

Cement Stabilized Soil (CSS) **(Portland cement)**

1.0 DESCRIPTION.

This specification shall govern the process known as **Cement Stabilized Soil (CSS)**. CSS consists of mixing the existing base, subbase and subgrade materials and uniformly mixing with Portland cement and water. Mixture shall then be compacted, finished, and cured in such a manner that the CSS mixture forms a dense, uniform mass conforming to the lines, grades, and cross sections shown on the Plans.

2.0 GENERAL

2.1 Materials.

Materials – Materials to be stabilized with Portland cement shall consist of existing aggregate base, subbase and underlying native subgrade soils incorporated into the mix design.

Existing materials shall be pulverized so that 100 percent will pass a 2-inch (50-mm) sieve and a minimum of 85 percent will pass a 1-inch (25-mm) sieve.

Portland cement – All cement to be used or furnished shall conform to ASTM C150. The cement shall be protected from moisture until used and be sufficiently dry to flow freely when handled. Cement shall be furnished in bulk and not exposed until applied to prepared grade.

Water – Water shall be free from oils, acids, organic matter or other substances deleterious to the cement treatment of materials. The water shall not contain more than 1000 parts per million of chlorides nor more than 1000 parts per million of sulfates as SO₄. Water shall be clean and potable and shall be added as needed during mixing, compacting, and finishing operations and during the curing period, as required.

2.2 Cement Application Rate. The cement application rate is based on the laboratory mix design. The percentage of cement is determined according to the maximum dry weight of the untreated material determined in the laboratory by ASTM D1557.

For bidding purposes, the Contractor shall use a cement application rate of 5-percent (5%) at ___ pcf-soil weight. The application rate will be expressed in lbs. per sq. ft. of cement. The final application rate shall be determined by a mix design confirmation performed by the Contractor.

2.3 Contractors Qualification. The contractor performing the CSS cement stabilization shall document a minimum of five years' experience performing similar stabilization work. The contractor shall submit a list of equipment to be utilized in performance of the stabilization process. The contractor shall submit a detailed description of work procedures for approval by the Engineer prior to beginning CSS cement stabilization.

The contractor performing CSS cement stabilization shall have a representative on site with a minimum of 5 years' experience in cement stabilization. Their function should include coordinating with other contractors and site representatives. All personnel should be properly trained in the CSS treatment process, including quality control and safety procedures.

2.4 Protection of Existing Utilities. Where existing underground utilities or utility services lie within the CSS section, the contractor shall verify, by potholing or other means acceptable to and approved by the Engineer, that there is sufficient cover over the utilities to provide clearance for the CSS mixing process without damage to the existing utility facilities. This verification shall be carried out where each utility crosses the boundary of the CSS section, and at a minimum of one location in between. This paragraph shall not relieve the Contractor of conforming to all utility protection requirements contained elsewhere in these special provisions.

The Contractor shall be responsible for the protection of existing pipelines, manholes, catch basins, valve boxes and other utility structures that are to remain within the CSS work area. Any such utility facilities that are damaged from roadway excavation work performed by the Contractor shall be either repaired or replaced to the satisfaction of the Engineer at no cost to the City, in accordance with Section 15-1.02, "Preservation of Property." of the State Standard Specifications.

2.5 Equipment. CSS section shall be constructed utilizing a combination of equipment that will produce results that meet all the requirements herein. The Engineer prior to use shall approve such machines.

Cement Spreader: The cement spreader shall be equipped with such instrumentation and equipment to control spread rates over variable travel speeds. The operator shall demonstrate that the instrumentation and equipment is calibrated and capable of controlling the spread rates within specifications.

Mixer: The mixing equipment shall be capable of mixing the full-specified depth of cement treatment, leaving a relatively smooth plane at the bottom of the CSS section. Mixing equipment shall be equipped with a visible depth indicator showing the mixing depth, and odometer or foot-meter to indicate travel speed, and a controllable water additive system for regulating water added to the mixture.

Compactors: When compacting cement treated sections greater than eight (8) inches, a sheepsfoot type compactor capable of compacting the entire section to the project specification shall be used.

3.0 CONSTRUCTION

3.1 The contractor shall use the soil designated by the engineer and the cement type and moisture content determined by the Engineer, and confirmed by the mix design in accordance with standard laboratory tests and set forth in the plans and specifications.

The soil materials shall be graded to conform to the lines and grade shown on the Plans prior to application of the cement. Grading operations will require some movement of material along the grade and/or off-hauled to conform to the lines and elevations shown on the Plans and to allow for the subsequent construction activities to proceed.

3.2 Portland Cement Application. The Portland cement shall be applied in one operation to the required width, grade and cross section. Cement shall be evenly spread at the designated rate and shall not vary more than 5 percent on any area. Only a calibrated spreader able to provide a uniform distribution of the cement throughout the treatment area shall spread cement. The cement shall be added in a dry state and every precaution shall be taken to prevent fugitive dust outside the work zone.

The spreader truck shall demonstrate the ability to maintain a consistent spread rate over variable travel speeds. The contractor will demonstrate the consistency of the spread rate by conducting multiple pan tests. The pan test consists of placing a 3 square foot pan on the grade in front of the spreader truck. After cement spreader truck has passed over the pan, the cement captured in the pan is weighed to determine the rate of spread in pounds per square foot. Truck tags will be used to verify amount of cement delivered to project. No traffic other than the mixing equipment or other related construction equipment would be allowed to pass over the exposed cement until after completion of mixing.

Cement shall not be spread or mixed/hydrated while the atmospheric temperature is below 35° F. At the Engineers discretion, processing will be allowed if temperature is rising.

3.3 Mixing and Hydrating. The thickness of the CSS treatment shall be designated on the Plans or as determined by the Engineer. In areas where mixing equipment cannot access, such as around manholes or curbs, the Contractor can process the mixture, within allowable time constraints, by pulling the recycled material and applied cement away from obstacles and relayed to an area accessible to mixing equipment.

Cement treatment can be conducted in one lift provided the contractor can demonstrate that the spread rate, particle size, and compaction can be achieved. The mixer shall be capable of automatically adjusting itself to maintain a constant depth. On the initial mix, the water truck must have a solid connection to the mixer. The water shall be injected directly into the mixing chamber and shall produce a homogenous blend free from streaks or pockets of dry cement. Leakage of water from equipment will not be permitted. Care shall be exercised to avoid the addition of any excessive water into the mixture.

When mixed material, exclusive of one inch or larger clods, is sprayed with phenolphthalein alcohol indicator solution, areas showing no color reaction will be considered evidence of inadequate mixing.

Contractor is required to complete mixing and initial compaction of the CSS-cement section within 2 hours of initial hydration of cement.

3.4 Construction Joints. When horizontally joining two treated sections, contractor shall overlap the new treated section with previously treated section by 12-inches. When joining two treated sections on same day, care shall be taken to adjust water content along overlapping zone.

3.5 Compaction. Maintain moisture above the optimum moisture content, but within allowable moisture range as determined by the moisture/density relationship of the compaction curve. The CSS-cement section shall be compacted to 95 percent of the maximum dry density as determined by ASTM 1557.

The maximum compacted thickness of a single layer may be any thickness the contractor can demonstrate to the engineer that his equipment and method of operation will provide the required compacted density throughout the treated layer.

3.5.1 Initial Compaction – Contractor shall achieve the projects minimum compaction requirement during initial compaction operation. Lift thickness of 8 to 12 inches shall be compacted by means of a sheepfoot compactor. Lift thickness greater than 12 inches shall be compacted by a sheepfoot compactor with an open ring design to prevent bridging of the lower half of the CSS section. Areas inaccessible to rollers shall be compacted to the required compaction by other means satisfactory to the Engineer.

3.5.2 Surface Compaction. Surface compaction is defined as the upper 3 inches of the CSS section. Surface compaction shall be by means of steel-tired or pneumatic-tired roller.

3.6 Final Grading. Surface compaction and finish grading shall proceed in such a manner as to produce, in not more than 2 hours from initial compaction, a

smooth, closely knit surface conforming to the crown, grade and line indicated and will be free of cracks, ridges or loose material.

Maintain moisture content on surface within allowable moisture range during all grading procedures.

All excess material above the grade tolerance specified by the plans should be removed from the grade prior to final surface compaction of the CSS section. This excess material can be used in areas inaccessible to treatment equipment, provided the CSS mixture is used within the allotted time constraints.

Minor indentations may remain in the surface of the finished material as long as no loose material remains in the indentations.

3.7 Traffic Loading. Once the CSS section is finished, contractor may be allowed to place subsequent structural layers over the CSS section provided that the following criteria's are met:

- A. The CSS section is stable and non-yielding under a minimum 10 ton proof-roll.
- B. The CSS section has no evidence of cracking
- C. The CSS section criteria's have been met, including CSS thickness, percentage of cement applied, compaction, and square footage of the treated area confirmed.

3.8 Curing. After CSS section is completed, it shall be protected against drying and traffic for 3-days. The Engineer may reduce the 3-day cure period, based on factors such as degree of traffic, temperature, and stability.

Curing shall be moist (water fogging), bituminous seal, or other method approved by the Engineer. If moist curing is used, exposed surfaces of the CSS section shall be kept continuously moist with a fog spray for 3 days. If a bituminous curing is used, it shall consist of liquid asphalt or emulsified asphalt meeting the requirements of CT Section 203.

The bituminous curing seal shall be applied in sufficient quantity to provide a continuous membrane over the soil at a rate of between 0.10 and 0.20 gallons per square yard of surface with the exact rate determined by the Engineer. It shall be applied as soon as possible after the completion of final rolling. The surface shall be kept moist while the seal is applied. At the time the bituminous material is applied, the soil surface shall be dense, shall be free of all loose and extraneous material, and shall contain sufficient moisture to prevent excessive penetration of the bituminous material.

3.9 Repair. If the CSS-cement section is damaged, removing and replacing the entire depth of affected layers in the damaged area shall repair it. Feathering will not be permitted for repair of low areas.