
Test Procedure for**LIME TREATED MATERIALS**TxDOT Designation: **Tex-121-E**Effective Date: **May 2022**

1. SCOPE

- 1.1 This test method consists of three parts for the laboratory compaction of lime treated materials. Lime treated materials may include subgrade (soils), reclaimed roadway (existing materials), existing materials blended with flexible base, or flexible base only.
- 1.2 Part I is used to determine the optimum moisture content and maximum dry density (M-D) curve in accordance with [Tex-113-E](#) for lime treated materials prepared in the laboratory or sampled from the roadway after mixing. This part may also be used to verify a M-D curve with material sampled from the roadway after mixing.
- 1.2.1 Specimens are compacted using an automatic tamper (compaction) device equipped with a Soil Compactor Analyzer (SCA). All specimens are 6 in. in diameter and 8 ± 0.250 in. in height.
- 1.3 Part II is a mixture design procedure used to determine a target lime content from materials prepared in the laboratory based on the unconfined compressive strength (UCS). This part may also be used to verify the UCS of material sampled from the roadway after mixing.
- 1.3.1 The target lime content is determined from the minimum percentage of lime to achieve a pH of 12.4 and UCS of compacted specimens after seven days of curing and ten days of capillary rise.
- 1.4 Part III determines the minimum percent lime needed for a lime treated mixture to achieve a pH of 12.4 in conjunction with [Tex-128-E](#). Cation exchange occurs at this pH where the soil particle structure will achieve improved workability and decrease in swell and plasticity.
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2. APPARATUS

- 2.1 As outlined in test methods:
- [Tex-100-E](#);
 - [Tex-101-E](#);
 - [Tex-113-E](#);
 - [Tex-117-E](#);
 - [Tex-128-E](#); and
 - [Tex-400-A](#).

- 2.2 Load cell, minimum 10K (for use with automated load frame).
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3. REPORTING

- 3.1 Report all data and pertinent information pertinent using SiteManager form '[Tx120-21.xlsm](#)'.
- 3.2 This form is available from the Materials & Tests Division/Soils & Aggregates Section and online at the following link <https://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/forms/site-manager.html>.
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4. MATERIAL SAMPLING AND PREPARATION

- 4.1 *This test procedure does not claim to address the safety concerns associated with its use. It is the responsibility of the user of this test procedure to establish the appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations before use.*
- 4.2 Obtain a minimum of 1 gal. of hydrated lime in a sealed container from a fresh supply of an approved source from the Department's Material Producer List unless otherwise directed by the lab or project Engineer.
- 4.3 When testing materials for Part I, sample a minimum of 100 lb. in accordance with [Tex-100-E](#) for soils or [Tex-400-A](#) for flexible base and prepare in accordance with [Tex-101-E](#), Part II.
- 4.4 When testing materials for Part II, sample a minimum of 300 lb. in accordance with [Tex-100-E](#) for soils or [Tex-400-A](#) for flexible base and prepare in accordance with [Tex-101-E](#), Part II.
- 4.5 When reclaimed asphalt pavement (RAP) is greater than 1-3/4 in., resize the RAP to pass the 1-3/4 in. sieve.
Note 1-Heating the RAP to a maximum temperature of 140°F can assist in resizing the RAP.
- 4.6 When testing material from the roadway after reclamation and mixing, sample a minimum of 100 lb. of the treated material before the start of compaction.
- 4.6.1 Screen the lime treated material using a 7/8 in. sieve and a 1/4 in. sieve at the field moisture content, without drying.
- 4.6.2 Separate the material retained on the sieve from the material passing the sieve.
- 4.6.3 Cover the materials to retain field moisture.
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PART I—MOISTURE-DENSITY CURVE

5. PROCEDURE

- 5.1 *This test procedure does not claim to address the safety concerns associated with its use. It is the responsibility of the user of this test procedure to establish the appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations before use.*

- 5.2 Select a percentage of lime.
- 5.3 Determine the optimum moisture content and maximum dry density (M-D) curve for the material prepared from Section 4 in accordance with the applicable Sections of [Tex-113-E](#).
- 5.3.1 Before compaction of [Tex-113-E](#), add the lime uniformly to ensure even distribution of the lime throughout the sample. The amount of lime added is a percentage based on the dry weight of the material to be treated.
- 5.4 *Using Roadway Mixed and Treated Material.*
- 5.4.1 Recombine the material from Section 4 to produce samples for laboratory compaction.
- 5.4.2 Determine the M-D curve for this material in accordance with the applicable Sections of [Tex-113-E](#). Alternatively, compact samples to only verify a M-D curve that was produced from laboratory prepared materials in Section 5.3.
- 5.4.2.1 Estimate the field moisture content. Place material in a pan and weigh to the nearest 0.001 lb.
- 5.4.2.2 Adjust the moisture content of material by adding or removing moisture as needed. When removing moisture, do not oven dry the material. Stir frequently and as needed to achieve the necessary weight of material.
- 5.4.2.3 Determine the mass of material needed to achieve the desired moisture content.
- 5.4.2.4 Weigh material to the nearest 0.001 lb.

6. TEST REPORT

- 6.1 Lime Content, 0.1%;
- 6.2 Optimum Moisture Content, 0.1%; and
- 6.3 Maximum Dry Density, 0.1 pcf.

PART II—MIXTURE DESIGN TO DETERMINE THE TARGET LIME CONTENT

7. PROCEDURE

- 7.1 *This test procedure does not claim to address the safety concerns associated with its use. It is the responsibility of the user of this test procedure to establish the appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations before use.*
- 7.2 Determine the lime content to achieve a pH of 12.4 or higher in accordance with Part III.

- 7.3 Determine the optimum moisture content and maximum dry density (M-D curve) at this lime content for the material prepared from Section 4 in accordance with the applicable Sections of [Tex-113-E](#). A higher lime content may be used.
- 7.3.1 Before compaction of [Tex-113-E](#), add the lime uniformly to ensure even distribution of the lime throughout the sample. The amount of lime added is a percentage based on the dry weight of the material to be treated.
- 7.4 Recombine the material prepared from Section 4 and mold three samples using the M-D curve from Section 7.3.
- 7.5 Place a card on each specimen labeling the laboratory identification number and the percent of lime.
- 7.6 Proceed to Section 7.8 for curing the specimens.
- 7.7 *Using Roadway Mixed and Treated Material to Verify UCS.*
- 7.7.1 Recombine the material from Section 4.6 and mold three samples in accordance with the applicable Sections of [Tex-113-E](#).
- 7.7.2 Estimate the field moisture content. Place material in a pan and weigh to the nearest 0.001 lb.
- 7.7.3 When necessary, adjust the moisture content of material by adding or removing moisture as needed. When removing moisture, do not oven dry the material. Stir frequently and as needed to achieve the necessary weight of material.
- 7.7.4 Determine the mass of material needed to achieve the desired moisture content.
- 7.7.5 Weigh material to the nearest 0.001 lb.
- 7.8 *Curing*
- 7.8.1 Place the compacted specimens in triaxial cells.
- 7.8.2 Enclose the specimens with top and bottom porous stones and store on a countertop for seven days at room temperature.
- 7.9 After seven days of curing, remove the specimens from the triaxial cells.
- 7.9.1 Remove the top porous stone, and place them in an oven with the bottom porous stone only at a maximum temperature of 140°F until 1/3 to 1/2 of the molding moisture has been removed.
- 7.9.1.1 Measure the moisture content from weighing a sample before and after drying periods of time, such as hourly or as deemed necessary to achieve the 1/3 to 1/2 molding moisture. Allow the specimens to cool to room temperature.
- 7.10 Weigh the specimens to the nearest 0.001 lb. and measure the sample height with the micrometer dial assembly to the nearest 0.001 in.
- 7.11 Enclose the specimens in triaxial cells, with top and bottom porous stones.

- 7.12 Subject the specimens to capillary rise for ten days in accordance with [Tex-117-E](#), Sections 5.8-5.13, Figure 1, and Table 1.
- 7.13 Measure the unconfined compressive strength (UCS) in accordance with the applicable Sections of [Tex-117-E](#), Part II.
- 7.14 When testing lime treated soil, if the UCS is less than 50 psi or less than the minimum UCS as shown on plans, a new mixture design is required. Proceed to Section 7.3 and add a minimum of one additional percent of lime to the soil.
- 7.15 When testing lime treated soil blended with existing materials, or lime treated flexible base, or lime treated flexible base blended with existing materials, if the UCS is less than 150 psi or less than the minimum UCS as shown on plans, a new mixture design is required. Proceed to Section 7.3 and add a minimum of one additional percent of lime to the material.

8. TEST REPORT

- 8.1 Target Lime Content, 0.1%.
- 8.2 Optimum Moisture Content, 0.1%;
- 8.3 Maximum Dry Density, 0.1 pcf; and
- 8.4 Unconfined Compressive Strength, nearest whole psi.

PART III—PH SERIES

9. PROCEDURE

- 9.1 *This test procedure does not claim to address the safety concerns associated with its use. It is the responsibility of the user of this test procedure to establish the appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations before use.*
- 9.2 Prepare the sample in accordance with [Tex-128-E](#).
- 9.3 Weigh 30 ± 0.01 g of the sample and place it in a clean container. Repeat five additional times to weigh up a total of six test samples in six different containers.
- 9.4 Weigh 0.6 ± 0.01 g of lime which is 2% of the dry sample weight of 30 g and combine it with one of the samples from Section 9.2.
- 9.5 Repeat this for lime contents of 4, 6, 8, and 10% by adding 1.2 ± 0.01 , 1.8 ± 0.01 , 2.4 ± 0.01 , and 3.0 ± 0.01 g of lime, respectively, into a sample from Section 9.2. One sample from Section 9.2 will not be combined with any lime and tested as is at 0% lime.
- 9.6 Measure the pH of each sample from Section 9.3 and 9.4 in accordance with [Tex-128-E](#).

- 9.6.1 When the pH readings are 12.4 or higher, the sample with the lowest percentage of lime is the percent required to treat the material.
 - 9.6.2 When the pH readings do not go above 12.3 and two or more samples give this reading, the sample with the lowest percentage of lime is the percent required to treat the material.
 - 9.6.3 When the highest pH reading is 12.3 and only the sample with the highest percentage of lime achieves this, additional testing is required using higher percentages of lime.
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10. **TEST REPORT**

- 10.1 Lime Treated Sample pH, 0.1%.