SECTION 32 11 13

SOIL CEMENT FULL DEPTH RECLAMATION

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Engineer's Seal

Digital Signature

Timothy J. Kelly

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SECTION 32 11 13

SOIL CEMENT FULL DEPTH RECLAMATION

PART 1 - GENERAL

1.01 SCOPE

A. Supplying equipment and materials to remove and replace existing soil cement stabilization on a limited test section area.

1.02 APPLICABLE PUBLICATIONS (NOT USED)

1.03 DEFINITIONS (NOT USED)

1.04 SUBMITTALS

A. Soil Cement Removal plan of the existing soil cement located within the test section limits shown on the Drawings for review and approval by the Purchaser.

B. Soil Cement Mix Design, Mixing and Transportation Plan, and Spreading and Compaction Plan shall be submitted to Purchaser for review and approval.

1.05 QUALIFICATIONS (NOT USED)

1.06 RESPONSIBILITIES

The Supplier is responsible for the supply, storage, and handling of all equipment and materials set forth in this Specification. Remove the existing soil cement and asphaltic concrete stabilization within the limits shown on the Drawings. The soils within the limits of construction shall be protected throughout construction to prevent undermining of existing soil cement or soil that is to remain. Install uniformly mixed soil cement slope stabilization in two (2)- 9” lifts achieving a minimum 28-day unconfined compressive strength of 875 lb/in^2 (basis: specimen having length to diameter ratio of 2:1). If a 4”x 4.584” specimen is cast using ASTM D559, then the unconfined compressive strength shall be 675 lb/in^2 at 7 days and 1,000 lb/in^2 at 28 days.

1.07 CERTIFICATIONS AND TESTING

A. The compressive strength tests shall conform to ASTM D1633, "Standard Test Method for Compressive Strength of Molded Soil Cement Cylinders".

B. A set of four standard cylinders shall be molded and tested from the first placement of 50 cubic yards, or any fraction thereof, placed each day. Additional sets shall be molded and tested for each additional 50 cubic yards, or fraction thereof, placed in the same day.

C. Unconfined compressive strength tests shall be performed on one of the cylinders at 7 days and two of the cylinders at 28 days, holding the fourth cylinder in reserve to verify the test results or test at a greater age if necessary. The acceptance of the test results shall be based on the average of the two specimens tested at 28 days.

D. The soil shall be a fine silty sand (SM or SP-SM by the Unified Soil Classification System (USCS)) and shall be free of clay lumps, soft or flaky particles, organic matter, loam, or other extraneous substances. The soil shall have a good distribution of sizes and between 15 to 25% shall pass the #200 sieve. The fines shall be of low plasticity or non-plastic fines. Maximum aggregate size shall be 1-½". A certification of the gradation analysis shall be provided for the borrow source along with credentials that the borrow source is a State-approved aggregate borrow source per Chapter 14-103, FAC.

E. The Supplier shall ensure that the plant-produced soil cement mixture is a homogeneous and uniform mixture of soil and cement. The uniformity shall be checked visually as it comes out of the plant. It also can be checked by the Supplier at the placement area by digging trenches or a series of holes at regular intervals for the full depth and inspecting the color and texture of the exposed material. When the mixture is of uniform color and texture from top to bottom, the mixture is satisfactory. Soil and cementitious material shall be mixed sufficiently to prevent cementitious balls from forming when water is added.

Allowable tolerances for soil cement uniformity are shown in Table 1.

Table 1- Soil Cement Uniformity Test Tolerance

Test	Allowable maximum difference*	ASTM standard
Water content of mixture	15%	D 2216
Maximum density	2%	D 558 D1557
Compressive strength at 7 days	25%	C 39 D1633

F. Batching or feeding operations shall conform to the mixture proportions directed within the tolerances shown in Table 2.

Table 2- Tolerances for Batching or Feeding Operations

Material	Plant
Cementitious material	± 2.0%
Water	± 2.0%
Soil aggregate	± 3.0%

For batch-type plants, the variation is in percent by weight from batch weight of each material, based on the mixture proportions specified. For continuous feeding and mixing plants, the variation is in percent by weight from the mixture proportions of each material designed to be in a total timed sample obtained from a designated location in the plant.

Whenever it is found that either the weighing or the batching accuracy does not comply with specification requirements, the plant should be shut down until necessary adjustments or repairs have been made. Discrepancies in recording should be corrected immediately.

G. Batch-Mixing Plants: Accuracy of the batching equipment should be checked by the contractor for amount of cementitious materials and aggregate at the beginning of operations and at least once every 5 shifts in the presence of the engineer. Such checks also should be made whenever there are variations in properties of the fresh soil-cement, which could be the result of batching errors. Standard test weights accurate to 0.1% should be provided for checking plant scales.

H. Continuous-Mixing Plants: Accuracy of proportioning of the continuous-mixing plant should be checked by the contractor for the cementitious material, and for each aggregate at the beginning of construction and after every 5 shifts. The accuracy of proportioning should be checked by simultaneously securing timed samples of the cementitious materials and the aggregate as they are fed to the mixer, and weighing each as appropriate.

I. Monitoring Cementitious Content: The contractor should, at least once per day, take a sample of soil-cement and determine the cement content in accordance with ASTM D 5982 – Heat of Neutralization Method. At the end of each shift a mass balance check should be made on all cementitious materials. The amount of cementitious materials stored on-site and delivered that shift should be compared to the amount of cementitious materials used during the shift.

J. Stockpiled Aggregate: Samples from stockpiles for moisture-density tests and mix design should be obtained by the engineer by taking a minimum of four face cuts at different locations on a stockpile and blending the sampled material. A minimum of one moisture-density relation should be determined in accordance with ASTM D 558 for each 1,000 cu yd of stockpiled soil aggregate or one per stockpile, whichever is less. In addition, one sieve analysis should be performed in accordance with ASTM C 136 and ASTM C 117 and one Atterberg limit test in accordance with ASTM D 4318 for each of the four face cuts of stockpiled aggregate, and one for the blend of the four face cuts.

K. Batched Aggregate: At least once during each shift in which soil-cement is being placed, there should be one sieve analysis performed on soil aggregate from the batching plant in accordance with ASTM C 136 for aggregates. When two consecutive tests show the soil aggregate to be deficient in grading, the mixing operation should be stopped until acceptable material is furnished for delivery to the mixer. Each time a moisture-density relation is determined, an additional gradation analysis in conformance with ASTM C 136 should be performed, corresponding to the material used in the moisture-density relation. When the amount passing any sieve is outside the specification limits or tolerances, the aggregate should be immediately resampled and retested. If the second sample fails on the same sieve, immediate steps should be taken to correct the grading.

L. Moisture Content: The contractor should conduct at least two tests for moisture content in accordance with either ASTM C 70 or ASTM C 566 during each 8-hour period of mixing plant operation. The first test should be at the beginning of each shift and subsequent tests should be selected randomly within the 8-hour period. Additional tests should be made whenever there is excessive variation in workability of the soil-cement.

M. Placement Area: The contractor should inspect foundation or construction joints prior to each lift of soil-cement placement. The contractor should obtain approval from the engineer prior to placing soil-cement at the start of each shift and at previously placed joints. The contractor should not permit placement to begin until

there is adequate equipment, manned by competent operators, available for compacting the soil-cement. Placement should be temporarily discontinued if any lift is inadequately compacted until such time as that lift has been reworked, retested, and meets the density requirements. The contractor's quality control personnel should supervise all placement operations and should be responsible for measuring and recording soil-cement temperature, air temperature, weather conditions, time of placement, yardage placed, and method and location of placement. The engineer will provide quality assurance over placing operations.

N. Curing: The curing operation should be inspected to assure that the surface of the permanently exposed soil-cement is kept moist (or wet) continuously until the end of the curing period. All temporarily exposed soil-cement should be kept moist. The engineer should be notified when any soil-cement surface is allowed to dry before the end of the curing period, and immediate steps should be taken to correct the situation.

O. Density: Field density testing should be performed by the engineer on the soil-cement in accordance with ASTM C 1040 as soon as possible, but within 30 minutes, after the completion of vibratory rolling. Only wet density should be used for evaluation. The test should be performed using a single probe nuclear density gauge operating in the direct transmission mode so density of the full depth of the soil-cement can be measured. Each test should include readings near the bottom of lift and at 3-in. (76-mm) increments; however, only the deepest reading should be used to evaluate the density. Both wet and dry densities should be reported, as well as individual readings. Periodically, densities should be determined by the sand core method (ASTM D 1556) as a check against the results obtained by the nuclear density gauge. If any nuclear density gauge reading is below 96%, another test will be performed within a 5 to 8 ft (1.5 to 2.5 m) radius of the previous testing location. If the adjacent reading is also below the density requirements, additional vibratory roller passes should be made across the full lane width between the last testing location that produced an acceptable reading and the placement operations. If additional vibratory roller passes cause the density to decrease or cause the surface texture and appearance to deteriorate in the opinion of the engineer, the placing operation should be discontinued until appropriate adjustments are made to the moisture content of the mixture, placement operations, rolling procedures, or other operations to assure that the specified density and surface requirements can be achieved. Density tests should be taken at least one test per work shift and at least one density test per lift. The moving average of any five consecutive in-place density tests should not be less than 98% of the maximum density obtained by ASTM D 558, with no individual test less than 95%. Additional tests should be made during start-up and when problems with attaining required density occur.

P. Moisture Content: The moisture content should be determined in accordance with ASTM D 3017 at the same depths as the density testing and in accordance with ASTM C 566 at least once a day.

Q. Compressive Strength: The engineer should make at least three compressive strength specimens for each 1,000 cu yd or less of soil-cement placed. A “test” is defined as the average of two companion soil-cement cylinders. Samples should be taken from the placement area prior to compaction. Tests should determine the 1-day and 7-day compressive strengths in accordance with ASTM D 1633, Method A, except that curing of specimens in the mold will be required only for the length

of time necessary to satisfactorily remove the specimens from the mold without damage to the specimens. Some engineers also will determine the 3-day compressive strength. The 1-day compressive strength test can be used to monitor the daily production of the central mixing plant and to adjust soil-cement mixture proportions. Table 3 shows the typical relationship of the 1-day, 3-day, and 28-day compressive strengths to the 7-day design strength. The 7-day compressive strength test typically will be used for final acceptance of the soil-cement.

Table 3- Relationship of Various Ages as Percentage of 7-Day Compressive Strength

1-day		3-day		28-day	
Range %	Average %	Range %	Average %	Range %	Average
40-60	50	60-80	70	120-150	130

R. Temperature: The temperature of the soil-cement mixture usually is taken at the mixing plant and at the placement area on randomly selected batches of each mix design of soil-cement used per shift of placement. Additional tests usually are made when rapid set time or workability loss is reported. The engineer should be notified whenever the soil-cement temperature falls below 40°F (4°C) or is above 90°F (32°C). In such cases remedial action or even discontinuation of placement may be required.

1.08 INSPECTION COORDINATION

A. The Supplier shall provide access to the Work for the Purchaser Representative on a continual basis as required for inspection and testing.

1.09 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.01 SOIL CEMENT MIX

A. The soil cement mix shall contain 12.5% portland cement. The soil shall be a silty sand or fine silty sand classified as SM or SP-SM. Maximum aggregate size shall be 1 ½" in size. A minimum of 85% of the soil aggregate shall pass a No. 4 sieve and between 15 and 25% shall pass the No. 200 sieve. The soil shall be of low plasticity or have non-plastic fines and shall be absent of clay balls. Water used for the mix shall be free of soluble sulfate salts and should be of quality normally accepted for use in concrete structures.

PART 3 - EXECUTION

3.01 SOIL CEMENT DELIVERY

A. The mixing plant shall be of adequate capacity that the capacity of the equipment can produce adequate quantities of the required uniform mixture within the required time limits. Provisions for routine equipment cleanout to ensure consistent mixture quality shall be provided.

B. The Supplier's on-site construction superintendent and the soil cement supplier shall attend a pre-placement meeting with the Purchaser Representative at least two weeks prior to the first scheduled placements. The soil cement placement plan may be revised at the request of the Supplier or Purchaser Representative based on the meeting. Soil cement placement shall not proceed until the revised placement plan has been submitted and approved by the Purchaser.

C. The maximum time allowed for the soil cement to be spread into the fill from discharge from the mixer shall not exceed 30 minutes.

D. The soil-cement mixture should be transported to the site in trucks having clean, tight, and smooth beds to facilitate construction and minimize contamination of the mix. Trucks may have to be covered to prevent excessive drying by wind or contamination of the mix by rain or dust.

E. The soil surface subgrade shall be compacted to at least 95% of its modified Proctor maximum dry density (ASTM D-1557) prior to placement of the soil cement.

3.02 SOIL CEMENT PLACEMENT

A. The Supplier shall give the Purchaser Representative a minimum of two days advance notice of a soil cement placement date.

B. Soil cement placement shall not be started until the Purchaser has inspected and approved all methods of mixing, conveying, spreading, consolidating, finishing, curing, and protection of the soil cement.

C. The soil cement shall be deposited in a manner meeting with the approval of the Purchaser. The Purchaser may stop the Supplier from placing soil cement in the event of adverse or even threatening adverse weather conditions when, in the Purchaser's opinion, these weather conditions may adversely influence the proper placing of the concrete.

D. All equipment proposed for use in mixing, conveying, placing and compacting concrete shall be approved by the Purchaser prior to its use. All the necessary equipment for any particular placement shall be on site and proven to be in working condition before the placement commences, with backup equipment on site as determined by the Purchaser. The equipment shall be well maintained, suitable in kind, and adequate in capacity for the work.

E. In preparation for the soil cement placement, all soils/sediments, loose soil-cement, debris and other deleterious matter shall be removed from the interior of the proposed fill area.

F. All transporting and handling equipment shall be thoroughly cleaned.

G. Soil cement shall be conveyed from the mixer to the place of final deposit by a method that will prevent separation and loss of materials. Only equipment of such size and design as to ensure a practically continuous flow of soil cement at the delivery end without loss or separation of materials shall be used. Soil cement shall be deposited as nearly as possible in its final position to avoid segregation due to re-handling and flowing. Deliveries should be scheduled so that soil-cement will be spread and rolled within the time limit specified in Section 3.02(L). Loads that have crusts of partially hardened material or have become wet by rain should not be used. Rubber tired vehicles transporting soil-cement may travel across compacted soil-cement

only for the purposes of depositing the subsequent lift. Vehicles transporting soil-cement should be operated to prevent sudden stops, sharp turns, or other operations that damage the surface of the previously compacted lift. When dumping soil-cement, it should not free fall more than 5 ft or be piled higher than 5 ft.

H. Soil cement shall be placed at such a rate that it is at all times plastic and flows readily. Once soil cement placement is started, it shall be a continuous operation until placement of the panel or section is complete.

I. Soil cement batches delivered to the job site shall be kept as uniform as possible in consistency and strength. The following shall be considered a basis for the rejection of the soil cement delivered to the site:

1. Soil cement that has been contaminated with foreign material;
2. Slump exceeding maximum specified;
3. Percent of entrained air outside specified limits; and
4. The maximum time allowed for discharge has been exceeded.

J. All necessary precautions should be taken to prevent damage to completed soil-cement by the equipment and to prevent the deposition of raw earth or foreign materials between layers of soil-cement. Earth ramps crossing completed soil cement must have at least 2 ft of compacted thickness. Where ramps are constructed over soil-cement that is not to final grade, all foreign materials must be removed prior to continuation of the soil-cement construction.

K. The equipment for spreading the soil-cement mixture should be suitable for the purpose and be capable of discharging the mixture in layers to produce reasonably smooth uniform surfaces. The equipment should be controllable so as to produce layers which when compacted will each be approximately of the specified thickness. Under no condition should tracked vehicles be operated on other than fresh uncompacted soil-cement. Soil-cement mixtures should be placed and distributed in such a manner as to produce a reasonably smooth and uniform surface in layers of such uncompacted thickness that when compacted each layer will be 9 inches in thickness. The contractor must demonstrate that proper densities could be obtained to full depth in a test section. The soil-cement should be placed and compacted as rapidly as possible. Soil-cement should be placed in successive horizontal layers for most applications. Placing soil-cement during excessively hot, cold, or wet weather should be avoided where possible.

L. The active working area must be limited such that no more than 1 ½ hours have passed since the soil-cement was mixed until final compaction is achieved.

M. Compaction is accomplished by tamping rollers, pneumatic- tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well suited to the material being compacted. The equipment should provide uniform compaction across the width of the equipment for each pass. Trucks, tractors, or other hauling equipment should not be used for compaction of soil-cement mixtures. Light, walk-behind, or similar sized vibratory rollers and mechanical tampers should be used for compacting areas inaccessible to the large rollers. This equipment must be able to compact the soil-cement to the required densities. At the start of compaction, the mixture should be in a uniform, loose condition throughout its full depth. No section should be left undisturbed for longer than 30 minutes during compaction operations. Compaction of each layer should be done in such a manner as to

produce a dense surface, free of compaction planes, within 1 ½ hours from the time cement is added to the mixture.

N. Readings to determine the density of compacted soil-cement should be made using a single probe nuclear density gauge. The number of tests per lift will vary depending on the size of the project and the surface area of each lift. Density tests should be taken at least one test per work shift and at least one density test per lift. The moving average of any five consecutive in-place density tests should not be less than 98% of the maximum density obtained by ASTM D 558, with no individual test less than 95%.

3.03 SURFACE FINISH & CURING

A. After compaction to the required lines and grades, the soil cement surface shall be reasonably smooth and free of surface tears and rock pockets. Any trimming to remove loose soil-cement, or as indicated on project drawings, must be completed within 6 hours from the time of mixing.

B. Temporarily exposed surfaces of soil-cement that will be in contact with succeeding layers of soil-cement should be kept continuously moist by water curing until placement of the subsequent layer. Curing of permanently exposed surfaces should begin immediately after compaction and shall continue for at least 7 days. Soil-cement should be cured and protected from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain or flowing water. All equipment needed for adequate curing and protection should be on hand and ready to install before actual placement begins. All soil cement should be protected from the damaging effects of rain for 8 hours and of flowing water for 7 days. Horizontal surfaces that will be exposed permanently may be cured by covering with a minimum uniform thickness of 6 in. of continuously saturated sand. Temporarily exposed surfaces should not be cured by saturated sand.

C. Water trucks may be used to keep surfaces wet at all times. The water truck should be supplemented, as necessary, by mists from hand-held hoses. The spray should cover all portions of the soil-cement surface. All spray nozzles both on the trucks and the hand-held hoses should be of a type that produces a true fog spray without any concentrated streams of water. The mist should not be applied in a channelized or pressurized manner that in any way erodes the surface of the soil-cement. It also should be applied at a rate which does not cause ponding at the surface.

D. An approved sprinkler system consisting of pipelines and rotating or other approved types of sprinklers may be used. Sprinklers should deliver a fine mist of water and should not cause any erosion to the surface of the soil-cement. The sprinkler system should cover all portions of the soil-cement surface, and keep the surface wet at all times.

END OF SECTION