12 in.) high, fitted with standard air valve and straight, tubular rubber membrane 152 mm (6 in.) in diameter.
- 3.10. *Vacuum Pump*, 20 to 35 L/min (0.70 to 1.25 cfm), or aspirator.
- 3.11. *Air Compressor*, 4.7 to 7.1 L/s (10 to 15 cfm) with 230-L (60-gal) storage tank and controls, pressure regulators, gauges, and valves.
- 3.12. *Moist Room*, equipped with shelves and a constant pressure supply of air.

- 3.13. *Micrometer Dial Gauge*, calibrated to 0.02 mm (0.001 in.) with support to measure deflection of specimen.
- 3.14. *A supply of 2.27- and 4.54-kg (5- and 10-lb) Lead Surcharge Weights*.
- 3.15. *Calibrated Proving Ring or Other Continuous Force Measuring Device*, according to ASTM E4, except that an error of plus or minus 2 percent is allowed.
- 3.16. *Circumference Measuring Device*—A specially made metal tape measure.
- 3.17. *Screw Jack Press and Assembly* or other suitable testing press, with dial housing and two loading blocks.
- 3.18. *Sieves* with square openings of the following sizes conforming to ASTM E11: 75-, 53-, 50-, 45-, 31.5-, 22.4-, 16.0-, 12.5-, 9.5-, 4.75-, 2.00-, 0.850-, and 0.425-mm (3.0-, 2.12-, 2.00-, 1.75-, 1.25-,  $\frac{7}{8}$ -,  $\frac{5}{8}$ -,  $\frac{1}{2}$ -,  $\frac{3}{8}$ -in., No. 4, No. 10, No. 20, and No. 40) sieves.
- 3.19. *Mechanical Pulverizer* with adjustable clearance rotating plate.
- 3.20. *Mechanical Sieve Shaker*—A laboratory size [0.014 m<sup>3</sup> ( $\frac{1}{2}$  ft<sup>3</sup>)] sieve shaker, convenient but not absolutely necessary, used for separating material for recombining specimens.
- 3.21. *A Supply of Small Tools and Accessories* such as wedgewood mortar and pestle, rubber-covered pestle, rawhide hammer, spatulas, trowels, level, scoops, siphon tubes, sample containers, cardboard cartons, 510-by-510-mm (20-by-20-in.) filter papers, etc.

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## 4. MATERIALS

- 4.1. A supply of lime, preferably meeting the requirements of M 216 for either Type I or II lime.
- 4.2. Good quality tap water.

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## 5. SOIL PREPARATION

- 5.1. Select a 91-kg (200-lb) minimum representative sample for testing.
- 5.2. Spread the sample on a clean, dry floor to air-dry or use forced drafts of warm air.
- 5.3. The aggregations or hard lumps of clay in soils containing no appreciable amounts of coarse particles shall be crushed to pass the 2.00-mm (No. 10) sieve without breaking the coarse particles. The sample shall then be screened on the 0.850-mm (No. 20) sieve and the percentages retained and passing the 0.850-mm (No. 20) sieve determined.
- 5.4. Clays and other soils containing coarse particles shall be broken up to pass the 4.75-mm (No. 4) sieve without breaking the coarse particles. This may be done by means of a plastic mallet, rubber covered tamper, or similar hand tools. The material shall then be separated as follows:
- 5.4.1. Coarse particle materials (crushed stone, gravel, sand, and caliche) shall be dry-screened over the following suggested sieves: 45, 31.5, 22.4, 16, 9.5, 4.75, and 2.00 mm (1.75, 1.25,  $\frac{7}{8}$ ,  $\frac{5}{8}$ ,  $\frac{3}{8}$  in., No. 4 and No. 10) to separate the various sizes of materials. Retain all material passing the 2.00-mm (No. 10) sieve. The material passing the 45-mm (1.75-in.) sieve is used in making specimens. Mix all minus 2.00-mm (No. 10) material on the floor until it is uniformly blended with respect to color, appearance, and moisture content.

- 5.5. Determine the mass of each size of material and compute the cumulative percentages retained on each sieve and the percent passing the 2.00-mm (No. 10) sieve. These values are not to be used as true sieve analysis, but are used to recombine individual specimens to ensure uniform gradation within each specimen.
- 5.6. On the basis of the cumulative sieve size percentages obtained in Section 5.5 above, calculate and weigh out a 4.54-kg (10-lb) representative sample for sieve analysis and soil constants (Atterberg Limits). This 4.54-kg (10-lb) sample is prepared for testing by the wet method, R 74. Rolls, tumblers, or mills that might alter the coarse particles should not be used in this preparation. After preparation of the sample by the wet method, the following tests shall be performed in Table 1:

**Table 1**—Required Soils Tests

|                                                 |      |
|-------------------------------------------------|------|
| Mechanical Analysis                             | T 88 |
| Liquid Limit, LL                                | T 89 |
| Plastic Limit (PL) and<br>Plasticity Index (PI) | T 90 |

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## 6. SELECTION OF PERCENTAGE OF LIME

- 6.1. Enter plasticity index and percent minus 0.425 mm (No. 40), determined as in Section 5, of untreated soil on Figure 1, and determine the percentage of lime to add to the soil.