

APPROVED:

Division Administrator

By: \_\_\_\_\_  
FEDERAL HIGHWAY ADMINISTRATION

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# Supplemental Technical Specification for CEMENT STABILIZED EARTH BASE

SCDOT Designation: SC-M-307 (01/25)

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## 1. SCOPE

- 1.1. This supplemental technical specification contains specifications for the materials, equipment, construction, measurement, and payment for increasing the strength of the subgrade by the addition and mixing of additional rock, water, and Portland cement for the construction of a Cement Stabilized Earth Base (CSEB) on a properly prepared foundation course (subgrade or subbase) for pavement structure in conformance with the lines, grades, thickness, and typical cross section shown in the Plans or otherwise established by the RCE.

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## 2. SUBMITTALS

- 2.1. At least 30 days prior to the beginning of mixing CSEB in the roadway, submit the results of SC-T-26 (clearly indicating the ratio of subgrade material and aggregate by weight), and Contractor's Quality Control Plan as outlined below, to the Reclamation Engineer (RE) at the Office of Materials and Research for review. Additionally, submit copies of the Contractor's Quality Control Plan outlined in this Supplemental Technical Specification to the RE and RCE at the same time for review. The RE will specify the rate of cement in pounds per square yard.
- 2.2. *Mix Design:* Ensure that the testing of the soil-aggregate mixture is conducted according to SC-T-26 by a laboratory AASHTO accredited in the test procedures referenced in this supplemental technical specification. Include the gradation for the additional rock material (AASHTO T 27), the bulk specific gravity (AASHTO T 85) of the additional rock material (+ #4 material), absorption (AASHTO T 85) of the additional rock material (+ #4 material), cementitious materials, compressive strengths and moisture-density curve. Make no production until the RE has provided the cement spread rate. Proportions for mix design can be calculated by determining the density of the additional rock material by AASHTO T 19 (shoveling procedure) and the subgrade by AASHTO T 99 and then calculating the weights for a 50:50 thickness ratio. Ensure that the roadway sampling and testing is representative of the entire area and depth to be treated. Several samples and/or designs may be necessary.
  - 2.2.1. Mix designs not meeting a target strength of 450 psi at 7 days in accordance with SC-T-26 will need to undergo additional durability testing for determination of cement content. The State Pavement Design Engineer will provide guidance for acceptable durability testing procedures.
- 2.3. *QC Plan:* The quality control plan should include but not be limited to addressing the following items.
  - 2.3.1. Include contingency plans for mixing and compaction when specification criteria is not met and consider the specific roadway conditions at the site.
  - 2.3.2. Plan for identifying the in-situ moisture conditions, adjusting the moisture content to meet specifications, checking moisture during mixing operations, and maintaining moisture content through the time of curing. Include a description of the methods and minimum contractor testing frequency for moisture. Consider specific environmental conditions for the project site and schedule.

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### 3. MATERIALS

- 3.1. *Portland Cement*: Use Portland cement that conforms to the requirements of Subsection 301.2.1 of the Standard Specifications.
- 3.2. *Water*: Use water conforming to the requirements of Subsection 701.2.11 of the Standard Specifications.
- 3.3. *Asphalt Material*: Use RS-2, CRS-2, EA-P Special, or Emulsified Trackless Tack for the asphalt curing coat that conforms to the requirements of Subsection 401.2.1.3 of the Standard Specifications.
- 3.4. *Granular 'Blotter'*: Use FA-10 or FA-10M material meeting the requirements of the Standard specifications.
- 3.5. *Additional Rock for CSEB*: Use aggregate meeting the requirements of one of the following:
- 3.5.1. *Crushed Reclaimed Asphalt Pavement (RAP) Material*: Additional RAP material may be added to meet the additional rock requirement and, if added, must meet the requirements of Subsection 401.2.2.6 of the Standard Specifications and **Table 1** herein.

**TABLE 1 – ADDITIONAL CRUSHED RAP**

Tests	Method	Limit
Deleterious Materials: Clay Lumps and Friable Particles in Aggregate	AASHTO T 112	0.2 maximum
Maximum Sieve Size, 2.0 inches (50mm)	AASHTO T 27	100 % Passing

- 3.5.2. Ensure that any additional aggregate comes from a source listed on Qualified Product Lists Nos 1 and/or 2 and meets the requirements of **TABLE 2** herein.

**TABLE 2 – ADDITIONAL AGGREGATE**

Tests	Method	Limit
Los Angeles Abrasion Value	AASHTO T 96	55% maximum loss
Sand Equivalent	AASHTO T 176	45% minimum
Maximum Size, 100% passing, Sieve Size	AASHTO T 27	2.0 inches
Water Absorption	AASHTO T 85	3.0% maximum

- 3.6. *Soil*: Utilize the soil for the cement stabilized earth base course from natural material in the roadbed, hauled-in material, or a combination of these materials proportioned as directed. Ensure that hauled-in material meets the requirements for borrow material in the top 18 inches of the embankment in Subsection 203.2.1.8 of the Standard Specifications. Unless otherwise specified, furnishing of soil is not measured for payment and there is no payment for overhaul. Provide soil for CSEB (natural, hauled-in, or combination) that is free of organics, roots, sod, weeds or other deleterious materials.

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### 4. EQUIPMENT

- 4.1 *General*: Ensure that the equipment necessary for the proper construction of the work is on

site and in acceptable working condition. Provide sufficient equipment to enable prosecution of the work in accordance with the project schedule and completion of the work in the specified time.

- 4.2 *Mixer / Reclaimer:* Construct the base with self-propelled rotary mixer(s)/reclaimer(s) capable of mixing in place to the required depth. Ensure that the mixer(s)/reclaimer(s) have a mechanism for controlling the reclaimed material gradation via a breaker bar and/or a door opening on the mixer(s)/reclaimer(s). Ensure that mixer(s)/reclaimer(s) are fitted with an integrated liquid injection system capable of introducing water into the cutting drum during the mixing process at a consistent rate that is automatically varied by the speed of the reclaimer.
- 4.3 *Water Trucks:* Provide a sufficient number of water trucks on the jobsite at all times of operation to maintain the moisture requirements listed in Subsection 5.9. Ensure that the water truck used in conjunction with the reclaimer uses a direct injection system, and additional trucks maintain surface moisture during grading and compaction work and until the curing treatment is applied in accordance with Subsection 5.14. Accomplish this procedure using a controlled and uniform application of water without eroding or otherwise damaging the CSEB surface.
- 4.4 *Cement Spreader:* Provide a spreader/distributor capable of achieving consistent, accurate, and uniform distribution across the entire length and width of the roadway while minimizing dust. Ensure that the spreader has adjustable openings or gate headers and is not solely dependent on vehicle speed to obtain the required spread rate.
- 4.5 *Compactors:* Provide a combination of sheepsfoot rollers, smooth wheel tandem rollers, and pneumatic-tired rollers that have the ability to adequately compact reclaimed material throughout the entire specified CSEB thickness. Ensure the necessary weight, size, and number of rollers to achieve the compaction and construction limitation requirements of this special provision.
- 4.6 *Inspection of Equipment:* Before start-up, carefully inspect the equipment. During construction, should any of the equipment fail to operate properly, cease work until the deficiencies are corrected.

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## 5. CONSTRUCTION REQUIREMENTS

- 5.1. *Weather Limitations:* Apply cement only when the temperature is above 40°F in the shade and rising, and no freezing temperatures are predicted for at least 48 hours. Do not perform work on frozen or excessively wet subgrade.
- 5.2. *Preparation of Subgrade:* Construct the subgrade for the CSEB in accordance with the requirements specified in Section 208 of the Standard Specifications. Roll and compact the subgrade for at least 500 feet ahead of the placing of the additional rock material to form a trench or channeled section as prescribed on the Plans. When included in the work, construct shoulders in accordance with the requirements of Section 209 of the Standard Specifications and accurately trim to the alignment and grade of the additional rock material to form a trench or channeled section as prescribed on the Plans. Ensure that the top 6 inches of the subgrade material or any portion of the subgrade material that will be incorporated into the CSEB meets the material requirement of Subsection 3.6.
- 5.3. *Placement of Additional Rock Material:* Spread additional rock material at the established rate from the mix design uniformly over the subgrade material using a mechanical spreader, paver, or by windrowing the material with dump trucks and spreading it to a uniform thickness with a motor grader. Blend the additional rock material with the subgrade material by means of a full depth mixing pass to form a homogeneous mixture prior to the application of cement.

- 5.4. *Test Strips:* Use the first load of cement on the roadway as a test strip to determine if the process is capable of producing a mixture according to specifications.
- 5.4.1. Ensure that particular attention is paid to the moisture and compaction requirements, mixing and processing requirements, and cement tolerances set in this supplemental technical specification.
- 5.4.2. The first load applied with the contingency plans is considered a test strip to evaluate the corrective action plan. Cease production after this initial load of cement if the requirements of this specification are still not being met and submit a revised corrective action plan to the RCE for acceptance prior to continuing work.
- 5.4.3. If the requirements of this specification are not being met in a section (a section is defined as one load of cement) not defined as a test strip then one additional load of cement will be allowed to provide the contractor an opportunity to meet the required specifications. Cease production after this additional load of cement if the requirements of this specification are still not being met and submit a revised corrective action plan to the RCE for acceptance prior to continuing work.
- 5.5. *Cement Application:* Supply test results in writing to the RE who will then determine the rate of cement. Allow two weeks from the date of submittal of the results required in subsection 2.2 of this supplemental technical specification for the selection of the appropriate cement rate.
- 5.5.1. Spread Portland cement uniformly on the blended CSEB material at the established rate, taking care to minimize fugitive dust and minimize overlapping of the passes (maximum 6 inches). Spread no more than 75 pounds per square yard in a single pass. Perform a mixing pass after each cement spreading operation. A tolerance of 5% (of the rate) is allowed in the spread rate for individual sections (load of cement) of roadway; however, adjustments should be made in order to keep the actual spread rate as close to that established in the approved mix design. Do not apply powdered cement on excessively windy days and apply so that work can be completed within the construction limitations given in this supplemental technical specification.
- 5.6. *Mixing & Processing:* After the cement has been applied per Subsection 5.5, mix and uniformly add necessary moisture to the CSEB material to ensure that the moisture content is above the optimum values as set in the laboratory testing reviewed by the RE during mixing and when tested prior to the start of compaction operations.
- 5.6.1. Mix with at least one pass of the reclaimer after cement application at a minimum. Additional passes are allowed, adhering to time limitations set forth within this specification. Ensure full width mixing by overlapping a minimum of 6 inches with each longitudinal pass, including at the longitudinal joint of each lane, and a minimum of 2 feet with each transverse joint. Additional mixing passes may be required in the contract documents. Lightly compact following each pass of the reclaimer to produce a uniform layer.
- 5.6.2. Perform grading operations to ensure requirements of Subsection 5.12 will be met after compaction is completed. Immediately begin compaction after the mixing process has been completed so that the requirements of Subsection 5.8 are met.
- 5.6.3. Remove excess material generated from the mixing process after final grading operations have been completed.
- 5.6.4. If the requirements of mixing and processing are not being met in a section not defined as a test strip (a section defined as one load of cement) then one additional load of cement will be allowed. Cease production after this additional load of cement if the requirements are still

not being met and submit a corrective action plan to the RCE for acceptance prior to continuing work.

- 5.7. *Segregation*: If segregation occurs in the base course during mixing or finishing operations, cease placement until the cause is determined and corrected to the satisfaction of the RCE. If the segregation is judged by the RCE to be detrimental to the final product, remove and replace the segregated area at no additional cost to the Department.
- 5.8. *Compaction*: Before beginning compaction, ensure that the mixture is free from excessive fluff and overly compacted areas to allow for uniform compaction of the layer.
  - 5.8.1. Continue compaction until the entire depth of the base course mixture is uniformly compacted to not less than 95% of the maximum density. SC-T-26 or SC-T-27 will be used at the discretion of the RCE to determine the maximum density of the composite mix. If tests show that the 95.0% requirement is not being met, adjust construction operations to obtain the required 95.0 % density. Complete the compaction work within 1 hour of the final mixing pass.
  - 5.8.2. After the mixture is compacted, reshape the surface of the base course as necessary to conform to the required lines, grades, and cross-section. Continue as required to obtain a uniform surface and to prevent scaling and delamination. Perform compacting and finishing in a manner that produces a smooth, closely knit surface, free from equipment imprints, cracks, ridges, or loose material.
- 5.9. *Moisture Content*: Maintain the surface moisture content of the mixture at or above the optimum moisture content (OMC) during mixing operations.
  - 5.9.1. Maintain the moisture content of the mixture between +/- 2.0% of OMC during compaction operations including at the time of the density acceptance tests. Measure the moisture content in accordance with SC-T-23 with the OMC determined by SC-T-26, SC-T-27, or other test method used at the discretion of the RCE.
  - 5.9.2. Do not allow the percentage of moisture in the CSEB material mixture at the time of cement application to exceed the quantity that permits uniform and thorough mixture of CSEB material or that creates instability of the roadway.
- 5.10. *Construction Limitations*: Limit the area over which the cement is spread in order that all operations specified can be continuous and all work completed within daylight hours, unless adequate artificial light is provided. Complete all work within 2 hours after the application of water to the soil aggregate cement mixture, unless the RCE approves a longer period.
  - 5.10.1. If operations are interrupted for a continuous period of greater than 1 hour after the cement has been mixed into the soil aggregate mixture, reconstruct the entire affected section in accordance with this supplemental technical specification. When the uncompacted mixture of soil, aggregate, and cement is wetted so that the moisture content exceeds the amount specified, manipulate and aerate the mixture to reduce the moisture to the specified content if the base course is completed within the limits of this supplemental technical specification.
- 5.11. *Reconstruction*: If the construction of the base course is proceeding with the approval of the RCE and the uncompacted soil, aggregate, and cement mixture is wetted by rain so that the moisture content exceeds the allowable, the Department will pay for additional cement used in reconstructing the section but will not pay for the reconstruction work. If the reconstruction of any section is necessary because of negligence or omission, unsatisfactory equipment performance, or the section does not comply with the allowable variation in thickness, reconstruct the section without additional compensation.

- 5.12. *Surface Smoothness*: Ensure that that the finished surface of the base varies neither more than 3/8 inch from a straight edge 10 feet long when applied parallel to the centerline of the road, nor more than 1/2 inch from the typical cross-section shown on the plans.
- 5.12.1. Do not disturb the finished surface of the base course after the final finishing and compaction. Random high spots may be removed by surface planing as long as the required thickness of the CSEB is not reduced. Where low areas or depressions in the finished surface of the base occur, level and true the surface using the same material that the course is to receive as the next component of the pavement structure, but in a separate operation. If the material specified as the next component of the pavement structure is considered unsatisfactory by the RCE, the RCE will specify what material to use. Provide necessary materials and perform such corrective work without any additional compensation.
- 5.13. *Tolerance in Base Course Thickness*: The thickness of the completed modified base is measured at random intervals not to exceed 500 feet in length for a two lane road. The depth measurements will be made by test holes on the day of production. Where the base course is less than the specified thickness by more than 1 inch, remove and replace such areas as directed by the RCE.
- 5.13.1. Where the measured thickness is more than 1/2 inch greater than the specified thickness, it is considered as the specified thickness plus 1/2 inch. The average daily job thickness is the average of the depth measurements determined as specified above. If this average job thickness is less than the specified thickness by more than 1/4 inch, an adjusted unit price is used for calculating payment. This adjusted contract unit price bears the same ratio to the contract unit price bid as the average job thickness bears to the specified thickness.
- $$\text{Pay Factor} = (\text{Average Job Thickness}) / (\text{Specified Job Thickness})$$
- 5.13.2. When the Contract includes more than one road, each road is considered separately.
- 5.13.3. No additional payment over the contract unit price is made for any base course where the average job thickness, determined as provided, exceeds the specified thickness.
- 5.14. *Curing Coat*: After the completion of the compaction and finishing operations, apply an asphalt curing coat of 0.20 to 0.25 gallons per square yard of asphalt as specified in Section 406 of the Standard Specifications. Keep the finished base course continuously moist until the curing coat is applied. At the time the asphalt material is applied, ensure that the base course surface is dense, free of all loose and extraneous material, and contains sufficient moisture to prevent penetration of the asphalt material.
- 5.15. *Opening to Traffic*: When staging of construction allows for extended closure to traffic, furnish such personnel and barricades along with other devices necessary to prevent construction equipment or other traffic, regardless of the type vehicle or its reason for being on the project, from using the finished base course. Do not place heavy construction equipment on the base without the approval of the RCE unless it is being used in the subsequent construction operation or a 3-day curing period has been completed, and in this event, ensure the base has hardened sufficiently to prevent marring, damaging or visible rutting of the surface and curing coat by such usage. The amount of time where the ambient temperature was below 32 °F is not counted in the 3-day curing requirements. Light trucks and automobiles related to construction activities are allowed immediately. Repair any areas damaged by construction traffic. If staging of construction requires prompt opening to traffic, place at least one lift of asphalt on the base course within 3 days. Surface treatments may be allowed by the RCE in some instances. Repair any damage to the base caused by early traffic before overlaying. If the asphalt material for the curing coat is not sufficiently dry to prevent pickup when the base course is opened to traffic as outlined above, apply a granular covering before opening.

- 5.16. *Maintenance*: Within the limits of the Contract, maintain the CSEB course in good condition until all work is complete and accepted. Maintenance includes the immediate repairs of any defects and damage that develops. If repair or patching is necessary, extend it to the full depth of the base course and construct in a manner that ensures the restoration to a uniform and durable base course.

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## 6. RIDEABILITY

- 6.1. Ensure that the final asphalt surface placed on the CSEB course meets the rideability requirements of SC-M-403 for New Construction.

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## 7. MEASUREMENT

- 7.1. The quantity for the pay item Cement Stabilized Earth Base at the specified nominal thickness is the surface area of a uniform base constructed by applying and mixing cement with the subgrade and aggregate material as specified and is measured by the square yard (SY) of the modified base in-place, complete and accepted. CSEB constructed outside the designated area is not measured for payment.
- 7.2. The quantity for the pay item Additional Rock for Full Depth Reclamation is the weight of the additional rock for full depth reclamation material incorporated into the constructed base course as specified, measured by the ton (TON), including water contained in the additional add rock material weighed on approved scales and actually incorporated into the work, complete and accepted. If a visual inspection indicates excessive moisture in the additional rock for full depth reclamation material, a deduction is made as determined by the RCE. The weight of the base course constructed outside the area designated, wasted or lost due to the negligence of the Contractor, and applied in excess of the rate specified or directed in writing is disregarded in calculating the quantity.
- 7.3. The quantity for the pay item Portland Cement for Cement Stabilized Earth Base Course is measured by the ton (TON) of Portland cement incorporated into the work, complete and accepted. Cement used in excess of 5% of the amount specified is not measured for payment. The measurement of Portland cement is by scale weights or delivered weights. Furnish to the RCE invoices of all cement received to verify the weight.
- 7.4. The quantity for the pay item Borrow Excavation is measured according to Subsection 203.5 of the Standard Specifications.

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## 8. PAYMENT

- 8.1. Payment for Portland Cement for Cement Stabilized Earth Base Course is full compensation for furnishing and weighing the cement as specified or directed and includes all other materials, labor, equipment, tools, supplies, transportation and incidentals necessary to complete the work in accordance with the plans, specifications, and other terms of the contract.
- 8.2. Payment for Cement Stabilized Earth Base (of the uniform thickness required) is full compensation for constructing the CSEB as specified or directed and includes grading, applying and spreading cement, processing and mixing base course material, watering and maintaining proper moisture content, compacting, finishing, curing, hauling and disposing of excess shoulder and reclaimed material, and curing base course, forming construction joints, and all other materials, labor, equipment, tools, transportation, and incidentals necessary to complete the work in accordance with the Plans, the Specifications, and other terms of the

Contract.

- 8.3. Payment for Additional Rock for Full Depth Reclamation includes all direct and indirect costs or expenses required to complete the work.
- 8.4. Payment for Borrow Excavation is paid according to Subsection 203.6 of the Standard Specifications.
- 8.5. Payment for each item includes all direct and indirect costs or expenses required to complete the work. Pay items under this section include the following:

<b>Item No.</b>	<b>Pay Item</b>	<b>Unit</b>
3071060	CEM.STAB.EARTH BASE CR.4"UNIFORM.	SY
3071080	CEM.STAB.EARTH BASE CR.6"UNIFORM.	SY
3071100	CEM.STAB.EARTH BASE CR.8"UNIFORM.	SY
3071120	CEM.STAB.EARTH BASE CR.10"UNIFORM.	SY
3071160	CEM.STAB.EARTH BASE CR.12"UNIFORM.	SY
3072000	CEM.STAB.EARTH BASE CR.16"UNIFORM.	SY
3081060	PORTLAND CEMENT FOR EARBASECR.	TON
3060005	ADD ROCK FOR F.D. RECLAMATION	TON