

**Supplemental Technical Specification for
Cement Modified Recycled Base**

SCDOT Designation: SC-M-306 (07/21)

**APPROVED:
Division Administrator**

By: _____
FEDERAL HIGHWAY ADMINISTRATION

1.0 DESCRIPTION

- 1.1 This section contains specifications for the materials, equipment, construction, measurement, and payment for the modification of an existing paved roadway or shoulder by scarifying the existing pavement structure, mixing it with Portland cement, and constructing the base course in conformance with the lines, grades, dimensions, and cross-sections shown on the Plans or as directed by the **RCE**.

2.0 MATERIALS

- 2.1 Portland Cement - Use Portland cement that conforms to the requirements of **Subsection 301.2.1**.
- 2.2 Water - Use water conforming to the requirements of **Subsection 701.2.11**.
- 2.3 Asphalt Material – Use asphalt material conforming to the requirements of **Subsection 301.2.4**.

3.0 EQUIPMENT

- 3.1 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.
- 3.2 Construct the base with self-propelled rotary mixer(s)/reclaimer(s) capable of mixing in place to the required depth. The mixer(s)/reclaimer(s) shall have a mechanism for controlling the reclaimed material gradation via breaker bar and/or a door opening on the mixer(s)/reclaimer(s). Mixer(s)/reclaimer(s) shall be fitted with an integrated liquid injection system capable of introducing liquid into the cutting drum during the mixing process.
- 3.3 Provide a sufficient number of water trucks on the jobsite at all times of operation to maintain the moisture requirements listed in **Subsection 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 13**. Accomplish this using a controlled and uniform application of water without eroding or otherwise damaging the CMRB surface.
- 3.4 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.
- 3.5 Provide a combination of sheepsfoot rollers, smooth wheel tandem rollers, and/or pneumatic-tired rollers that have the ability to adequately compact reclaimed material throughout the entire specified CMRB thickness. Ensure the necessary weight, size and number of rollers to achieve the requirements of **Subsection 10**.

4.0 CONSTRUCTION

- 4.1 Regulate the sequence of work to process the necessary quantity of material to provide the full depth of modification as shown on the Plans:
 - 4.1.1 Ensure structural integrity of reclaimed material is consistent throughout the depth of the modification.
 - 4.1.2 Ensure surface quality is sufficient to provide durable temporary pavement structure surface and supports permanent pavement structure performance.
 - 4.1.3 Incorporate appropriate material as specified in the plans for drainage correction, cross slope correction or roadway strengthening.

5.0 QUALITY CONTROL PLAN, TEST STRIP & CORRECTIVE ACTION REQUIREMENTS

- 5.1 Prepare an annual Quality Control Plan that ensures that operational techniques and activities provide integral and finished material of acceptable quality for each Cement Modified Recycled Base project. Submit a Quality Control Plan for acceptance to the Chemical Stabilization Engineer (**CSE**) in writing a minimum of two weeks before work begins for the year.
- 5.2 The Quality Control Plan should include, but not be limited to addressing the following items;
 - 5.2.1 Contingency plans for pulverization, mixing and compaction when specifications criteria are not met. Consider the specific roadway conditions of various project sites.
 - 5.2.2 Plan for identifying in-situ moisture conditions, adjusting the moisture content to meet specifications, and maintaining moisture content through the time of curing. Include a description of the methods and minimum contractor testing for moisture. Consider specific environmental conditions of various project sites and schedules.
- 5.3 Test Strips
 - 5.3.1 The first load of cement on the roadway will be used as a test strip to determine if the contractor is capable of producing a mixture according to specifications. Particular attention will be paid to the moisture and compaction requirements set in **Subsection 10**, mixing and processing requirements set in **Subsection 9**, pulverization requirements set in **Subsection 7**, depth requirements in **Subsection 17**, and cement tolerances in **Subsection 8**. Cease production after the first load if any of the requirements of the specification are outside of the tolerances and change procedures to contingency plans approved in the QC Plan to continue work. Continue production as normal on the same day when the test strip meets the specification requirements.
 - 5.3.2 The first load applied with the contingency plans will be used as 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.
 - 5.3.3 If the requirements of this specification are not being met in a section not defined as a test strip (a section is 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.

6.0 SHOULDERS & ROADWAY PREPARATION

- 6.1 Remove all excess vegetation generated from the clipping and cleaning of shoulders from the roadway and any other debris, including Reflective Pavement Markers, prior to performing the mixing operations. Remove material from the shoulders as necessary to ensure proper drainage at all times.

7.0 PULVERIZATION

- 7.1 Provide means, methods, and equipment necessary to obtain satisfactory pulverization of the pavement so that at the completion of pulverization and mixing (prior to compactive efforts), a uniform mixture is created in which 100% of the reclaimed material mixture (by weight) passes a 3 inch sieve and 95% of the reclaimed material mixture (by weight) passes a 2 inch sieve. When necessary, SC-T-1 Section 6.6 will be used for sampling to run gradation tests. Rework areas not meeting this gradation control measure as necessary, adhering to the time limitations in **Subsection 11**. The pulverization pass is defined as at least one pass of the mixer prior to the application of cement. Additional passes are allowed. Lightly compact following each pass of the mixer to produce a uniform layer. Carefully control the depth of pulverization and conduct operations in a manner to ensure that the surface of the roadbed below the pulverized material remains undisturbed and conforms to the required cross-section. Means, methods and equipment including but not limited to additional passes of the reclaimer, milling in place or the use of supplementary equipment to achieve pulverization is the responsibility of the contractor and incidental to the process.
- 7.2 If the requirements of pulverization are not being met in a section not defined as a test strip (a section is 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.

8.0 APPLICATION OF CEMENT

- 8.1 The **CSE** will determine the rate of cement based on test results supplied in writing by the Contractor. Do not commence construction until an approved rate has been determined by the **CSE**. Allow two weeks from the date of submittal for the results and selection of appropriate cement rate. The test results will be conducted according to SC-T-26 by an AASHTO-accredited laboratory with material obtained from the roadway in which construction is to occur. Ensure that the roadway sampling and mix design testing is representative of the entire area and depth to be treated, several samples and/or designs may be necessary.
- 8.2 Spread Portland Cement uniformly on the pulverized material at the rate established by the **CSE**, taking care to minimize fugitive dust and minimize overlapping of the passes (maximum 6 inches). Apply cement only when the temperature is 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. 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 by the **CSE**. Only apply cement to such an area that all the operations (including final compaction) can be continuous and completed in daylight, unless adequate artificial light is provided. Ensure that all operations (including final compaction) can be completed within 3 hours of application of cement.

- 8.3 Do not allow the percentage of moisture in the reclaimed material mixture at the time of cement application to exceed the quantity that permits uniform and thorough mixture of reclaimed material or that creates instability of the roadway. Do not allow equipment, except that used in spreading and mixing, to pass over the freshly spread cement until it is mixed with the reclaimed material mixture.
- 8.4 If the requirements of cement application are not being met in a section not defined as a test strip (a section is 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.

9.0 MIXING & PROCESSING

- 9.1 Pulverize material as necessary to meet the requirements given in **Subsection 7**. The pulverization pass is defined as at least one pass of the mixer prior to the application of cement. Lightly compact following each pass of the mixer to produce a uniform layer.
- 9.2 After the cement has been applied per **Subsection 8**, mix and uniformly add necessary moisture to the reclaimed material to ensure that the moisture content is above the optimum value as set in the approved mix design and within +/- 2% of the optimum moisture content when tested within 30 minutes of final compaction. Mix with at least one pass of the reclaimer after cement application at minimum. Additional passes are allowed, adhering to time limitations set forth within this specification. Ensure full width pulverizing and 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 mixer to produce a uniform layer.
- 9.3 Immediately begin final compaction after the mixing process has been completed so that the requirements of **Subsection 10** are met.
- 9.4 Remove excess material generated from the mixing process after final grading operations have been completed.
- 9.5 If the requirements of mixing and processing are not being met in a section not defined as a test strip (a section is 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.

10.0 COMPACTION

- 10.1 Before beginning compaction, ensure that the mixture is free from excessive fluff and overly compacted areas to allow for uniform compaction of the layer. 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-23, SC-T-26, SC-T-27, or SC-T-29 will be used at the discretion of the **RCE** to determine the maximum density of the composite mix. If tests show that 95.0% requirement is not being met, adjust construction operations to obtain the required density. Complete the compaction work within 1 hour of the final mixing pass.
- 10.2 After the mixture is compacted, reshape the surface of the base course as necessary to conform to the required lines, grades, and cross-section. Perform light scarifying to a depth which removes the sheepsfoot imprints at minimum. Continue as required to obtain a uniform surface and to prevent scaling and delamination.

- 10.3** Perform compacting and finishing in a manner that produces a smooth, closely knit surface, free from equipment imprints, cracks, ridges, or loose material. Maintain the moisture content of the mixture within +/- 2% of the optimum moisture as determined by the pre-approved mix design and keep the surface continuously moist to the time of final curing coat being applied. The moisture content and density requirements for compaction will be tested for acceptance within 30 minutes of final compaction. Additional moisture contents tests will be randomly performed for acceptance through the curing application to ensure that the surface moisture is maintained above optimum moisture.
- 10.4** If the requirements of compaction are not being met in a section not defined as a test strip (a section is 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.

11.0 CONSTRUCTION LIMITATIONS

- 11.1** Perform work in daylight hours unless adequate artificial light is provided. Limit the area over which the cement-pavement mixture is spread so that all operations specified in **Subsections 7, 8, 9, 10 and 13** are performed continuously until completion of a section (load of cement). Complete all grading and compaction work on a section (load of cement) within 2 hours after the initial mixing pass of the reclaimer unless the **RCE** approves a longer period.
- 11.2** If operations are interrupted for a continuous period of greater than 1 hour after the cement has been mixed with the reclaimed material, reconstruct the entire affected section (area of interruption) in accordance with these specifications. When the un-compacted reclaimed material mixture and cement is wetted so that the moisture content exceeds that specified, manipulate and aerate the mixture to reduce the moisture to the specified content provided the base course is completed within the time limits of these specifications.
- 11.3** Begin subsequent lifts of asphalt or chip seals which cover the Cement Modified Recycled Base curing methods and act as a final riding surface within 7 calendar days of completion of the CMRB section unless the **RCE** approves a longer period. Begin these subsequent lifts so that no more than 4 miles have temporary surface treatment on them at any time. A section is defined as the contract section of roadway receiving CMRB treatment. When using Curing Methods B or C, ensure that a milled surface is not left open to the public for more than 72 hours.

12.0 WEATHER LIMITATIONS

- 12.1** Apply cement only when the temperature is 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. The temperature restrictions for single treatment, when used as a curing option, shall meet the requirements of this reclamation specification. If the successive course is a final riding course, the seasonal restrictions of December, January and February apply unless otherwise approved by the DOC.

13.0 CURING

- 13.1** After the Cement Modified Recycled Base has been finished as specified, cure the surface using the specified method in the plans or contract. Dampen and sweep the CMRB immediately prior to the application of the surface treatment.

Curing Method A: Surface (Single) Treatment

Curing Method B: Surface (Single) Treatment with Milling

Curing Method C: Surface (Double) Treatment with Milling

- 13.2** After the Cement Modified Recycled Base has been finished as specified, protect the base from rapid drying and traffic by placing Asphalt Surface Treatment as specified in **Section 406 or 407**, with the exception that lightweight aggregate is not required and CRS-2 may be used in place of CRS-2P. Perform this operation daily to protect the newly constructed Cement Modified Recycled Base, unless otherwise directed by the **RCE**.
- 13.3** Prior to placement of the HMA course in Methods B & C, mill the Cement Modified Recycled Base course surface to obtain a true and level finish for the asphalt placement. Ensure that a diamond milling pattern with a double or triple strike is clearly visible in the finished surface. Consider the final thickness during construction, leaving the specified depth of treatment after the milling has occurred. Ensure that the surface is left in a condition ready for paving, free from scabbing, scaling and other defects. Ensure that any structure lost to additional, deeper milling to remove these defects is replaced with asphalt. Include this cost in the Cement Modified Recycled Base price.

14.0 CONSTRUCTION JOINTS

- 14.1** At the end of each day's construction, form a straight construction joint as specified in **Subsection 301.4.9**.

15.0 SURFACE SMOOTHNESS

- 15.1** Ensure that the finished surface of the recycled base meets the requirements of **Subsection 301.4.10**. The grade of the road will be based on existing conditions of the roadway. Grade the cross slope to obtain positive drainage as well as smooth transitions from crown to superelevated sections of the roadway, re-grade roads with a pre-existing cross slope of 2% or greater to the same cross slope. On roads with a pre-existing cross slope of less than 2%, the Contractor and **RCE** will determine the measures required to obtain positive drainage and the final cross slope.

16.0 RIDEABILITY

- 16.1** Ensure that the final asphalt surface placed on Cement Modified Recycled Base course meets the Rideability requirements of SC-M-403 for either New Construction or Resurfacing, whichever is applicable based on the specified pavement structure.

17.0 THICKNESS TOLERANCE

- 17.1** The thickness of the completed Cement Modified Recycled Base will be measured at random intervals not to exceed 1,000 feet in length. The average job thickness will be measured daily using the average value of all measurements taken by the inspector each day. Where the measured thickness is more than 1 inch greater than the specified thickness, the thickness of that location will be considered the specified thickness plus 1 inch. If the average job thickness varies from the specified job thickness by more than ½ inch, an adjusted unit price is used for calculating payment. The pay factor will be calculated as below and applied;

$$\text{Pay Factor} = 1 - \frac{|\text{Average Job Thickness} - \text{Specified Job Thickness}|}{\text{Specified Job Thickness}}$$

$$\text{Adjusted Contract Unit Price} = \text{Pay Factor} * \text{Contract Unit Price}$$

17.2 If the requirements of thickness (any single test value greater than 1 inch different from the specified depth) are not being met in a section not defined as a test strip (a section is 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.

18.0 OPENING TO TRAFFIC

18.1 Local traffic may use completed portions of the Cement Modified Recycled Base provided the base has hardened sufficiently to prevent marring, damaging or visible rutting of the surface by such usage. Ensure that no damage occurs to the curing coat. With approval of the District Office, temporary detours may be utilized during the reclamation process to reduce the traffic on the reclaimed roadway. Use the subgrade shoulders or completed pavement, when available, for transporting materials, workers, and equipment throughout the project. Do not place construction equipment on the base without the approval of the **RCE** unless it is being used in the subsequent construction operation.

19.0 MAINTENANCE

19.1 Maintain the Cement Modified Recycled Base in accordance with **Subsection 301.4.13**.

20.0 MEASUREMENT

20.1 The quantity for the pay item Cement Modified Recycled Base (of the uniform thickness required) is the surface area of a uniform base constructed by applying and mixing cement with the subgrade as specified and is measured by the square yard (SY) of the modified base in-place, complete and accepted. Cement Modified Recycled Base constructed outside the designated area is not measured for payment.

20.2 The quantity for the pay item Portland Cement for Cement Modified Recycled Base is the weight of cement incorporated into the base at the rate established by the **CSE** and is measured by the ton (TON), complete and accepted. Portland cement incorporated in excess of 5% of the amount established by the **CSE** is not included in the measurement. Furnish the **RCE** with invoices of all cement received to verify weight.

21.0 PAYMENT

21.1 Payment for the accepted quantity of Cement Modified Recycled Base (of the uniform required thickness) or Portland Cement for Cement Modified Recycled Base, measured in accordance with **Subsection 20** is determined using the contract unit bid price for the applicable item.

21.2 Payment for Cement Modified Recycled Base (of the uniform required thickness) is full compensation for constructing the Cement Modified Recycled Base course as specified or directed and includes pulverizing and scarifying the existing pavement, 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 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.

- 21.3** Base course that is deficient in thickness is paid for at the adjusted unit price specified in **Subsection 20**.
- 21.4** Payment for Portland Cement for Cement Modified Recycled Base 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, the Specifications, and other terms of the Contract.
- 21.5** Payment for excess reclaimed material generated from the roadway (excluding shoulder material) is paid for as unclassified excavation.
- 21.6** Payment for each item includes all direct and indirect costs or expenses required to complete the work.
- 21.7** Pay items under this section include the following:

Item No.	Pay Item	Unit
3063306	Cement Modified Recycled Base (6" Uniform)	SY
3063308	Cement Modified Recycled Base (8" Uniform)	SY
3063310	Cement Modified Recycled Base (10" Uniform)	SY
3063312	Cement Modified Recycled Base (12" Uniform)	SY
3064000	Portland Cement for Cement Modified Recycled Base	TON