MICHIGAN

DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

FOR

**CHEMICALLY STABILIZED SUBGRADE**

CFS:MJE 1 of 12 APPR:DMG:CRB:09-23-24

**a. Description.** This work consists of constructing and testing of a compacted uniform layer of chemically stabilized subgrade to the thickness shown on the plans and determining the minimum amount of cement, lime, lime-cement or lime-fly ash combination and water required for the soil.

Perform the work at the locations shown on the plans and in accordance with this special provision, the standard specifications and as directed by the Engineer.

Furnish onsite staff with a minimum of 5 years’ experience in subgrade stabilization and a minimum experience of 5 completed projects of similar scope. Submit project experience information before or during the pre-production meeting.

For bidding purposes only, the minimum rate of cement application is six percent of the treated soil volume on a dry weight basis for the soil, the minimum rate of lime application is five percent of the treated soil volume on a dry weight basis for the soil. Fly ash may or may not be required as determined by the Contractor furnished mix design. For bidding purpose only, the estimated quantity of fly ash is to be 1,000 tons.

Select cement, lime, lime-cement or lime-fly ash mixture as the stabilizing agent as justified by the site-specific mix designs.

**b. Materials.**

1. Cement. Furnish Portland cement in accordance with section 901 of the Standard Specifications for Construction.

2. Lime. Furnish quicklime, hydrated lime or lime slurry in accordance with *ASTM C977* with the modification that all quicklime passes the 3/8-inch size sieve. The lime will be accepted with test data certification in accordance with the *MQAP Manual.* Ensure the lime represents each lot of lime delivered to the project.

3. Fly ash. Furnish fly ash in accordance with *ASTM C618* *for Class F*. Bulk fly ash may be transported dry in bulk trucks and stored in tanks or may be transported in dampened condition (15 percent moisture, maximum). Only furnish Class F fly ash from the list of Approved Manufacturers in the *Materials Source Guide*.

4. Water. Ensure water for mixing and curing is in accordance with section 911 of the Standard Specifications for Construction.

5. Soil. Soil used in this special provision is the existing in-place subgrade soil material. Ensure the soil is uniform in quality and gradation, is free of roots, sod, weeds, foreign debris and stones larger than 2½ inches and approved by the Engineer.

6. Asphalt Emulsion. Furnish Type SS-1h or CSS-1h asphalt emulsion in accordance with section 904 of the Standard Specifications for Construction.

**c. Mix Design.** Develop and submit for approval a mix design or designs specifying percent of cement, lime, lime-cement, or lime-fly ash combination for the soil to be stabilized. Develop and submit a sampling plan to the Engineer for review and approval prior to sampling the soil. Take at least one sample for every 20,000 square yards of subgrade area treated, or at least one for every major type of soil, or a minimum of 5 samples for each project, whichever is greater.

At each sample location, collect a minimum of 200 pounds of subgrade soil representative of the actual anticipated depth of treatment. Submit samples to an *AASHTO* or *ASTM* accredited geotechnical testing laboratory to determine the recommended percentage of stabilizer for each soil type taken. Ensure the accreditation includes all applicable *AASHTO* and *ASTM* test procedures referenced in this special provision.

Ensure the *AASHTO* or *ASTM* accredited geotechnical testing laboratory performs the tests and services for the untreated soil listed in Table 1. Ensure the lab performs the tests on the chemically treated soil in Table 2 for lime or lime-fly ash treatment. For treatment using cement or lime-cement, ensure the lab performs the tests in Table 3. Prepare samples with the same stabilizing material(s) from the same material suppliers that will be used for the project. Select and determine the treatment type and rate to produce a mix design meeting the specified requirements.

**Table 1: Required Geotechnical Laboratory Tests for Untreated Soils**

|  |  |  |
| --- | --- | --- |
| Soil Property | Test Methods | Specification Limits |
| Grain Size Analysis | *AASHTO T88* | None |
| Soil Classification | *ASTM D2487* | None |
| Moisture Content | MTM 407 | None |
| Atterberg Limits | *AASHTO T89 & T90* | None |
| pH | *ASTM G51* | None |
| Sulfate | *AASHTO T290* | ●Sulfate content should be <3,000 ppm.  ●If sulfate content is >3,000 ppm, do not treat with cement  ●If sulfate content is >3,000 but <7,000 ppm, mellow the soil for at least 7 days for lime stabilization after adding lime to reduce the sulfate content to <3,000 ppm.  ●If sulfate content >7,000 ppm, do not treat with lime notify the Engineer immediately. |
| Unconfined Compressive Strength (UCS) | *MTM 405* | None |

**Table 2: Required Steps, Test Methods, and Requirements to Document Mix Design for Lime and Lime-Fly Ash Stabilization**

| Step/Property | Test Method | Specification Limits |
| --- | --- | --- |
| 1.pH | *ASTM D6276* | Ensure lime content meets or exceeds that required to achieve a pH of at least 12.4. |
| 2.Optimum moisture content and maximum dry density | *ASTM D3551* & *MTM 404* | Use the lime percentage determined from *ASTM D6276* for this determination.  Mellowing time, if anticipated, is to be included when determining the optimum moisture and maximum dry density. |
| 3.Expansion Index | *ASTM D4829* | Required only if sulfates on the untreated soil are >3,000 ppm and <7,000 ppm. Maximum Expansion Index (EI)<50. |
| 4.Unconfined Compressive Strength | *AASHTO T220* | At least 50 psi greater than untreated soil and a minimum of 125 psi\* |
| \*Minimum 150 psi UCS for dual treatments with lime-fly ash. | | |

**Table 3: Required Steps, Test Methods, and Requirements to Document Mix Design for Cement and Lime-Cement Stabilization**

| Step/Property | Test Method | Specification Limits |
| --- | --- | --- |
| 1.Determine cement type and estimated dosage | Not applicable | Use a minimum three dosage rates between 0% to 7% (i.e. 0%, 3%, 5%, and 7%) of the oven-dry weight of untreated soil. |
| 2.Atterberg Limits | *AASHTO T89* & *T90* | Determine Atterberg limits on treated soil with each cement content. Complete testing within 2 hours of mixing cement. |
| 3.Optimum Moisture Content and Maximum Dry Density | *ASTM D558* | Determine the optimum moisture content and maximum dry density of treated soils with each cement content. |
| 4.Unconfined Compressive Strength | *ASTM D1633* Method B | At least 50 psi greater than untreated soil and a minimum of 150 psi. |

Submit copies of test reports from the geotechnical lab with all data to the Engineer for review and approval at least 10 calendar days prior to starting the work.

Once the Engineer approves the stabilizer percentages, ensure the Contractor’s qualified representative or geotechnical engineer furnishes moisture density curves for the treated soil mix in accordance with *AASHTO T99* for each soil type. Allow treated soils to mellow in accordance with the mix design requirements when making the curves. Submit the moisture density results to the Engineer at least 10 calendar days before the work begins. The Engineer will use these curves and the *Density Testing and Inspection Manual* for compaction acceptance.

**d. Equipment.** Furnish approved equipment to conduct the work and maintain the equipment in satisfactory condition at all times. Other compaction equipment may be used in lieu of that specified where it can be demonstrated that the results are equivalent. Furnish personal protective equipment, apparel, and barriers to protect eyes, respiratory system, and skin of all workers who may be exposed to cement, lime or fly ash.

1. Mechanical Spreader. Spreaders or distributors are non-pressurized mechanical vane-feed cyclone or screw-type machines capable of providing a consistent, accurate and uniform distribution for applying stabilizing agents and additives. Ensure the spreader or distributor has a visible meter that displays the application rate and minimizes dust during construction.

2. Rotary Pulvimixer. Ensure the equipment for pulverizing and mixing the existing subgrade materials is a self-propelled machine capable of pulverizing in-place the existing subgrade at a minimum width of 7.5 feet at the specified minimum depth. Ensure the cutting drum can operate at various speeds (RPM), independent of the machine’s forward speed with an adjustable mechanism to control gradation. Ensure the machine can push a tanker via an interlocking push bar and directly injecting additional water into the mixing drum. Ensure the machine can regulate and monitor the liquid application rate relative to depth of cut, width of injection, advance speed, and material density. Ensure the cutting drum can completely mix the material to a homogeneous consistency to the depth shown on the plans. Drums equipped with random tine pattern will be allowed only if approved by the Engineer.

3. Calibrated Scales. Furnish calibrated scales that can measure the weight of stabilizing agent used each day.

4. Sheepsfoot or Vibratory Padfoot Roller. Furnish self-propelled rollers with a minimum weight of 15 tons or greater as needed for compaction.

5. Steel-Wheeled Smooth Roller. Furnish self-propelled steel-wheeled rollers with a total weight of at least 10 tons and a minimum weight of 300 pounds per inch width of rear wheel. Ensure the wheels of the rollers are equipped with adjustable scrapers. The use of vibratory rollers is optional.

6. Pneumatic-Tired Roller. Ensure pneumatic-tired rollers are self-propelled and weigh when ballasted at least 8 tons but not more than 30 tons. Ensure the roller is equipped with a minimum of seven wheels situated on axles in such a way that the rear group of tires will not follow in the same tracks of the forward group of tires.

7. Motor Grader. Use a self-propelled motor grader capable of shaping the material to the line, grade, and cross section shown on the plans.

8. Watering Equipment. Ensure watering equipment consists of tank trucks, pressure distributors, or other Engineer approved equipment designed to apply controlled quantities of water uniformly over the stabilized area.

9. Tamper. Ensure tampers are an Engineer approved mechanical type, operated by either pneumatic pressure or internal combustion, and have sufficient weight and striking power to produce the compaction required.

**e. Construction.**

1. General. Perform subgrade stabilization work when the air temperature is 40 °F or above and rising. If the forecasted low temperature for the next 5 days is expected to fall below 40 °F, do not start subgrade stabilization work. Do not apply cement, lime, lime-cement or lime-fly ash combination to frozen or frosted subgrade under any circumstances. Do not apply subgrade stabilization materials during heavy rainfall (more than 0.25 inch/hour). Uniformly mix the designed percentage of the stabilizing material through the entire stabilized depth and compact the subgrade to at least 95 percent of the maximum unit weight. Ensure adequate drainage is provided during the entire construction period to prevent water from collecting or standing on the area to be stabilized or on pulverized, mixed or partially mixed material. Do not apply cement, lime, lime-cement or lime-fly ash combination to standing or pooling water. Ensure finished stabilized subgrade is in accordance with the line and grade as shown on the plans. Ensure adequate SESC measures are in place and maintained.

2. Chemical Stabilization Omission/Modification Locations. If during construction the Engineer determines that certain locations are inappropriate for chemical stabilization, the treatment may be omitted, replaced with an alternate method, or the Engineer may request a modified stabilization procedure.

3. Test Strip. At the start of the work, a 300-foot test strip comprised of either one or more lane widths (depending upon construction staging) will be selected and approved by the Engineer to initiate the subgrade stabilization. Submit a work plan for the test strip at least 10 working days in advance of construction of the test strip. Ensure the work plan includes details of subgrade preparation, chemical application, initial mixing, final mixing, compaction, curing/protection processes, and testing. Ensure the work for this test strip is in accordance with this special provision. After approval of the test strip by the Engineer production stabilization of the subgrade may proceed. At the Engineer’s discretion, the test strip may be accepted as part of the total required chemically stabilized area. If not part of the plan area for stabilization, ensure the test strip location matches the soil type of the plan area to be stabilized. When a material source is changed or different soil conditions are encountered, the Engineer may require a new test strip.

4. Subgrade Preparation. Prior to adding stabilizing materials, remove all deleterious materials such as topsoil, roots, organic material, foreign debris and rock fragments larger than 2½ inches. Grade the subgrade treatment area to meet the line and grade shown on the plans prior to being processed for stabilization. Dispose of deleterious material removed as part of subgrade preparation in accordance with subsection 205.03.P of the Standard Specifications for Construction.

5. Chemical Application. Spread the designed quantity of chemical on a dry weight basis uniformly on a scarified subgrade using a spreader or distributor. Place a canvas shroud on the distribution bar and extend the shroud down to the subgrade. Do not apply the chemical when the wind conditions are such that blowing material would become objectionable to the adjacent property owners or create potential hazards to traffic. To enhance dust control, use moisture conditioned fly ash. Lime and fly ash can be spread as individual components. While spreading the stabilizer, minimize dusting and impact to the traffic by periodic water sprinkling at no cost to the contract.

Conduct verification testing to show that the chemical is being applied at the required application rate. Furnish the results to the Engineer at the completion of the testing. Ensure the verification testing consists of the following:

A. Incorporate a receptacle made of metal, plastic, canvas or similar material of known area, volume, and weight. Ensure the spreader passes over the receptacle and spreads the chemical at the anticipated rate. Weigh the receptacle in the field and determine the actual application rate.

B. Yield calculation is based on the weight and surface area treated.

Only spread lime or lime-fly ash on an area where initial mixing can be completed within 4 hours. Due to its faster reaction rate, only spread cement on an area where initial and final mixing, and compaction, can be completed within 4 hours after application.

6. Initial Mixing.

A. Lime or Lime-Fly Ash Combination. Immediately after the lime or lime-fly ash combination has been spread, thoroughly mix into the subgrade by using an approved rotary pulvimixer to a depth sufficient to obtain a final compacted layer thickness as shown on the plans. Add sufficient water to raise the moisture content of the soil mixture to three to five percent above the optimum moisture content. Continue mixing until the lime or lime-fly ash combination has been uniformly incorporated into the subgrade to the required depth with the mixture being homogeneous and friable. Complete this initial mixing within 4 hours of spreading the lime or lime-fly ash. Mellow the mixture for a minimum of 24 hours, or as reported in the mix design.

(1) Use of Moisture Conditioned Fly Ash. The use of moisture conditioned fly ash (Class F only) for the lime-fly ash combination of soil stabilization is acceptable. Ensure moisture conditioned fly ash does not contain more than 15 percent moisture by dry weight of fly ash. When moisture conditioned fly ash is used, ensure the lime and fly ash is spread in two separate applications and the following procedures apply:

(a) Add the lime to the subgrade and mix in accordance with subsection e.6, Initial Mixing of this special provision. Once the lime is thoroughly mixed, compact the subgrade with a steel wheeled roller to achieve the surface strength and smoothness required to spread the moisture conditioned fly ash.

(b) Mellow the mixture for a minimum of 24 hours, or as reported in the mix design. Uniformly spread the moisture conditioned fly ash onto the lime treated soil to provide the equivalent dry weight basis content of fly ash as determined by the designed mix. Ensure the soil is thoroughly remixed to blend the moisture conditioned fly ash homogeneously with the lime treated soil.

B. Cement. Immediately after the chemical has been spread, mix into the subgrade soil using a rotary pulvimixer to a depth sufficient to obtain a final compacted layer thickness shown on the plans. Do not add water during the initial mixing unless the initial and final mixing will be combined into one operation in accordance with subsection e.7.B, Final Mixing of this special provision. Continue mixing until the chemical has been uniformly incorporated into the subgrade to the required depth with the mixture being homogenous and friable.

C. Lime-Cement Combination.

(1) Add the lime to the subgrade and mix in accordance with subsection e.6, Initial Mixing of this special provision. Once the lime is thoroughly mixed, compact the subgrade with a steel wheeled roller to achieve the surface strength and smoothness required to spread cement.

(2) Mellow the mixture for a minimum of 24 hours, or as reported in the mix design. Uniformly spread cement onto the lime treated soil to provide the equivalent dry weight basis content of cement as determined by the designed mix. Ensure the soil is thoroughly remixed to blend cement homogeneously with the lime treated soil. Once cement is placed as described, ensure the stabilization process continues in accordance with subsection e.6, Initial Mixing of this special provision.

The Engineer may run field gradation testing to determine the adequacy of mixing. To determine the adequacy of the mixing, two control sieves, 1 inch and No. 4, will be used. Ensure all soil clods pass through the 1-inch sieve and at least 60 percent pass through the No. 4 sieve, exclusive of rock particles. Ensure mixing continues until the required gradation is achieved.

7. Final Mixing.

A. Lime or Lime-Fly Ash Combination. After the required mellowing period from the mix design, remix the soil, adding water as needed to raise the moisture content two to three percent above optimum. Continue mixing until the lime or lime-fly ash combination has been uniformly incorporated into the subgrade to the required depth and with soil clods broken down to pass a 1-inch sieve and at least 60 percent passing the No. 4 sieve, exclusive of rock particles. Ensure there are no unhydrated lime particles present before compaction operations start. The Engineer will confirm that any visible particles are not unhydrated lime before compaction begins. The Engineer may run field gradation testing to determine the adequacy of mixing.

B. Cement and Lime-Cement Combination. Within 2 hours of initial mixing, remix the soil and introduce water through the mixer to bring the mixed material to at least optimum but no more than 3 percent above optimum moisture. Uniformly distribute the water in sufficient quantity to hydrate the cement. For cement only: Initial and final mixing can be combined into one step so long as the test strip demonstrated the requirements for mixing can be achieved in one step as approved by the Engineer.

It is the Contractor’s responsibility to determine the in situ moisture content of the soil or soil chemical mixture using the Speedy Moisture Tester, oven dry method, or other approved methods to determine the quantity of water required to raise the moisture content to the required level. A nuclear density gauge may be used to determine the in situ moisture content of the soils prior to treating with the chemical.

8. Compaction.

A. Lime or Lime-Fly Ash Combination. Begin compaction immediately after final mixing and approval by the Engineer. Add water or aerate the subgrade to bring the soil chemical mixture to optimum moisture content, plus or minus two percent. Continue compaction until the stabilized subgrade has a density of at least 95 percent of the maximum unit weight established for the soil chemical mixture. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one half width of the roller, or as determined by the Engineer based upon construction staging. At all times, ensure the speed of the roller does not cause displacement of the mixture to occur. Ensure areas inaccessible to the rollers are compacted with mechanical tampers or other appropriate equipment, and shaped and finished by hand methods as needed.

Perform final compaction with steel wheeled smooth drum rollers. Shape, fine grade and compact within the subgrade tolerances in accordance with the standard specifications. The Engineer will perform the density, moisture, and Dynamic Cone Penetrometer (DCP) testing for the compacted subgrade for acceptance in accordance with this special provision and the standard specifications.

For failing density tests within 72 hours after compaction, rework and recompact to achieve the required density. For failing density tests more than 72 hours after compaction, refer to subsection e.11, Restabilization of this special provision.

B. Cement or Lime-Cement Combination. Begin compaction immediately after final mixing and approval by the Engineer. Compact the cement treated mixture in one lift and complete compaction within 2 hours after final mixing. Add water or aerate the subgrade to bring the soil chemical mixture to optimum moisture content, plus or minus two percent. Continue final compaction until the stabilized subgrade has a density of at least 95 percent of the maximum unit weight established for the soil chemical mixture. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one half width of the roller, or as determined by the Engineer based upon construction staging. At all times, ensure the speed of the roller does not cause displacement of the mixture to occur. Ensure areas inaccessible to the rollers are compacted with mechanical tampers or other appropriate equipment, and shaped and finished by hand methods as needed.

Perform final compaction with steel wheeled smooth drum rollers. Shape, fine grade and compact within the subgrade tolerances in accordance with the standard specifications. The Engineer will perform the density, moisture, and DCP testing for the compacted subgrade for acceptance in accordance with subsection g, Field Quality Assurance of this special provision.

9. Finishing. Immediately after compaction, shape, and fine grade the surface of the treated material in accordance with the typical cross sections shown on the plans. Remove loosened material and dispose of it at an approved location. Roll the finished surface immediately, adding water by sprinkling as needed during rolling. Use smooth drum steel wheeled rollers during finishing.

10. Curing and Protection. Immediately after the stabilized subgrade has been compacted and finished, protect the surface against rapid drying for 5 days by periodic sprinkling with water (when about 1/3 of the surface area no longer appears moist) or by placing a curing coat of asphalt emulsion. If a curing coat is used, apply asphalt emulsion at a rate of 1 gallon per 30 square feet. Other suitable methods of curing the compacted stabilized soil mix may be utilized as approved by the Engineer.

Completed portions of stabilized subgrade may be opened immediately to light construction traffic at the Contractor’s risk and option, given that the curing is not impaired. After the curing period has elapsed, completed areas may be opened to construction traffic to commence placement of subsequent pavement layers. Placement of subsequent pavement layers may begin the day following the completion of stabilization only if the completed stabilized area has strengthened sufficiently. The strength of completed stabilized areas can be evaluated using proof rolling or DCP testing. Proof rolling can be performed using a loaded tandem axle truck (with at least 24 tons of gross vehicle weight) traveling at walking speed. After one pass of the proof rolling truck, the observations of the subgrade should not show any pumping, cracking, or more than 0.5 inch of deflection or deformation. Ensure DCP test results meet the requirements of Table 6. Protect finished portions of stabilized subgrade sections from marring and damage of the completed work. Correct and restabilize all damaged areas as determined by the Engineer at no additional cost to the contract.

Do not allow the treated subgrade to freeze during the curing period prior to placing subsequent layers. If the treated subgrade is not covered with base or pavement and is subjected to freezing, add additional stabilizer and recompact the treated subgrade before placing any subsequent layers. The Engineer, with the consultation of the Contractor’s mix design consultant, will determine the additional quantity of stabilizer to add, if any, and the extent of recompaction.

11. Restabilization. If an approved stabilized area shows failure, tenderness, or damage after curing, or areas with failed density testing, the Engineer will require restabilization to be performed, where appropriate, at no additional cost to the contract. The Engineer, with the consultation of the Contractor’s mix design consultant, will determine the additional quantity of stabilizer to add and the extent of restabilization.

A. Lime or Lime-Fly Ash: When an area is restabilized more than 72 hours after compaction, add 25 percent of the mix design lime or lime-fly ash rate when restabilizing, unless otherwise approved.

B. Cement or Lime-Cement: When an area fails to meet density requirements, and 2 hours have passed after final mixing, remove and replace the material and/or restabilize the section by adding the mix design cement content, remixing, and recompacting, to provide the required density, as directed or approved by the Engineer.

**f. Field Quality Control.** Ensure the results of field QC testing confirm that the materials and procedures comply with this special provision and the standard specifications. Perform field QC testing during the treatment process in accordance with Table 4 at locations independent from the Engineer’s testing locations, unless otherwise directed. Test results from field QC will not be used for acceptance. Additional testing may be performed if deemed necessary for field QC. Report test results and all pertinent information to the Engineer. When test results do not meet specification requirements, modify operations and perform the test methods required in Table 4. Suspend operations when any of the test results performed after the modifications do not meet specification requirements. Perform all field QC tests in the presence of the Engineer or the Engineer’s designated representative.

**Table 4: Field Quality Control Tests**

|  |  |
| --- | --- |
| Test Type | Testing requirement |
| Chemical application rate | 1 test per 4,000 square yards or at least once per day |
| Field moisture content | 1 test per 4,000 square yards or at least once per day |
| Stabilized layer thickness | 3 tests per 4,000 square yards or at least once per day |

Ensure completed thickness of the chemically stabilized subgrade soil layer is not less than 1/2 inch of the specified thickness.

Where the measured thickness of the stabilized subgrade layer is thicker than required, the stabilized layer will be considered in accordance with the specified thickness, provided the elevation of finished subgrade is within the tolerance specified in the standard specifications.

Stabilized layer thickness will be measured in three inch diameter or larger test holes penetrating the stabilized subgrade. Apply a phenolphthalein solution to the cut surface as an aid to determine the presence of stabilizing agent.

**g. Field Quality Assurance.** The Engineer will perform chemical application rate, field moisture content, field density, stabilized layer thickness, and DCP tests in accordance with Table 5 to confirm that the required depth of subgrade is uniformly stabilized and compacted.

**Table 5: Field Quality Assurance Tests**

|  |  |
| --- | --- |
| Test Type | Testing requirement |
| Chemical application rate | 1 test per day |
| Field moisture content | 1 test per 4,000 square yards or at least once per day |
| Stabilized layer thickness | 3 tests per 4,000 square yards or at least once per day |
| Field Density | 1 per 4,000 square yards or at least once per day |
| DCP | 1 per 4,000 square yards or at least once per day |

1.Stabilized Layer Thickness and DCP Test. The Engineer or Engineer’s designated representative will use a DCP or three inch diameter or larger test holes to confirm that the minimum thickness shown on the plans has been uniformly stabilized and compacted. The Engineer will evaluate the stabilized thickness and field stabilized subgrade strength in accordance with *ASTM D6951/D6951M*. A maximum average DCP rate of 14 mm/blow in the stabilized zone is required for acceptance. Table 6 provides the minimum number of DCP blows in the stabilized zone for acceptance based on the thickness of the stabilized layer.

**Table 6: Minimum Number of DCP Blows for Different Stabilized Layer Thicknesses**

|  |  |
| --- | --- |
| Stabilized Layer Thickness (inches) | Minimum Number of DCP Blows in the Stabilized Zone (after 1 seating drop) |
| 8 | 15 |
| 12 | 22 |
| 18 | 33 |

The DCP test should start on the top of the stabilized subgrade and use 1 seating drop to properly seat the DCP tip before recording cumulative penetration values.

Correct areas where the average DCP rate is more than 14 mm/blow by scarifying, adding additional chemical, remixing and re-compacting as directed by the Engineer. Complete all corrections at no additional cost to the contract.

When the measured thickness of the stabilized subgrade soil is more than 1/2 inch deficient follow the following steps:

A. For lime or lime-fly ash stabilized subgrade correct deficient areas by scarifying, adding additional chemical, remixing and recompacting as directed by the Engineer.

B. For cement or lime-cement stabilized subgrade correct deficient areas by scarifying, adding the mix-design chemical amount, remixing and compacting as directed by the Engineer.

2. Field Density Testing. The Engineer will perform density testing at a rate of 1 test for every 4,000 square yards or at least 1 test per day. The nuclear density gauge will be used to measure the wet density but will not be used to measure the moisture content. The Engineer will use the Speedy Moisture Tester or other approved method to measure the moisture content to calculate the dry density. The Engineer will use a multipoint density curve from the mix design to obtain the maximum dry density and optimum moisture content. One-point density curves are not allowed to obtain the maximum dry density.

**h. Measurement and Payment.** The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

**Pay Item** **Pay Unit**

Chemically Stabilized Subgrade Square Yard

Lime Ton

Fly ash Ton

Cement, Spec Ton

1. **Chemically Stabilized Subgrade** as completed to the thickness and cross sections shown on the plans, will be measured in square yards of horizontal surface area based on in place quantity. Ensure all calculations of areas measured for payment are based on measurements made to the nearest 0.1 yard with area calculated to the nearest square yard. The length will be measured along the surface of the completed roadbed parallel to the centerline. The width will be the top surface width of the completed roadbed specified on the plans, measured perpendicular to the centerline of the roadbed at 100-foot intervals. Additional areas required by the contract will be measured by length and width along the surface area stabilized.

**Chemically Stabilized Subgrade** includes sampling, mix designs of cement, lime, lime-cement or lime-fly ash combination soil mixture(s), test strip(s), preparing subgrade, scarifying, pulverizing, mixing, shaping, water, curing, asphalt emulsion, compaction, maintaining, and application of cement, lime and fly ash, testing, including all labor, equipment and materials necessary to complete the work as described.

2. **Cement, Spec; Lime;** and **Fly Ash** incorporated into the work will be measured in tons. Payment includes furnishing, transporting, storing, handling, and spreading, including all labor, equipment and materials necessary to complete the work as described. Furnish certified delivery tickets to the Engineer for cement, lime and fly ash incorporated into the stabilized subgrade for payment. Ensure the tickets contain project number, material type, date, time, truck identifier number, tare weight, gross weight, net weight, supplier name and source location.