

**OKLAHOMA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS
FOR
SUBGRADE TREATMENT**

These Special Provisions revise, amend and where in conflict, supersede applicable sections of the 1999 Standard Specifications for Highway Construction, English and Metric, as applicable. Units of measurement are provided in the subsections in both English and Metric equivalents. The units applicable for this project will be those specified on the project plans.

327.01. DESCRIPTION.

This work shall consist of furnishing, placing and compacting one or more courses of a mixture of soil, a chemical additive and water in accordance with these Specifications and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the Plans or established by the Engineer for the purpose of achieving stabilization or modification. Stabilization or modification additives for the purposes of this specification will be defined as cementitious additive (Portland Cement, fly ash or cement kiln dust) or lime.

- A. Subgrade Stabilization.** For Subgrade Stabilization, chemical additives are incorporated in sufficient quantities to increase the shear strength of subgrade soils and provide structural value for the pavement section.
- B. Subgrade Modification.** For Subgrade Modification, chemical additives are incorporated to change the PI and improve the workability of subgrade soils in order to establish a sound working platform for support of construction equipment.

On projects where sulfate soils may be present (especially Field Divisions 4, 5, 6, and 7) refer to the Materials Division test method for determining soluble sulfate content in soil, OHD L-49 , OHD L-50, and OHD L-51 to determine applicability of subgrade treatment. If sulfate content exceeds the threshold value specified in OHD L-49, OHD L-50, and OHD L-51, subgrade treatment will not be permitted.

327.02. MATERIALS.

Materials shall meet the requirements specified in the following Subsections of Section 700 - Materials.

Portland Cement	701.02
Water	701.04
Fly Ash	702.01
Cement Kiln Dust	702.03
Hydrated Lime	706.01
Quick Lime	706.02

All additives shall be stored in a suitable, weather-tight building or compartment which will protect them from dampness and permit easy access for proper inspection and identification of each shipment. Do not mix additives from different sources in storage. Do not mix lime from different sources in storage, even though they have been tested. Additives shall not be used if for any reason they have become partially set or if they contain hard lumps or cakes.

327.03. EQUIPMENT.

All equipment necessary for subgrade stabilization shall meet the requirements of Subsection 301.03.

327.04. CONSTRUCTION METHODS.

A. General. The primary requirement of these Specifications is to secure a completed course of treated material containing a uniform mixture of soil, additive, and water:

- free from loose or segregated areas,
- of uniform density and moisture content,
- well bound for its full depth and,
- with a smooth surface suitable for placing subsequent courses.

It shall be the responsibility of the Contractor to regulate the sequence of this work, to use the prescribed amount of additive, to maintain the work, and to rework the courses as necessary to meet the above requirements.

B. Weather Limitations. Additives shall not be applied for stabilization unless the air temperature is at least 40°F (4°C) and rising. For modification, the air temperatures should be at least 33°F (1°C) and rising. The air temperature shall be taken 4 feet (1.2 m) above the ground in the shade and away from artificial heat.

Additives shall not be applied when any portion of the ground is frozen. The Contractor shall be responsible for the protection and quality of the additive and treated subgrade under any weather conditions.

C. Preparation of Existing Roadbed. Prior to beginning any subgrade treatment, the roadbed shall be compacted and shaped to reasonably close conformity with the typical sections, lines, and grades as shown on the Plans or established by the Engineer. The subgrade shall be rolled in a manner approved by the Engineer, and any soft areas revealed by this rolling shall be corrected.

D. Scarifying and Loosening. Scarifying and loosening may be required prior to the application of additive to achieve the desired results as determined by the Engineer. The Contractor shall take precautions to avoid forming furrows of loosened material below the depth specified for the bottom of the treated subgrade. The Contractor shall not scarify or loosen any more of the roadway subgrade than can be chemically treated and compacted by the end of the workday.

In subgrade extents designated on the Plans or by the Engineer as having excessive rock making compliance with these Specifications impractical, the Engineer may waive certain portions of the work as described below. Excessive rock is defined as areas where the dimensions of 25 percent or more of the soil particles are greater than 2 1/2 inches (63 mm). The Engineer may require exploratory scarifying by the Contractor before designation of extents for which full compliance of these Specifications is waived.

E. Application. When the type and proportion of additive is indicated on the plans, it is approximate. The additive type and final application rate shall be based on classification tests of the subgrade soil. The classification tests shall be performed by the Department. However, with the approval of the Engineer, the Contractor has the option of having the tests performed by a Department approved laboratory at no additional cost. The additive shall be applied at a rate prescribed by the Materials Division procedures for stabilization, OHD L-50, or modification, OHD L-51, based on classification tests of the subgrade soil. When available, a copy of the soils report may be obtained from the Office Engineer Division prior to the Bid Opening for a project for soil classification data for

estimating purposes only. See the ODOT Materials Division Website for the most current OHD Procedures.

The Contractor may propose the use of a cementitious additive that was not specified on the Plans as a substitute, by submitting a proposal to the Engineer for review and approval. The proposal must include test results performed by a Department approved laboratory, in accordance with the Materials Division policy for soil stabilization or modification, the recommended application rates from those test results for the planned and proposed additives, and the cost comparison of the planned and proposed additives. Approval of the Engineer must be obtained prior to any substitution for the planned additive.

The Contractor shall provide equipment necessary for proper control of the application rate of additive. Where tests indicate a significant change in the classification of subgrade soil, a new application rate will be established in accordance with the Materials Division procedures for soil stabilization or modification, prior to the Contractor placing and spreading the additive.

(1) Application of Cementitious Additive. Dry methods of application shall be used for placement of the cementitious additive onto the subgrade. Equipment for spreading shall be approved types which demonstrate the ability to distribute the additive uniformly.

Cementitious additive shall not be applied by the slurry method. The additive shall not be placed on wet subgrade or otherwise allowed to become wet during application prior to mixing.

Cementitious additive shall not be applied when wind conditions are such that blowing additive becomes objectionable to traffic or adjacent property owners. The additive shall be placed only on that area of roadway where mixing, compaction, and finishing can be completed in the same day. During the interval of time between application and completion of the first mixing operations, the additive that has been exposed to weather conditions resulting in wetting or excessive loss by blowing will not be accepted for payment, and the additive unacceptable as the result of wetting shall be removed from the project. Specific extents of the subgrade may require modification with lime as a pretreatment to lower the plasticity index of the subgrade soils to below 20 prior to the application of a cementitious additive. The lime pretreatment shall be performed at the rate prescribed in the Materials Division procedure for soil modification. Application of lime for pretreatment shall be as described in Subsection 307.04(e)2.

(2) Application of Lime. Lime shall not be applied when wind conditions are such that blowing lime becomes objectionable to traffic and adjacent property owners. Equipment for spreading shall be approved types which demonstrate the ability to distribute lime uniformly.

When lime is applied to the soil ahead of the mixing equipment, the lime shall be placed only on that area where the first mixing operations can be completed during the same working day. During the interval of time between application and mixing, lime that has been exposed to the open air for a period of six hours or more may not be accepted for payment; in addition, payment will not be made for lime loss due to excessive washing or blowing.

(a) Dry Method.

- 1) *Quick Lime.* When quick lime is used, the equipment for spreading lime shall be an approved type which shall demonstrate its ability to distribute the lime uniformly in controlled amounts.
- 2) *Hydrated Lime.* Bagged hydrated lime may be used for dry-method application only under unusual circumstances, i.e., when it would be impossible or impracticable to use other methods and only upon written approval of the Engineer. All applicable Federal, State, and local laws shall be met. The bagged lime shall bear the manufacturer's certified weight.

(b) Slurry Method. Lime shall be mixed with water into a slurry by either of the following methods. Use of compressed air for mixing will not be permitted in either of the methods.

- 1) *Central Plant.* Mixing shall be accomplished through integral paddles, recirculating pumps, or other devices that will meet mixing requirements. The slurry distributor truck, hauling from the central plant, shall be equipped with a recirculating pump or agitator of sufficient size which will keep the lime and water in a uniform mixture until spread.
- 2) *Transit Mix.* The lime from the storage bin shall be metered or weighed by an approved method into the tank transit mix equipment. The tank truck shall be equipped with a recirculating pump or agitator to maintain a uniform mixing of the lime and water while in transit.

The distributor truck shall be equipped with a pump, regardless of the type of mixing method used. The slurry will be applied through the spray bars under pressure to assure a uniform flow and distribution. The slurry produced by either method shall consist of a minimum mixture of approximately 1 ton (0.9 metric ton) of lime to each 500 gallons (1893 L) of water and shall not contain more than 40 percent lime.

F. Mixing. Mixing of the additive with the subgrade soil shall follow application and spreading as a continuous construction operation. Work areas for mixing shall not exceed the area of treatment which can be completed on the same day. Prior to field mixing, the Contractor will determine the optimum moisture content for maximum density of the compacted soil-additive mixture in accordance with AASHTO T-99. Normally enough water will be added to obtain a water content of 2 to 5 percentage points above the optimum moisture content to account for moisture loss during the mixing process.

A pulvex mixer shall be used that is equipped with a spray bar in the mixing chamber, capable of injecting a sufficient quantity of water to produce a soil-additive mixture with a moisture content within the specified range. The method of mixing shall be an approved procedure utilizing traveling mixing equipment that demonstrates uniform dispersion of the additive and water throughout the soil.

(1) Mixing for Cementitious Additive Treatment. All clods shall be reduced in size by mixing until the soil-additive mixture meets the following gradation requirements when tested dry by laboratory sieves:

SIEVE SIZE	PERCENT PASSING
1 1/2 inch (37.5 mm)	100
3/4 inch (19.0 mm)	50 minimum

Achieve the gradation and moisture content requirements to the depths specified in the plans in a single mixing of the cementitious additive. If the Engineer determines that the gradation or moisture requirements are not met, a second pass with a pulvex mixer will be required at the Contractor's expense. The Engineer may further require that the Contractor modify the work process to meet the above requirements in a single mixing.

Cementitious additive shall be added and the section shall be repulverized at the correct moisture content to any portion of the work area that the additive has hydrated prior to compaction at the contractor's expense, unless waived by the Engineer.

(2) Mixing for Lime Treatment. The mixing procedure shall be as hereinafter described.

- (a) *First Mixing.* The Contractor shall mix the soil, lime, and water until a uniform mixture is obtained in which all clods and non-aggregate lumps are reduced to a maximum of 1 1/2 inches (37.5 mm) diameter in size. Sufficient water shall be added in the first mixing process to insure proper chemical reaction between the lime and soil. When proper mixing has been accomplished, the mixture shall be allowed to cure. Curing time when hydrated lime is used shall be 72 hours at ambient temperatures above 40°F (4°C). Curing time when quick lime is used shall be 48 hours at ambient temperatures above 40°F (4°C).

In the unexpected event that the temperature falls below 40°F (4°C) during the curing time for stabilization, the Engineer may extend the cure time. No cure time extension is required for modification or lime pretreatment.

During the curing period, the material shall be maintained in a moist condition. The surface of the treated area shall be sealed by light rolling to the extent that the surface will repel water and contain the moisture. When deemed necessary by the Engineer, the Contractor shall rescarify any portion of the area under treatment for additional sprinkling to insure proper moisture for the curing.

- (b) *Quick Lime Mixing.* Within two hours after spreading quick lime and before water is added, approved means shall be used to turn under a significant portion of the quick lime to reduce harmful exposure to the heat of hydration. Sufficient water shall be added within 6 hours after spreading to permit hydration of the quick lime.

CAUTION: Uncovered quick lime may be hazardous when in the presence of moisture.

- (c) *Final Mixing.* After the required curing time, the material shall be mixed uniformly by approved methods. All clods shall be reduced until the soil-lime mixture meets the following requirements when tested dry by laboratory sieves:

SIEVE SIZE	PERCENT PASSING
1 1/2 inch (37.5 mm)	100
No. 4 (4.75 mm)	60 minimum

- (3) Mixing for Lime Pretreatment.** Mixing shall be in accordance with the first mixing for lime described in Subsection 307.04(f)(2.1).

- (4) Mixing for Depths of 8 inches (200 mm) or greater compacted thickness.** No treated course shall exceed 8 inches (200 mm) in depth. If the depth of material to be treated in cut sections is more than 8 inches (200mm), that portion above the lower 8 inches (200 mm) shall be removed so that the bottom course can be treated in place. The cost of excavation shall be included in the price bid for stabilization or modification.

During normal fill construction, treatment shall be accomplished by adding and mixing the amount of treatment additive as required on the plans to each 8 inch (200 mm) lift, completing the depth of fill to the typical section shown on the plans.

Variations to the mixing depths that may be properly performed by special equipment or methods may be used only after approved by the Engineer.

- (5) Mixing for Excessive Rock Areas.** In areas designated by the Engineer as excessive rock, pulverize and mix in two separate stages. The particle size requirement may be waived by the Engineer. It is the intent that the completed course of treated material shall comply with the

Standard Specifications as to uniformity of treatment additive, density, moisture content, and depth insofar as practicable.

G. Compaction.

- (1) General.** Compact the soil-additive mixture immediately after final mixing as a continuation of the mixing operation. Complete compaction the same day mixing is performed.

The material shall be sprinkled and rolled. All irregularities, depressions, or weak spots which develop shall be immediately corrected by scarifying the areas affected, adding or removing material or additive as required, and reshaping and recompacting by sprinkling and rolling.

Depths of two or more lifts or courses shall be compacted as specified in the mixing procedure.

- (2) Moisture-Density Requirements.** Compact before any appreciable loss of mixing moisture occurs. Ensure compaction within plus or minus 2 percentage points of optimum moisture content. During the course of construction, changes or adjustments in the specified moisture requirements to meet field conditions may be authorized by the Engineer.

Verify the target density for the soil-additive mixture by conducting moisture-density tests on representative samples obtained from the roadway before compaction is started. The test method for the target density will be in accordance with AASHTO T 99 modified to provide one compacted specimen of the soil-additive mixture. Separate portions of the sample will be used for additional specimens with the moisture reduced or increased.

Compaction shall be continued until the entire depth of the mixture is uniformly compacted to not less than 95 percent of target density. Field density will be determined in accordance with AASHTO T 310 or Subsection of 202.04(a)(4). The rate of operation and the number of rollers shall be sufficient to uniformly compact the section of roadway being processed.

- (3) Excessive Rock.** In areas designated by the Engineer as excessive rock, attempt substantial compliance with these Specifications. The soil-additive mixture may not be uniform and some variation is to be expected in both the target density and optimum moisture. In the event the in-place density tests are not practical because of rock in the soil-additive mixture, the Engineer may waive the density and moisture content requirements and approve compacting by visual observation in lieu of testing.

H. Finishing and Curing. After the final layer of the treated subgrade has been compacted, it shall be brought within reasonable compliance to the lines, grades, and typical sections. The completed section shall then be finished with a suitable roller sufficiently light to prevent hair line cracking. The treated subgrade shall be maintained at a moisture content satisfactory for proper curing by sprinkling until a prime coat seal or succeeding course is placed, whichever occurs first.

Should the material, due to any reason, lose the required stability, density, or finish before the next course is placed, it shall be replaced and refinished at the expense of the Contractor.

I. Tolerance. The finished surface tolerance shall be in conformity with Section 301.

327.05. METHOD OF MEASUREMENT.

Fly ash will be measured by the ton (metric ton).

Cement kiln dust will be measured by the ton (metric ton).

Portland Cement will be measured by the ton (metric ton).

Lime will be measured by the ton (metric ton).

Cementitious Stabilized Subgrade will be measured by the square yards (square meters) of subgrade stabilization completed in place.

Cementitious Modified subgrade will be measured by the square yards (square meters) of subgrade modification completed in place.

Lime Pretreatment will be measured by the square yard (square meter) of subgrade pretreatment completed in place.

Lime Stabilized Subgrade will be measured by the square yard (square meter) of subgrade stabilization completed in place.

Lime Modified Subgrade will be measured by the square yard (square meter) of subgrade modification completed in place.

Modified Subgrade will include the chemical additive at the rate specified for the appropriate soil classification as defined by the Materials Division policy for modification, OHD L-51. Modified Subgrade will be measured by the square yard (square meter) of subgrade modification, including chemical additive, completed in place.

Stabilized Subgrade will include the chemical additive at the rate specified for the appropriate soil classification as defined by the Materials Division policy for stabilization, OHD L-50. Stabilized Subgrade will be measured by the square yard (square meter) of subgrade stabilization, including chemical additive, completed in place.

Prime Coat will be measured and paid for in accordance with Section 408.

Water and Rolling will not be measured for payment.

In projects where there is a separate pay item for Selective Subgrade Topping, Cementitious or Lime additives will not be measured separately and the cost will be included in the pay item for *Cementitious Stabilized Subgrade, Cementitious Modified Subgrade, Lime Stabilized Subgrade, or Lime Modified Subgrade*.

327.06. BASIS OF PAYMENT.

Accepted quantities for Stabilized Subgrade, measured as provided above, will be paid for at the contract unit price as follows:

(A) FLY ASH	TON (METRIC TON)
(B) CEMENT KILN DUST	TON (METRIC TON)
(C) PORTLAND CEMENT	TON (METRIC TON)
(D) LIME	TON (METRIC TON)
(E) CEMENTITIOUS STABILIZED SUBGRADE	SQUARE YARD (SQUARE METER)
(F) CEMENTITIOUS MODIFIED SUBGRADE	SQUARE YARD (SQUARE METER)
(G) LIME PRETREATMENT	SQUARE YARD (SQUARE METER)
(H) LIME STABILIZED SUBGRADE	SQUARE YARD (SQUARE METER)
(I) LIME MODIFIED SUBGRADE	SQUARE YARD (SQUARE METER)
(J) MODIFIED SUBGRADE	SQUARE YARD (SQUARE METER)
(K) STABILIZED SUBGRADE	SQUARE YARD (SQUARE METER)

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

Payment for Quick Lime shall be based upon a 90 percent available lime index, calculated as percent CaO by weight, as determined by ASTM C-25 the "rapid sugar test method".

Payment for Hydrated Lime shall be based upon a 90 percent available lime index, calculated as percent Ca(OH)₂ by weight as determined by ASTM C-25 "the rapid sugar method".

When the available lime index percentage falls below 90 percent, payment will be made at an adjusted price; reduced at the rate of one percent of the Contract unit bid price for lime for each percent, or fraction thereof, from 90.0 percent to, and including, an available lime index of 80.0 percent.

When the available lime index falls below 80.0 percent for the type of lime used, add a sufficient quantity of additional lime of the same type to bring the total amount to the required 90.0 percent of available lime index at no additional cost to the Department.