

LIME TREATMENT - Section 304

Lime treatment is defined as the addition of lime to soil or soil-aggregate to modify the material's characteristics. Water also is required to be added to adjust the moisture content of the mixture to facilitate the chemical reaction of the lime and aid compaction.

Specification Section 304 designates the following types of lime uses.

TYPE	USE
Type B	Base or Subbase
Type C	Conditioning for Cement Treatment or Stabilization
Type D	Working Table under Embankment
Type E	Conditioning and Drying for Embankment

TYPES AND USES OF LIME TREATMENT

MATERIALS

Approved sources of lime will be published in QPL No. 34. Lime used in any type of treatment must be from an approved source listed in the QPL. Either hydrated or quicklime may be used.

Lime is supplied in various forms. The most common form is dry, hydrated (powder) lime. Quicklime (non-hydrated) comes in granular form often termed pelletized. Since quicklime is non-hydrated, it has a high demand for moisture. This characteristic creates a condition that requires constant vigilance on the part of personnel. This material can cause serious burns when contact with human tissue occurs. Lime slurry minimizes the problem due to the water added to the mixture. Quicklime is supplied in two different gradations, a 3/8-inch size which the department allows to be used in the same manner as powdered lime and a 3/4 inch size which is used for forming lime/water slurries.

Lime may be applied dry (powder or granular) or in slurry form. Lime may be applied directly to the prepared surface or may be mixed with the material in a central mix plant. In dust sensitive areas, designated in the plans, either granular (pelletized), slurry application, or central plant mixing may be required. The engineer will approve the type of material and application method to be used.

Lime may be delivered to the project site in bulk transports or in bags. Lime slurry is delivered in special transports that keep the slurry in its blended form until the material is spread on the project. A Certificate of Delivery shall accompany each transport. It shall be the responsibility of the contractor to verify that the transports are sealed and that the

seal number matches that indicated on the Certificate of Delivery. Seals shall be removed and turned over to the project engineer daily.

Lime must be protected from moisture prior to application or mixing in a plant or slurry. Caked or contaminated lime is not to be used. Lime which has been exposed to air for more than six hours and lime lost or damaged before incorporation due to rain, wind or other cause will be rejected, deducted from measured quantities, and shall be replaced by the contractor at no direct pay. Lime oxidizes when exposed to the atmosphere and loses its ability to react chemically with the soil. Lime exposed to air prior to placement, stored for an excessive length of time, or for which there is a significant delay between placement and mixing is not to be used. Lime which is improperly stored, exposed to the elements, gets damp, etc., is not to be used. If the lime's usability is questionable, project personnel are to sample the lime and submit it to the Materials and Testing Section for evaluation.

Water must meet the requirements of Specification Section 1018.

EQUIPMENT

The engineer must approve all equipment used in lime treatment.

SPREADING EQUIPMENT

The equipment used to spread lime must ensure a uniform coverage at the approved spread rate. Excessive dusting will not be allowed.

MIXING EQUIPMENT

The in-place mixer defined in Specification Section 303 is required for all types of lime uses. The engineer may approve other types of equipment for Types D and E when certain conditions occur (e.g., boggy areas) where in-place mixers are not practical. When high PI soils are to be modified, the in-place mixer may not be adequate for complete mixing due to the heaviness of the soil. Initial mixing may necessarily be achieved with a disc and final mixing with an in-place mixer.

WATER TRUCKS

Water trucks may be used to spray water over the lime treated material during construction operations. Water trucks are to be equipped with spray bars which uniformly spray water across the surface and do not apply water in streams or cause water to puddle on the surface.

COMPACTION EQUIPMENT

It is recommended that lime treated areas be compacted with a conventional sheepfoot roller or a self-propelled tamping foot compactor-type roller. The type of material and the thickness of the lime treatment shall be considered in determining the proper length and size of the spikes. The length of the spike shall be sufficient to achieve uniform

compaction for the full depth of the layer being compacted. The number and size of the spikes shall be selected to match the compaction characteristics of the material being compacted. Generally, in order to achieve full-depth uniform compaction, the spike must be long enough to penetrate the full depth.

The compacted material should be finished by sealing with static, smooth steel-wheel or pneumatic tire rollers. The drum of smooth steel-wheel rollers shall be smooth, with no flat spots, cracked, or damaged surfaces. They shall be equipped with scrapers to prevent the material from sticking to the wheels or drum. The pneumatic roller shall have an odd number of tires, arranged so that the spaces between one row of tires are covered by the tires of the other row. All tires shall be in place and shall be in good condition and properly inflated. Tires shall be smooth tread, of the same size and ply, and inflated to within ± 5 psi of each other.

Lime treatment shall be finished with approved equipment. It shall leave a tight, uniformly smooth surface meeting grade and cross slope requirements, if applicable.

SPECIAL TRAFFIC CONSIDERATIONS

The contractor shall provide a flagger who will stop vehicles before they enter the limed area. The flagger is to impress on the drivers the need to travel extremely slowly through the loose lime. Loose lime is highly flowable and dust prone; therefore, if traffic is allowed to disregard the situation the lime will be displaced and the percent incorporated into the soil will not be uniform or proper. The lime dusts in such a manner that it can be sucked into the intake of an automobile causing engine failure. This dusting characteristic also results in airborne particles that impact the environment and may invoke environmental protection regulations.

When traffic is maintained, the contractor shall control the operation to maintain free traffic flow through the project. Equipment shall not obstruct the orderly flow of traffic.

TYPE B TREATMENT

MIXING EQUIPMENT (Type B)

For Type B treatment, an approved in-place mixer that meets the same requirements of In-Place Cement Stabilized Base Course (Specification Section 303) must be used.

CONSTRUCTION DETAILS (Type B)

The lime is to be spread fully in a single application. Extra water is required to activate the lime. When lime slurry is used, the amount of water in the slurry will have to be considered when determining the amount of water to be added. Generally the water in the slurry is not sufficient to chemically treat the soil material and additional water will have to be added before the construction sequence is complete. Material at the proper moisture content for the chemical reaction to occur will appear excessively wet. The lime is to be mixed into the soil or soil-aggregate with an approved in-place mixer.

Sufficient water is to be added through the in-place mixer to provide for the chemical reaction between the lime, water, and soil. The amount of water required to activate the chemical reaction will bring the soil/lime mixture significantly above optimum moisture content determined by DOTD TR 415 or TR 418. The area is then sealed with rollers and allowed to mellow for 48 hours. Lime that is not sealed will oxidize through exposure to air and will not perform as required. The timing for the 48-hour mellowing period will begin when sealing is completed.

Following the 48-hour mellowing period, the lime treated area is pulverized with the in-place mixer until specification pulverization requirements on the 3/4-inch and No. 4 screen are met. The addition of a small amount of water may be necessary to bring the soil/lime mixture to within the specifications for optimum moisture content. Acceptance samples for moisture content and maximum dry density are to be taken immediately prior to compaction for acceptance. DOTD TR 415 or TR 418 may be used for this determination. The area is then compacted to at least 95.0% of maximum dry density and finished. Compaction and finishing must be completed within 6 hours of achieving pulverization. If the area cannot be compacted to specification density and finished within the six-hour time limit, the contractor will be required to make adjustments in the operation to prevent this from recurring in subsequent sections. **Sections not completed within the time limit will not be accepted.** Reconstruction with an addition of the original percent lime will be required at no direct pay. Sections that do not meet the minimum density requirements after the six-hour time limit will not be accepted.

PROTECTION AND CURING (Type B)

The lime modified soil shall never be allowed to dry out. The contractor shall apply an asphaltic curing membrane over the surface of the completed area as soon as smooth rolling is completed. No traffic, public or construction, shall be allowed over the completed lime treatment for the 72-hour curing period. When traffic must be maintained, it is to be routed off the completed course onto shoulders or other suitable areas, when conditions permit. Any damage to the lime treatment is to be corrected by the contractor.

QUALITY ASSURANCE

QUALITY CONTROL (QC) (Type B)

When lime is delivered in bulk, it shall be the responsibility of the contractor to determine the spread rate and length of spread for each transport. The contractor is to provide these values to the project engineer for approval. No lime is to be placed until the spread rate has been approved. The length of spread is to be calculated for each individual truck before lime is discharged on the surface.

If the percent of lime is not designated, it will be determined by the district laboratory. The contractor is to control the spread rate and length of spread to ensure that no less than the minimum required percent of lime is placed. The contractor shall perform DOTD TR 436 for each transport to ensure that the correct percent of lime is applied. The contractor shall observe the spread for uniformity and complete coverage. The

contractor is expected to adjust operations whenever the QC program indicates that deficiencies are occurring.

When lime is delivered in bags, the contractor will space the bags to meet at least the minimum spread rate requirements, in accordance with the approval of the project engineer. When bags are used, bags shall be opened, the contents spread uniformly, and the empty bags removed and discarded in an appropriate manner. The project engineer will approve the bag spacing to meet the spread rate requirements. The contractor is to monitor water application to ensure that the spray is uniform and that wet or dry spots do not occur.

After the 48-hour mellowing period, the contractor is to observe the blended material for uniformity of mixing. QC personnel shall determine the moisture content of the lime treated material after the 48-hour mellowing period, but before compaction begins, to ensure that the material will be within an acceptable range of optimum moisture during compaction. This test will be performed in accordance with DOTD TR 403. When maximum dry weight density is to be determined in accordance with DOTD TR 415, the material to mold the proctor will be obtained from beneath the nuclear device or from the area immediately adjacent to the sand cone density hole. The contractor is to determine the percent pulverization following the in-place mixer in accordance with DOTD TR 431. If the specification requirements are not met, the contractor is expected to alter the operation or equipment to ensure that all specification requirements are met. The contractor is to monitor pulverization and finishing to ensure that they are completed within the six-hour time limit.

Additionally, the contractor is to monitor the operation to ensure uniformity. No segregation, contamination, soft spots, laminations, undulations or other variations in elevation are to be left uncorrected. The contractor is to check thickness, width, cross slope, and grade (when applicable), to ensure that the finished project matches plan requirements.

INSPECTION AND ACCEPTANCE (Type B)

If the percent of lime is not designated, the district laboratory will determine it in accordance with DOTD TR 416.

Project personnel will independently determine spread rate and length of spread. The spread rate must result in at least the minimum percent lime designated or specified by the district laboratory being uniformly applied. During lime placement, project personnel will check the spread rate in accordance with the DOTD TR 436 in accordance with the schedule listed in the *Materials Sampling Manual* and the length of spread several times per day. When lime is delivered in bags, the project engineer will approve the bag spacing to ensure that the minimum spread rate is met. Project personnel will check bag spacing for conformance to the department's requirements. The length of spread and spread rate are also to be rechecked whenever visual inspection indicates a nonuniform spread. If the spread rate is not correct or is not uniform, the inspector is to require the contractor to make immediate corrections to ensure that the minimum percent lime is uniformly applied. Continuous placement of lime is not to be allowed until it has been established by the department that the minimum percent of lime is being uniformly applied.

Project personnel will determine the moisture content of the lime treated material after the 48-hour mellowing period, but before compaction begins, to ensure that the material will be within an acceptable range of optimum moisture during compaction. This test will be performed in accordance with DOTD TR 403. When maximum dry density is to be determined in accordance with DOTD TR 415 or TR 418, the material to mold the proctor will be obtained from beneath the nuclear device or from the area immediately adjacent to the sand cone density hole.

Project personnel are to determine the percent pulverization prior to compaction in accordance with DOTD TR 431. The pulverization process is to be continued until the acceptance test indicates that the percent pulverization meets the specifications. The inspector is not to allow compaction to begin until this test is completed. The inspector is also to monitor the six-hour time limit between pulverization and completion of compaction and finishing. Compaction is to be started as soon as pulverization is achieved.

Project personnel are to determine the percent compaction in accordance with DOTD TR 401 after compaction and finishing are completed. If the minimum percent density defined by the specifications has not been met, the contractor is to be required to reconstruct the area, beginning with reapplication of lime.

DOTD TR 602 MEASUREMENTS (TYPE B)

Project personnel will perform thickness and width measurements in accordance with DOTD TR 602 to verify the contractor's QC prior to requesting acceptance measurements by the district laboratory. The district laboratory will determine thickness and width for final acceptance in accordance with DOTD TR 602. The district laboratory engineer will notify the project engineer of areas that do not meet specification requirements and must be corrected. The project engineer will require the contractor to correct deficient areas prior to final acceptance. Additional thickness and width measurements will be performed on corrected areas by the district laboratory prior to final acceptance. To isolate an area, move up and down station five feet and retest. Then, retest at 25-foot intervals until the limits of deviation from specifications are found.

VISUAL INSPECTION (TYPE B)

Deficiencies identified by visual inspection, such as inadequate pulverization, laminations, nonuniform spread rate, dimensional deficiencies, soft areas, etc., shall be corrected before the section will be accepted. Project personnel will inspect the entire completed base regularly and daily when the base is open to traffic for damage to the curing membrane or to the base. The contractor shall repair deficiencies that develop prior to the placement of the next course at no direct pay.

Throughout the lime treatment process, project personnel are to inspect the operation for uniformity. No deficiencies such as wet spots, contamination, laminations, soft spots, etc., are to be allowed. When a deficiency is identified, the contractor is to be required to make immediate correction.

TYPE C TREATMENT

Type C lime treatment is used for preparation of material prior to cement treatment or stabilization.

MIXING EQUIPMENT (Type C)

For Type C treatment, an approved in-place mixer that meets the requirements of In-Place Cement Stabilized Base Course (Specification Section 303) must be used.

CONSTRUCTION DETAILS (Type C)

Construction operations for Type C Treatment are the same as for Type B treatment, with the following exceptions.

- ◆ There are no Atterberg Limits specified for Type C Treatment.
- ◆ There is no specified percent compaction required for Type C Treatment. The contractor is to make a reasonable effort to comply with the compaction requirements of Type B. Optimum rolling patterns are required when compaction in accordance with Type B is not achieved.
- ◆ No formal depth and width measurements in accordance with DOTD TR 602 will be required.
- ◆ No 72-hour cure is required for Type C Treatment.

QUALITY ASSURANCE

QUALITY CONTROL (QC) (Type C)

QC requirements for Type C Treatment shall be the same as for Type B Treatment.

INSPECTION AND ACCEPTANCE (Type C)

Inspection and acceptance for Type C Treatment are the same as for Type B Treatment, with the following exceptions. There is no percent compaction specified for Type C Treatment; project personnel will check density to ensure the contractor makes a reasonable effort to comply with the compaction requirements of Type B. Inspectors must make sure that the rolling patterns established by the contractor achieve the maximum compaction possible for the conditions when Type B compaction requirements are not met.

However, prior to cement treatment or stabilization, the lime treated material must be compacted to at least 93% of maximum dry density before cement is spread. Project personnel will take depth and width measurements and compare them to plan requirements. Since there are no tolerances in the specifications, it will be the responsibility of the project engineer to determine that plan dimensions are satisfactorily met by using the guidelines of DOTD TR 602. Underwidths or underdepths will not be accepted and shall be corrected before beginning the next operation.

TYPE D TREATMENT

Type D treatment is intended for constructing a working table upon which to place an embankment. It is to provide stability to support equipment to begin construction of the first lifts of embankment. **Type D Treatment is not to be used in construction of embankment lifts or Base Course or Subbase conditioning.**

MIXING EQUIPMENT (Type D)

For Type D Treatment, an approved in-place mixer that meets the requirements of In-Place Cement Stabilized Base Course (Specification Section 303), is required unless the engineer approves the use of other equipment. The equipment shall be capable of pulverizing the soil or soil-aggregate into particles small enough to be effectively coated with lime. If the soil is not adequately pulverized, the lime treatment will be ineffective. Heavy clays (e.g., above 30 P.I.) will require special effort to achieve adequate pulverization to allow the chemical reaction between soil and lime to take place. Double tandem disks may be acceptable for mixing lime with the soil. A plough disk will not adequately pulverize the material for effective coating. The plough disk may be necessary for initial cutting to proper depth, followed by the double tandem disk in lieu of a stabilizer for mixing of lime with the soil. Multiple passes will be necessary. Final blending with an in-place mixer is a superior method to ensure proper mixing and efficient use of the lime additive to achieve the highest quality product with the least amount of compaction difficulty.

CONSTRUCTION DETAILS (Type D)

Lime is to be spread fully in a single application. Lime is to uniformly cover the entire area at the spread rate approved by the engineer. The spread rate shall meet the percent lime to be incorporated as determined by the district laboratory or as specified. Lime may be mixed into the soil or soil-aggregate by in-place mixer or by disk, when approved by the engineer. There are no pulverization requirements established by the specifications; however, the material must be uniformly blended and the soil or soil-aggregate uniformly coated with lime to the satisfaction of the engineer. The specifications do not establish a minimum percent compaction. The lime treatment is to be compacted to the satisfaction of the engineer. The contractor shall obtain the maximum density possible as determined by the engineer.

PROTECTION AND CURING (Type D)

There is no curing method or time limit established by the specifications; however, it is important to the quality and effectiveness of the lime treatment process to keep the treated material moist, never allowing it to dry out. The contractor shall protect the completed lime treatment as directed. The contractor shall prevent damage to the lime treatment from traffic in the same manner as for Type B. Any damage is to be corrected as directed.

QUALITY ASSURANCE

QUALITY CONTROL (QC) (Type D)

QC requirements for Type D Treatment shall be the same as for Type C Treatment, with the exception that DOTD TR 431, pulverization test or control of a mellowing period will not be required.

INSPECTION AND ACCEPTANCE (Type D)

Inspection and acceptance procedures will be the same for Type D Treatment as for Type C Treatment, except that curing and pulverization will be to the satisfaction of the engineer.

TYPE E TREATMENT

Type E treatment is designed for use in embankment construction. Type E lime treatment is embankment construction with lime treatment of the individual lifts of soil or soil-aggregate.

MIXING EQUIPMENT (Type E)

The requirements for mixing equipment for Type E Treatment shall be the same as for Type D Treatment.

CONSTRUCTION DETAILS (Type E)

Lime is to be spread fully in one application for each lift of embankment. **After the lime is spread and mixed, the embankment lift is to meet the requirements for embankment construction in accordance with Specification Section 203 and the guidelines of this manual for embankment.**

PROTECTION AND CURING (Type E)

The contractor is responsible for the stability of embankments until final acceptance. Therefore, the contractor is to make every effort not to damage a lime treated lift of embankment in the same manner as required for raw embankment. Heavy loads, excessive exposure to hauling, too much water, or too little water are examples of conditions that may damage a lift (and underlying lifts) requiring reconstruction. There is no curing period or time limit established by the specifications, however, it is important to the quality and effectiveness of the lime treatment process to keep the treated material moist, never allowing it to dry out.

QUALITY CONTROL (QC) (Type E)

QC requirements for Type E Treatment shall be the same as for Type B Treatment, with the exceptions that there is no mellowing period and DOTD TR 431, pulverization test will not be required. There are no pulverization requirements specified; however, a poorly pulverized and blended material will be difficult to compact to specification density. The individual lifts of lime treated embankment will be constructed and the quality controlled by the contractor in accordance with Specification Section 203.

INSPECTION AND ACCEPTANCE (Type E)

The inspection and acceptance procedures, including visual inspection, for Type E Treatment shall be in accordance with Type B treatment and Embankment Construction, Specification Section 203.

QUALITY ASSURANCE DOCUMENTATION

Quality Control

The contractor shall maintain documentation of the QC program in accordance with the Quality Control Plan, and as required by the project engineer, and the *Materials Sampling Manual*.

Inspection and Acceptance

Department personnel will maintain documentation of construction progress, inspection, acceptance tests, etc., in a field book and on proper MATT forms if applicable, in accordance with standard department practice. The length of spread, spread rate, pulverization (for Type B), time of application, mellowing times, and thickness and width shall be noted.

Density & Moisture Content Worksheet

The test procedure DOTD TR 401 - The Determination of In-Place Density, contains a worksheet to be used to facilitate the calculations associated with the determination of density, moisture, and pulverization. This worksheet is to be completed in conjunction with this procedure and used for these calculations. Department personnel will submit this form for acceptance testing regularly to the district laboratory for MATT system entry. The district laboratory will retain the original for inclusion in the 2059 Review. A copy of the documentation of QC tests and results shall be given to department personnel as noted on page 5.