

Section 02336

LIME-STABILIZED SUBGRADE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes foundation course of lime-stabilized subgrade material.
 - 1. Application of lime slurry to subgrade.
 - 2. Mixing, compaction, and curing of lime slurry, water, and subgrade into a stabilized foundation.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Measurement and payment for lime-stabilized subgrade is on per ton basis compacted in place to proper density. Separate measurement will be made for each required thickness of subgrade course.
 - a. Limits of measurement shall match actual pavement replaced, but no greater than maximum pavement replacement limits shown on Plans. Limits for measurement will be extended to include installed lime stabilized subgrade material that extends to 2 feet beyond outside edge of pavement to be replaced, except where proposed pavement section shares common longitudinal or transverse edge with existing pavement section. No payment will be made for lime stabilized subgrade in areas beyond these limits.
 - b. Limits of measurement and payment shall match pavement replacement limits shown on Plans, except as noted in Paragraph 1.02.A.1.a, or as approved by Project Manager.
 - 2. Measurement and payment for lime is by ton of 2,000 pounds dry weight basis. Calculate weight of dry solids for lime slurry based on percentage by dry weight solids.
 - 3. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³).
- B. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

- C. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- D. TxDOT Tex-101-E (Part III) - Preparing Soil and Flexible Base Materials for Testing.
- E. TxDOT Tex-140-E - Measuring Thickness of Pavement Layer.
- F. TxDOT Tex-600-J - Sampling and Testing Lime.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 – “Submittal Procedures”.
- B. Submit certification that hydrated lime, quicklime, or commercial lime slurry complies with specifications.
- C. Submit weight tickets, certified by supplier, with each bulk delivery of lime to work site.

1.05 RELATED REQUIREMENTS

- A. Section 01270 – “Measurement and Payment”
- B. Section 01330 – “Submittal Procedures”
- C. Section 01454 – “Testing Laboratory Services”

1.06 – 1.07 NOT USED

1.08 DELIVERY, STORAGE AND HANDLING

- A. Bagged lime shall bear manufacturer’s name, product identification, and certified weight. Bags varying more than 5 percent of certified weight may be rejected; average weight of 50 random bags in each shipment shall not be less than certified weight.
- B. Store lime in weatherproof enclosures. Protect lime from ground dampness.

1.09 PROJECT SITE CONDITIONS (NOT USED)

1.10 DEFINITIONS

- A. Moist Cure: Curing soil and lime to obtain optimum hydration.
- B. 1,000-Foot Roadway Section: 1,000 feet per lane width or approximately 500 square yards of compacted subgrade for other than full-lane-width roadway sections.

1.11 – 1.13 NOT USED

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. WATER

Use clean, clear water, free from oil, acids, alkali, or vegetation.

B. LIME

1. Type A - Hydrated Lime: Dry material consisting essentially of calcium hydroxide or mixture of calcium hydroxide and an allowable percentage of calcium oxide as listed in chemical composition chart.
2. Type B - Commercial Lime Slurry: Liquid mixture consisting essentially of lime solids and water in slurry form. Water or liquid portion shall not contain dissolved material in sufficient quantity to be injurious or objectionable for purpose intended.
3. Type C - Quicklime: Dry material consisting essentially of calcium oxide. Furnish quicklime in either of the following grades:
 - a. Grade DS: Pebble quicklime of gradation suitable for use in preparation of slurry for wet placing.
 - b. Grade S: Finely-graded quicklime for use in preparation of slurry for wet placing. Do not use grade S quicklime for dry placing.
4. Conform to the following requirements:

CHEMICAL COMPOSITION	TYPE		
	A	B	C
Active lime content, % by weight $\text{Ca(OH)}_2 + \text{CaO}$	90.0 min ¹	87.0 min ²	-
Unhydrated lime content, % by weight CaO	5.0 max	-	87.0 min
Free water content, % by weight H ₂ O :	5.0 max	-	-
SIZING			
Wet Sieve, as % by weight residue retained:			
No. 6	0.2 max	0.2 max ²	8.0 max ³
No. 30	4.0 max	4.0 max ²	-
Dry sieve, as % by weight residue retained:			
1-inch	-	-	0.0
¾-inch	-	-	10.0 max

Notes:

1. Maximum 5.0% by weight CaO shall be allowed in determining total active lime content.
2. Maximum solids content of slurry.
3. Total active lime content, as CaO, in material retained on No. 6 sieve shall not exceed 2.0% by weight of original Type C lime.

5. Deliver lime slurry to job site as commercial lime, or prepare at job site by using hydrated lime or quicklime. Provide slurry free of liquids other than water and of consistency that can be handled and uniformly applied without difficulty.
6. Lime containing magnesium hydroxide is prohibited.

C. SOIL

Soil to receive lime treatment may include borrow or existing subgrade material, existing pavement structure, or combination of all three. Where existing pavement or base material is encountered, pulverized or scarify material so that 100 percent of sampled material passes 2-inch sieve.

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S) (NOT USED)

3.02 PREPARATION

A. Examination

1. Verify compacted subgrade will support imposed loads.
2. Verify subgrade lines and grades.

B. Complete backfill of utilities prior to stabilization.

C. Cut material to bottom of subgrade using an approved cutting and pulverizing machine meeting following requirements:

1. Cutters accurately provide smooth surface over entire width of cut to plane of secondary grade.
2. Provide cut to depth as specified or shown in the Plans.

D. Alternatively, scarify or excavate to bottom of stabilized subgrade. Remove material or windrow to expose secondary grade. Obtain uniform stability.

E. Correct wet or unstable material below secondary grade by scarifying, adding lime, and compacting as directed by Project Manager.

F. Pulverize existing material so that 100 percent passes a 1³/₄-inch sieve.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Lime Slurry Application

1. Apply slurry with distributor truck equipped with an agitator to keep lime and water in consistent mixture. Make successive passes over measured section of roadway to attain proper moisture and lime content. Limit spreading to an area where preliminary mixing operations can be completed on same working day.

2. Minimum lime content shall be 5 percent of dry unit weight of subgrade as determined by ASTM D698.

B. Preliminary Mixing

1. Use approved single-pass or multiple-pass rotary speed mixers to mix soil, lime, and water to required depth. Obtain homogeneous friable mixture free of clods and lumps.
2. Shape mixed subgrade to final lines and grades.
3. Eliminate following operations and final mixing if pulverization requirements of Paragraph 3.05C can be met during preliminary mixing:
 - a. With light pneumatic rollers.
 - b. Cure soil-lime material for 24 to 72 hours or as required to obtain optimum hydration. Keep subgrade moist during cure.

C. Final Mixing

1. Use approved single-pass or multiple-pass rotary speed mixers to uniformly mix cured soil and lime to required depth.
2. Add water to bring moisture content of soil mixture to optimum or above.
3. Mix and pulverize until all material passes 1¾-inch sieve; minimum of 85 percent, excluding non-slacking fractions, passes ¾-inch sieve; and minimum of 60 percent excluding non-slacking fractions passes No. 4 sieve. Test according to TxDOT Tex-101-E, Part III using dry method.
4. Shape mixed subgrade to final lines and grades.
5. Do not expose hydrated lime to open air for 6 hours or more during interval between application and mixing. Avoid excessive hydrated lime loss due to washing or blowing.

D. Compaction

1. Aerate or sprinkle to attain optimum moisture content to 3 percent above optimum, as determined by ASTM D698 on material sample from roadway after final mix with lime.
2. Start compaction immediately after final mixing.
3. Spread and compact in two or more equal layers where total compacted thickness is greater than 8 inches.
4. Compact with approved heavy pneumatic or vibrating rollers, or combination of tamping rollers and light pneumatic rollers. Begin compaction at bottom and continue until entire depth is uniformly compacted.

5. Do not allow stabilized subgrade to mix with underlying material. Correct irregularities or weak spots immediately by replacing material and recompacting.
6. Compact subgrade to minimum density of 95 percent of maximum dry density, according to ASTM D698, at moisture content of optimum to 3 percent above optimum, unless otherwise indicated on Plans.
7. Seal with approved light pneumatic tired rollers. Prevent surface hair line cracking. Rework and recompact at areas where hairline cracking develops.

E. Curing

1. Moist cure for minimum of 3 days before placing base or surface course, or opening to traffic. Subgrade may be opened to traffic after 2 days when adequate strength has been attained to prevent damage. Restrict traffic to light pneumatic rollers or vehicles weighing less than 10 tons.
2. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to keep surface knit together.
3. Place base or surface within 14 days after final mixing and compaction. Restart compaction and moisture content of base material when time is exceeded.

3.04 REPAIR/RESTORATION

A. Rework of Failed Sections

1. Rework sections that do not meet specified thickness.
2. Perform the following steps when more than 72 hours have lapsed since completion of compaction.
 - a. Moist cure for minimum of 3 days after compaction to required density.
 - b. Add lime at rate of 25 percent of specified rate at no additional cost.
 - c. Moisture density test of reworked material must be completed by laboratory before field compaction testing can be completed.

3.05 FIELD QUALITY CONTROL

A. Tolerances

1. Completed surface: smooth and conforming to typical section and established lines and grades.
2. Top of compacted surface: Plus or minus $\frac{1}{4}$ inch in cross section or in 16-foot length.
3. Depth of lime stabilization shall be plus or minus one inch of specified depth for each 1,000-foot roadway section.

- B. Testing shall be performed under provisions of Section 01454 - Testing Laboratory Services.
- C. Test soils, lime, and mixtures as follows:
 - 1. Tests and analysis of soil materials shall be performed in accordance with ASTM D4318, using the wet preparation method.
 - 2. Sampling and testing of lime slurry shall be in accordance with TxDOT Tex-600-J, except using a lime slurry cup.
 - 3. Sample mixtures of hydrated lime or quicklime in slurry form shall be tested to establish compliance with specifications.
 - 4. Moisture-density relationship shall be established on material sampled from roadway, after stabilization with lime and final mixing, in accordance with ASTM 698, Moist Preparation Method.
- D. In-place depth will be evaluated for each 1,000-foot roadway section and determined in accordance with TxDOT Tex-140-E in hand excavated holes. For each 1,000-foot section, 3 phenolphthalein tests will be performed. Average stabilization depth for 1,000-foot section will be based on average depth for three tests.
- E. Perform compaction testing in accordance with ASTM D6938. Three tests shall be performed for each 1,000-foot roadway section.
- F. Pulverization analysis shall be performed as required by Paragraph 3.05C on material sampled during mixing of each production area. Three tests shall be performed per 1,000-foot roadway section or a minimum of once daily.

3.06 – 3.08 NOT USED

3.09 PROTECTION

- A. Maintain stabilized subgrade to lines and grades and in good condition until placement of base or surface course. Protect asphalt membrane from being picked up by traffic.
- B. Repair defects immediately by replacing material to full depth.

3.10 SCHEDULES (NOT USED)

END OF SECTION