
Test Procedure for**SOIL-LIME TESTING****TxDOT Designation: Tex-121-E****Effective Date: August 2002**



1. SCOPE

- 1.1 This method consists of three parts.
- 1.1.1 Part I determines the unconfined compressive strength as an index of the effectiveness of hydrated lime treatment in improving structural properties in flexible base and subgrade materials (10 lb. hammer, 18-inch drop, 50 blows/layer using 6 x 8 in. mold).
- 1.1.2 Part II applies to lime treated materials sampled from the roadway during construction.
- 1.1.3 Part III determines the minimum percent lime needed for a soil-lime mixture to attain a pH of 12.4. Cation exchange occurs at this pH, resulting in modification of the soil particle structure to achieve improved workability and decrease swell and plasticity.
- 1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.
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2. APPARATUS

- 2.1 Apparatus outlined in Test Methods:
- Tex-101-E
 - Tex-113-E
 - Tex-117-E.
- 2.2 *Compression testing machine*, with capacity of 267 kN (60,000 lb.), meeting the requirements of ASTM D 1633.
- 2.3 *Triaxial screw jack press*, if anticipated strengths do not exceed 2758 kPa (400 psi.)
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3. MATERIALS

- 3.1 *Hydrated lime.*
- 3.2 *Tap Water.*
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4. PREPARING SAMPLE

- 4.1 Select approximately 91 kg (200 lb.) of material and prepare in accordance with Tex-101-E, Part II.

PART I—COMPRESSIVE STRENGTH TEST METHODS (LABORATORY MIXED)

5. PROCEDURE

- 5.1 Determine the optimum water content and maximum dry density for the soil-lime mixture using Tex-113-E.
- 5.2 Determine the amount of lime needed based on the dry mass of the soil.
Note 1—Store lime in an airtight container or use a fresh supply.
- 5.3 Recombine the sizes prepared according to Tex-101-E, Part II to make three individual samples and add the optimum moisture content. Mix thoroughly and cover the mixture to prevent loss of moisture by evaporation.
- 5.3.1 Allow the wetted samples to stand for at least 12 hours before compaction.
- 5.3.2 A standing time of at least 12 hours is required for materials with a PI greater than or equal to 12. When the PI is less than 12, the standing time may be reduced to not less than three hours. Split or referee samples should stand the full term.
- 5.3.3 Prior to compaction, replace any evaporated water and thoroughly mix each specimen.
- 5.3.4 Add the desired amount of lime uniformly to a specimen and mix thoroughly.
- 5.4 Following Tex-113-E, compact three specimens, 152.4 mm (6 in.) in diameter, and 203.2 mm (8 in.) in height, at the optimum moisture content found in Section 5.1. You may use a 101.6 mm (4 in.) diameter mold 152.4 mm (6 in.) high when the material meets the requirements of Note 2.
Note 2—To determine moisture-density relationship of fine-grained materials with less than 20 % retained on the 6.3 mm (1/4 in.) sieve and 100 % passing the 9.5 mm (3/8 in.) sieve, the engineer may elect to use a mold with approximate dimensions of 101.6 mm (4.0 in.) in diameter by 152.4 mm (6.0 in.) in height. Calculate the number of blows when changing mold size to maintain a compactive effort of 1100 kN-m/m³ (13.26 ft.-lb./in.³).
- 5.4.1 Lime-treated subgrade soil specimens should be compacted as nearly identical as possible and three specimens cured and tested for unconfined compression.
- 5.4.2 If the material to be improved by lime treatment is a flexible base material, the unconfined compression test is used to evaluate the strength. Compact three identical specimens for each percentage of hydrated lime, cure, and test for unconfined compression.

- 5.5 Cover specimens with top and bottom porous stones and place in triaxial cells immediately after extrusion from molds.
- 5.5.1 Store specimens at room temperature for seven days of moist curing at room temperature on the countertop.
- 5.6 After curing, remove cells and place the specimens in an air dryer oven at a temperature not to exceed 60°C (140°F) for about six hours or until 1/3 to 1/2 of the molding moisture has been removed. All lime-treated soils are dried as given above even though a considerable amount of cracking may occur. Allow the specimens to cool to room temperature before continuing the test.
- 5.7 Weigh, measure, and enclose the specimens in triaxial cells, and subject them to capillarity for ten days. Use a constant lateral pressure of 6.9 kPa (1 psi), and a surcharge pressure of 3.4 kPa (1/2 psi) for base to 6.9 kPa (1 psi) for subgrade depending upon the use of the material being tested. (A wet room is not required for this curing.)
- 5.8 Test the specimens for unconfined compression without a cell. A compression testing machine of adequate range and sensitivity may be used.
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6. CALCULATIONS AND GRAPHS

- 6.1 Calculate, plot and interpret test data for the unconfined compression test. Lime stabilized clay soils are not recommended for top course of base, regardless of strength.
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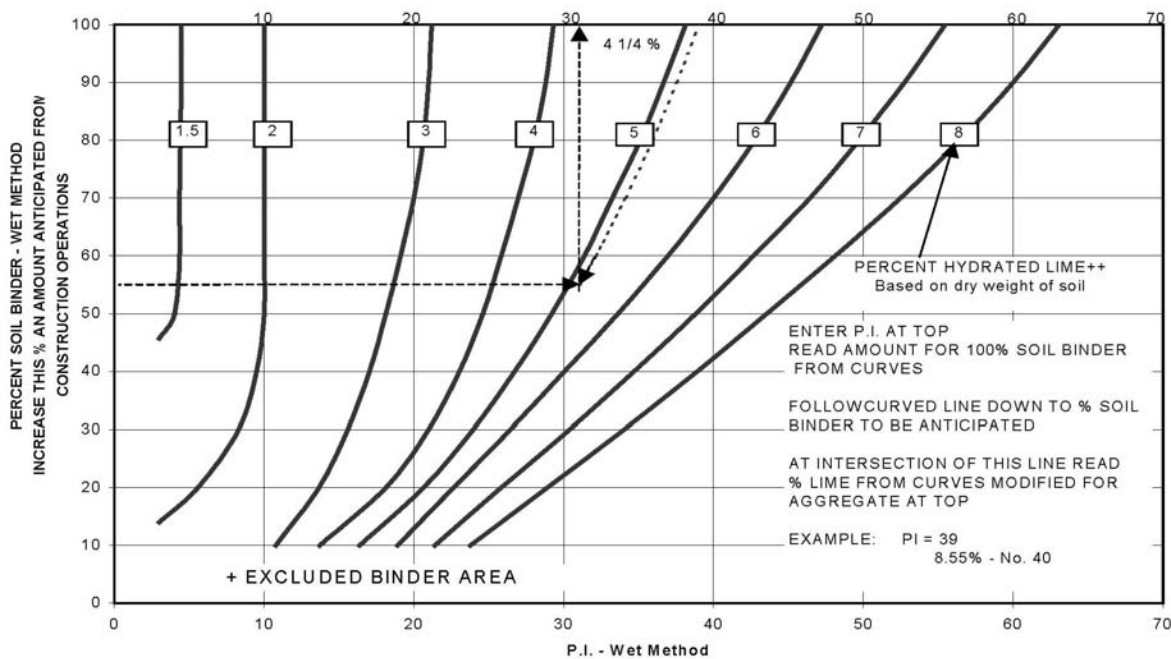
7. TEST REPORT

- 7.1 Strength value, reported to the nearest whole kPa (psi) for each lime content tested
- 7.2 Density, reported to the nearest 1 kg/m³ (0.1 pcf)
- 7.3 Optimum moisture content, reported to the nearest 0.1%
- 7.4 Recommended lime content, reported to the nearest 0.5%

Note 3—This test determines the quality of soils treated with lime to be used for subbase or base protected with a wearing surface. Flexible base materials and granular soils can usually be stabilized with about 3% lime. A larger amount of lime may be required to improve the strength of a very plastic clay subgrade. Unconfined compressive strength of 1035 kPa (150 psi) is satisfactory for final course of base construction and it is desirable that materials for such courses contain a minimum of 50 percent plus 425 µm (No. 40) before treatment.

The amounts of lime from Figure 1 are recommended amounts for stabilization of subgrade soils and base materials. These percentages of lime should be substantiated by these methods to insure adequate strengths. Unconfined compressive strengths of at least 345 kPa (50 psi) are suggested as adequate for subbase soils treated with lime. It is possible for short-term tests of soil-lime mixes, using smaller percentages of lime, to give

misleading results due to field variations in materials, mixing, lower densities, and so forth.



- + Exclude use of chart for materials with less than 10% minus 425um (No. 40) and cohesionless materials (PI less than 3).
- ++ Percent of relatively pure lime usually 90% or more of Ca and/or Mg hydroxides and 855 or more of which pass the 75um (No 200) sieve. Percentages shown are for stabilizing subgrades and base courses where lasting effects are desired. Satisfactory temporary results are sometimes obtained by the use of as little as ½ of above percentages. References to cementing strength is implied when such terms as "Lasting Effects" and "Temporary Results" are used.

Figure 1—Recommended Amounts of Lime for Stabilization of Subgrades and Bases

PART II—COMPACTION TESTING OF ROAD MIXED MATERIAL

8. PROCEDURE

- 8.1 Obtain samples for the moisture/density curve just prior to the start of compaction operations on the roadway.
- 8.1.1 If the material on the roadway is reworked and re-compacted for any reason, it will be necessary to obtain samples just prior to re-compaction of the reworked material for a new curve representing the reworked material.
- 8.2 Screen lime stabilized materials taken from the roadway during construction for density and/or strength testing over a 6.3 mm (1/4 in.) sieve at field moisture content, without drying.
- 8.2.1 Mix each size for uniformity and record the weight.

- 8.2.2 Cover each size material, plus 6.3 mm (1/4 in.) and minus 6.3 mm (1/4 in.) to maintain field moisture.
- 8.2.3 Recombine one representative specimen and mold at the field moisture condition.
- 8.2.4 Adjust mass, if necessary, and weigh out specimens for compaction and strength testing, if desired.
- 8.2.5 Molding moisture can be adjusted in each specimen by adding or removing moisture in the total specimen uniformly as needed.
- 8.2.6 Lime stabilized material should be sampled, prepared and molded during the same day compaction operations begin on the project.
- 8.2.7 Molding should be accomplished using the same equipment and compactive effort as in Part I.
- Note 4**—Compaction sample of lime-stabilized material from the road mix should not be prepared by oven drying.
- Note 5**—The contractor should be provided an initial optimum moisture based on preliminary tests.
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9. TEST REPORT

- 9.1 Density, reported to the nearest 1 kg/m^3 (0.1 pcf)
- 9.2 Optimum water content, reported to the nearest to 0.1%
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PART III—DETERMINING STABILIZATION ABILITY OF LIME BY SOIL pH

10. APPARATUS

- 10.1 Same as for Tex-128-E.
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11. MATERIALS

- 11.1 Same as for Tex-128-E.
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12. PREPARING SAMPLE

- 12.1 Use the same sample preparation as described in Tex-128-E.
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13. PROCEDURE

- 13.1 Heat sample and approximately 1400 mL (47.5 fl. oz.) of distilled water to 45–60°C (112–140°F) in separate containers.
- 13.2 Weigh to the nearest 0.01 g a series of 30 g samples of soil and place in separate containers.
- 13.3 Weigh to the nearest 0.01 a series of quantities of lime equivalent to 0, 2, 4, 6, 8, and 10% of the total dry soil sample.
- 13.4 Add one of the lime percentages to each of the soil samples, add 150 mL (5 fl. oz.) of distilled water to each combination, and stir vigorously.
- 13.5 Stir the samples every 15 minutes for 1 hour to disperse the soil and make sure all soluble material is in solution.
- 13.6 At the end of an hour, record the temperature of the mixture and adjust the pH meter to that temperature.
- 13.7 Standardize the meter (buffer solution of pH 7.0) according to the manufacturer's recommendations. (If the meter allows multiple standardizations, standardize the meter to buffer solutions of pH 7.0 and 10.0).
- 13.8 Clean electrode with distilled water.
Note 6—If there are scratches on the glass bulb of electrode, replace with new electrode.
- 13.9 Check the pH of each sample as described in Tex-128-E, Sections 5.7–5.9 and record.
- 13.10 Plot the pH of the samples versus the percent lime (pH on the y-axis, percent lime on the x-axis.) (See Figure 2.)
- 13.10.1 If the pH readings are 12.4 or higher, the lowest percentage of lime that gives a pH of 12.4 is the percent required to stabilize the soil.
- 13.10.2 If the pH readings do not go beyond pH of 12.3 and two percentages give this reading, the lowest percentage of lime to give a pH of 12.3 is the percent required to stabilize the soil.
- 13.10.3 If the highest pH reading is a pH of 12.3 and only the highest percentage of lime used gives a pH of 12.3, additional testing is required using higher percentages of lime.

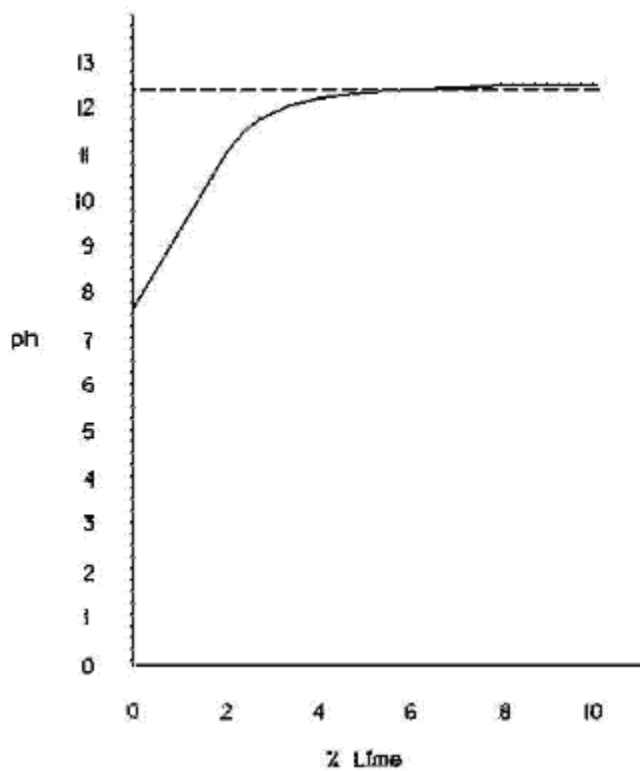


Figure 2—pH Versus Percent Lime

14. REPORT

14.1 Report the recommended percent lime to the nearest 0.1%.

15. ARCHIVED VERSIONS

15.1 Archived versions are available.