

SECTION 31 32 13.16 - CEMENT STABILIZATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Section pertains to the specifications for cement stabilization of sandy or silty soil and consists of pulverizing, addition of Portland cement, mixing, wetting and compacting the mixed material to the required density. This Section applies to natural ground, embankment, or pavement subgrade and shall be constructed as specified herein and in conformity with the typical sections, details, lines and grades as shown on the plans.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Drawings and general provisions of the Contract, including Procurement and Contracting Requirements, Division 00 and Division 01 apply to this section.
- B. Section 31 11 00 – Clearing and Grubbing
- C. Section 31 22 13 - Site Grading
- D. Section 32 01 16.72 – Asphalt Pavement Recycling
- E. Section 32 12 16 – Asphalt Concrete Paving
- F. Section 32 13 13 – Concrete Paving

1.3 PERMITS (NOT USED)

1.4 APPLICABLE PUBLICATIONS

The following publications of the latest issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto:

- A. Texas Department Transportation 2004 Standard Specifications for Construction of Highways, Streets and Bridges (TxDOT):
 - 1. Item 520-Weighing and Measuring Equipment
- B. American Society for Testing and Materials Standards (ASTM):
 - 1. C 150-07 Standard Specification for Portland Cement
 - 2. D 698-07e1 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)
 - 3. D 1557-07 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³)
- C. Texas Department of Transportation (TxDOT) Test Procedures:

1. Test Method Tex-114-E - Laboratory Compaction Characteristics and Moisture-Density Relationship of Subgrade, Embankment Soils, and Backfill Material

1.5 DEFINITIONS

- A. Subgrade: The uppermost surface of an excavation, including excavation for trenches, or the top surface of a fill or backfill immediately below base course, pavement, or topsoil materials.
- B. Backfill: Soil material or controlled low-strength material used to fill an excavation.
- C. Base Course: The layer placed between the subgrade and surface pavement in a paving system.
- D. Geotechnical Engineer: Person or company contracted by the owner and/or through the architect to provide testing and onsite Geotechnical services during the construction schedule.

1.6 QUALITY ASSURANCE

- A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.
- B. Testing and Inspection Service: **Owner** will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soil materials to verify that soils comply with specified requirements and to perform required field and laboratory testing. Contractor responsible to coordinate with the testing agency prior to start of work requiring testing so as to minimize unnecessary cost or delays to the project.
- C. Testing:
 1. Owner will retain and pay a qualified Geotechnical engineer to take all field samples and do all laboratory testing necessary to verify compliance of the work to these Specifications or as required by City or other regulatory agencies. The Geotechnical Engineer shall submit results of all testing done during the course of the work to the Owner, Architect, and Contractor.
 2. Notify testing lab a minimum of **48 hours** in advance of the time testing is required to satisfy requirements of this section.
 3. Should testing specified above show work which does not satisfy these Specifications, the Contractor shall pay, through the Owner, for all additional tests required to determine the extent of work that is not satisfactory and for all additional tests necessary to demonstrate compliance with these specifications.
 4. All tests shall be performed by the Soil Engineer in accordance with ASTM C150, D 698, D1557, Tex-114-E or other test method selected by Geotechnical Engineer.
- D. Certification: ***[NOTE HERE ANY ITEMS THAT ARE NEEDED UPON COMPLETION OF WORK, IF NEEDED]**

1.7 PROJECT/SITE CONDITIONS

- A. Cement treatment shall not be mixed or placed when the air temperature is below 40 degrees F and is falling, but may be mixed or placed when the air temperature is above 35 degrees F and is rising, the temperature being taken in the shade and away from artificial heat and with the further provision that cement treatment shall be mixed or placed only when weather conditions are suitable.
- B. Completed sections of cement treated material in place may be opened immediately to local traffic and to construction equipment and to all traffic after the curing period, provided the cement treated course has hardened sufficiently to prevent marring or distorting the surface by equipment or traffic.
- C. The Contractor shall be required, within the limits of his contract, to maintain the cement treated course in good condition until all work has been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done by the Contractor at his own expense and repeated as often as may be necessary to keep the area continuously intact. Faulty work shall be replaced for the full depth of treatment. It is the intent of this specification that the Contractor constructs the plan depth of cement treatment in one homogeneous mass. The addition of thin stabilized layers will not be permitted in order to provide the minimum specified depth.
- D. Design Strength

Cement mixture shall produce at least 750 psi unconfined compressive strength at 7 days. Percent of cement to be used shall be coordinated with Geotechnical Report but in no way shall the percent of cement added be less than 5%

1.8 SUBMITTALS

- A. None required for this section. *[REVISE AS NEEDED]

PART 2 - PRODUCTS

2.1 SOIL

- A. Soil shall consist of approved sand or silt material free from vegetation or other objectionable matter encountered in the existing subgrade and other acceptable material used in preparation of the subgrade in accordance with this specification.

2.2 PORTLAND CEMENT

- A. Cement shall be Type 1 of a standard brand of Portland cement and shall conform to the requirements of ASTM Designation: C 150-07.
- B. One sack, containing 1 cubic foot of cement, shall be considered as weighing 94 pounds net. One barrel of cement shall be considered as weighing 376 pounds net and containing 4 cubic feet.
- C. It is the Contractors option to use bulk cement, provided the apparatus for handling, weighing and spreading the cement is approved in writing. Cement weighing equipment shall be as specified below in 3.1.A.

2.3 WATER

- A. Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter or other substances injurious to the finished product.
- B. Water sources other than the local municipal domestic water supply must be approved by the Owner.
- C. If onsite reclaimed water sources are used, tanks and apprenices must be clearly marked with the words "non-potable" water.

PART 3 - EXECUTION

3.1 EQUIPMENT

- A. Equipment utilized where materials are specified to be measured or proportioned by weight shall conform to the requirements of the TxDOT specifications, Item 520, "Weighing and Measuring Equipment." Equipment necessary for the proper construction of the work shall be on the project, in first-class working condition, both as to type and condition, prior to the start of construction operations. The Contractor shall at all times provide sufficient equipment to enable continuous prosecution of the work and completion in the required number of working days.
- B. Portland cement treatment for materials in place may be constructed with any machine or combination of machines and auxiliary equipment that will produce results as outlined in this specification.
- C. Mixing may be accomplished by a multiple-pass traveling mixing plant or a single-pass traveling mixing plant.
- D. The equipment provided by the Contractor shall be operated by experienced and capable employees and shall be that equipment necessary to provide a cement treatment meeting the requirements herein specified.

3.2 CONSTRUCTION METHOD

- A. It is the primary requirement of this specification to secure a completed course of treatment containing a uniform Portland cement mixture 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 work, to process a sufficient quantity of material to provide full depth as shown on plans, to use the proper amount of Portland Cement to maintain the work and rework the courses as necessary to meet the above requirements.

3.3 PREPARATION OF SUBGRADE

- A. Before other construction operations are begun, the subgrade shall be graded and shaped as required to construct the Portland cement treatment for material in place in conformance with the lines, grades, thickness and typical cross section shown on the plans. Unsuitable soil or material shall be removed and replaced with acceptable soil.

- B. The subgrade shall be firm and able to support without displacement the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

3.4 PULVERIZATION

- A. The soil shall be pulverized such that at the completion of moist-mixing, 100 percent by dry weight passes a 1-inch sieve, and a minimum of 80 percent passes a No. 4 sieve, exclusive of gravel or stone retained on these sieves.

3.5 APPLICATION OF CEMENT

- A. Portland cement shall be spread uniformly on the soil in such quantity that all soil to be treated receives the minimum percentage of cement. If a bulk cement spreader is used, it shall be positioned by string lines or other approved method during spreading to insure a uniform distribution of cement.
- B. Cement shall be applied to an area such that the operation can be continuous and completed in daylight within 6 hours of such application.
- C. The percentage of moisture in the soil, at the time of cement application, shall not exceed the quantity that will permit uniform and intimate mixture of soil and cement during dry mixing operations. It shall not exceed the specified optimum moisture content for the soil cement mixture.
- D. No equipment, except that used in spreading the mixture, will be allowed to pass over the freshly spread cement until it is mixed with the soil.

3.6 MIXING AND PROCESSING

- A. Unless otherwise shown on the plans, either method (A) or (B) below may be used at the option of the Contractor.
 - 1. Multiple-Pass Traveling Mixing Plant
 - a. After the cement has been applied it shall be dry-mixed with the soil. Mixing shall continue until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied. Any mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than 30 minutes.
 - b. Immediately after the dry mixing of soil and cement is complete, water as necessary shall be uniformly applied and incorporated into the mixture. Pressurized equipment and supply provided shall be adequate to insure continuous application of the required amount of water to sections being processed within 3 hours of application of the cement. Proper care shall be exercised to insure proper moisture distribution at all times. After the last increment of water has been added, mixing shall continue until a thorough and uniform mix has been obtained.
 - 2. Single-Pass Traveling Mixing Plant

- a. After the cement has been applied it shall be sufficiently dry-mixed with the soil to prevent the formation of cement balls when water is applied. Un-pulverized soil lumps in the soil cement mixture immediately behind the mixer that are dry will not be allowed. Should this condition prevail, the Contractor shall "pre-wet" the raw soil as necessary to correct this condition.
- b. This mixer shall be provided with means for visibly and accurately gauging the water application. The water shall be applied uniformly through a pressure spray bar.
- c. After cement is spread, mixing operations shall proceed as follows:
 - i. The mixer shall in one continuous operation thoroughly moist-mix the soil, cement and water, spread the completed soil cement mixture evenly over the machine processed width of the subgrade and leave it in a loose condition ready for immediate compaction.
 - ii. The soil and cement mixture shall not remain undisturbed, after mixing and before compacting, for more than 30 minutes.

3.7 COMPACTION AND FINISHING

- A. The material shall be compacted to not less than 95 percent of the Standard Maximum Density (ASTM D698-07e1) and as shown on the plans. At the start of compaction, the percentage of moisture in the mixture and in un-pulverized soil lumps, based on oven-dry weights, shall not be below or more than two percentage points above the specified optimum moisture content and shall be less than that quantity which will cause the soil cement mixture to become unstable during compaction and finishing. When the uncompacted soil cement mixture is wetted by rain so that the average moisture content exceeds the tolerance given at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the Contractor.
- B. The specified optimum moisture content and density shall be determined in the field by Test Method Tex-114-E or other approved methods, on representative samples of soil cement mixture obtained from the area being processed.
- C. Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. The loose mixture then shall be uniformly compacted to the specified density within 2 hours after the application of cement.
- D. After the soil and cement mixture, is compacted, water shall be uniformly applied as needed and thoroughly mixed in with a spiketooth harrow or equal. The surface shall then be reshaped to the required lines, grades and cross section and then lightly scarified to loosen any imprint left by the compacting or shaping equipment.
- E. The resulting surface shall be thoroughly rolled with a pneumatic tire roller and "clipped", "skinned", or "tight bladed" by a power grader to a depth of approximately 1/4 inch, removing all loosened soil and cement from the section. The surface shall then be thoroughly compacted with the pneumatic roller, adding small increments of moisture as needed during rolling. If plus No. 4 aggregate is present in the mixture, one complete coverage of the section with the flat wheel roller shall be made immediately after the "clipping" operation. When directed by the Owner, surface finishing methods may be varied

from this procedure provided a dense, uniform surface, free of surface compaction planes, is produced. The moisture content of the surface material must be maintained within two (2) percent of its specified optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, a smooth, closely knit surface, free of cracks, ridges or loose material conforming to the crown, grade and line shown on the plans in a timeframe no longer than 2 hours from the initial application of cement.

- F. Finished Surface should not vary more than 3/8 inch when tested with a straight edge 10-16 feet long.
- G. Thickness of finished subgrade shall be at least the thickness shown on the plans within ¼ inch tolerance and can exceed the thickness shown on the plans as needed to meet the needs of the project

3.8 CURING

A. Protection and Cover

After the cement treated course has been finished as specified herein, the surface shall be protected against rapid drying by any of the following curing methods for a period no less than 3 days or until the surface or subsequent courses are placed:

- 1. Maintain in a thorough and continuously moist condition by sprinkling, or
- 2. Apply a 2-inch layer of earth on the completed course and maintain in a moist condition, or
- 3. Apply an asphalt membrane to the treated course, immediately after same is completed. The quantity and type of asphalt shall be sufficient to completely cover and seal the total surface of the base and fill all voids. If the Contractor elects to use this method, it shall be the Contractor's responsibility to protect the asphalt membrane from being picked up by traffic by either sanding or dusting the surface of same. The asphalt membrane may remain in place when the proposed surface or other base courses are placed.

B. Surface

- 1. The surface or other base courses may be applied on the finished base as soon after completion as operations will permit.

3.9 CONSTRUCTION JOINTS

- A. At the end of each day's construction a straight transverse construction joint shall be formed by cutting back into the total width of completed work to form a true vertical face free of loose and shattered material.
- B. Cement treatment for large, wide areas shall be built in a series of parallel lanes of convenient length and width as approved.

END OF SECTION