

307-R-657 CEMENT STABILIZED FULL DEPTH RECLAMATION, FDR

(Adopted 04-20-17)

The Standard Specifications are revised as follows:

SECTION 307, BEGIN LINE 1, INSERT AS FOLLOWS:

SECTION 307 – CEMENT STABILIZED FULL DEPTH RECLAMATION, FDR

307.01 Description

This work shall consist of pulverizing and stabilizing an existing asphalt pavement along with existing base and subgrade materials to construct a reclaimed base course, RBC, to the approved design properties in accordance with 105.03.

307.02 Just in Time Training, JITT

The Engineer and Contractor are required to attend a JITT course regarding FDR and both shall mutually agree on the course instructor, course content and training site. The training class shall be conducted at a project field location convenient for all project construction personnel responsible for FDR operations and inspection to attend.

The JITT course shall be held during normal working hours and be completed not more than 14 days prior to the start of FDR operations.

The Contractor shall provide a JITT instructor experienced in the construction methods, materials and test methods associated with cement stabilized FDR. A copy of the course syllabus, handouts and presentation materials shall be submitted to the Engineer at least five business days before the course is to be taught.

307.03 Quality Control

A quality control plan, QCP, shall be submitted to the Engineer a minimum of five calendar days prior to the JITT. The QCP shall include the proposed FDR mix design; a start to finish process description to include discussion on corrective action measures; a list of proposed equipment; a list of proposed QC tests and testing frequencies; the curing methods applied to the cement stabilized RBC and the stabilization process applied to the RBC and subgrade after a failed proofroll. All QC test results shall be maintained during the duration of the contract and made available to the Engineer upon request.

| QC TESTING | |
|--|------------------------------------|
| <i>Test</i> | <i>Frequency^{1,2}</i> |
| <i>Depth of Pulverization</i> | <i>1 per 500 ft</i> |
| <i>Pulverized Material Gradation</i> | <i>1 per 0.5 day of production</i> |
| <i>In-place Moisture of Pulverized Material</i> | <i>1 per 0.5 day of production</i> |
| <i>Cement Application Rate</i> | <i>1 per 500 ft</i> |
| <i>Maximum Density and Moisture Content of Stabilized Material</i> | <i>1 per 0.5 day of production</i> |
| <i>Compacted In-Place Field Density</i> | <i>1 per 1000 ft</i> |

Notes:

1. *The Contractor shall perform all QC tests within the first 500 ft after startup and after any change in the mix design.*
2. *Testing frequency is based upon linear feet of FDR laydown.*

MATERIALS

307.04 Materials

RBC shall consist of a homogenous blend of reclaimed asphalt pavement, RAP, base and subgrade materials that are combined with cement, water, and when required, recycling additives such as corrective aggregate. The cement may be dry powder or slurry with a minimum dry solids content of 60%. The actual materials used are dependent on the FDR mix design and project requirements.

Materials for use in RBC shall be in accordance with the following:

Corrective aggregate to adjust gradation or supplement material volume:

1. *Coarse or Dense Graded Aggregate, Class C or Higher904.03*
 2. *Fine Aggregate.....904.02*
 3. *RAP, shall be the product resulting from the cold milling or crushing of an existing asphalt pavement. The RAP coarse aggregate shall be processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.*
- Portland Cement, Type I901.01(b)*
Water.....913.01

307.05 Mix Design

The FDR mix design shall be in accordance with ITM 595 and comprised of existing RAP, existing base and subgrade materials, cement and if necessary, recycling additives. The 7-day unconfined strength shall be based on the overlay lay rate specified on the plans.

| <i>Test</i> | <i>Procedure</i> | <i>Requirement</i> |
|---|------------------------------|--------------------------|
| <i>7-Day Unconfined Strength</i> | <i>ASTM D 1633, Method A</i> | <i>see notes 1, 2, 3</i> |
| <i>Notes:</i> | | |
| <ol style="list-style-type: none"> 1. <i>300 psi minimum when a HMA overlay with a total lay rate \geq 330 lb/sq yd is specified on the plans.</i> 2. <i>400 psi minimum when a HMA overlay with a total 165 lb/sq yd \leq lay rate < 330 lb/sq yd is specified on the plans.</i> 3. <i>500 psi minimum when a HMA overlay with a total lay rate < 165 lb/sq yd or an applied seal coat surface is specified on the plans.</i> | | |

The mix design and all associated testing shall be performed using samples of the existing pavement, base and subgrade material from the project site representing the reclaiming depth, by a design laboratory that is AASHTO Material Reference Laboratory, AMRL, accredited for soil, aggregates, and concrete.

The sulfate content for the subgrade material shall be less than or equal to 1000 ppm as determined in accordance with ITM 510.

Additional mix designs shall be performed when the in-place material changes significantly in order to establish representative mixes for the entire job. The Contractor is responsible for obtaining all samples required to develop the mix design. One sample per lane mile of planned RBC shall be the minimum sampling frequency for mix design preparation.

The Contractor shall provide a mix design or designs for approval at least five calendar days prior to the JITT. The mix design shall include all test results performed. If new materials are added, a new mix design, including the revised test results, shall be submitted at least one day prior to implementation.

CONSTRUCTION REQUIREMENTS

307.06 Roadway Preparation

Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) prior to FDR operations.

Grass and other vegetation shall be removed from the edge of the existing pavement to prevent contamination of the RBC during milling operation.

Grade adjustments of existing structures shall be made in accordance with 720.04 except existing structures shall be lowered prior to FDR operations, properly covered and filled with material compatible with the FDR mix design to maintain traffic.

All areas of soft or yielding subgrade, as shown on the plans, shall be corrected prior to pulverization operations.

307.07 Equipment

The equipment shall be capable of pulverizing the existing asphalt pavement, base and subgrade materials. The equipment used for mixing the pulverized materials with cement, water, additives and corrective aggregate, when required, shall be capable of producing a homogenous and uniformly blended RBC. The equipment used for placement of the RBC shall be capable of placement in accordance to 105.03.

The equipment shall consist of the following major components:

(a) Spreaders and Distributors

Spreaders or distributors used to apply dry powder additives shall be non-pressurized mechanical vane-feed, cyclone or screw type capable of providing a consistent, accurate and uniform distribution of material while minimizing dust during construction. Corrective aggregate, when required, may be placed by a mechanical spreader, a conventional paver or by tailgating with end dump trucks and spread to a uniform thickness with a motor grader.

(b) Additive Slurry Storage and Supply Equipment

Slurry shall be produced using a batch or continuous-flow type stationary mixer equipped with calibrated metering and feeding devices that introduce the cement, water and additives into the mixer in the specified quantities. Additive slurry storage and supply

equipment shall have agitators or similar equipment to keep the slurry in suspension when held in the slurry batch or storage tanks. Slurry shall be kept in suspension during transport using agitator equipment.

(c) Mixing and Reclaiming Equipment

Only self-propelled, high powered, minimum 500 hp rotary mixers or reclaimers capable of mixing in-place to the depth specified shall be used. The minimum cutting drum width shall be 7 ft and fitted with cutting teeth capable of trimming earth, aggregate and HMA and be so designed that they may be accurately adjusted vertically and held in-place. The machine shall not weigh less than 25,000 lbs and shall have the strength and rigidity so that it shall not develop a center deflection of more than 1/8 in.

The mixer or reclaimer shall be fitted with an integrated water injection system capable of introducing the water into the cutting drum during the mixing process. The metering device shall be capable of automatically adjusting the flow of material to compensate for any variation in the amount of reclaimed material introduced into the mixing chamber. The water shall be calculated on a volumetric basis tied to a speed gauge, ft/min, using a calibrated meter that is capable of accurately measuring the amount of material to within 0.5% of the rate required. Automatic digital readings shall be displayed for both the flow rate and total amount of reclaimed material in appropriate units of weight and time.

(d) Motor Grader

A motor grader for pre-shaping, aerating, spreading and final shaping of the material shall be provided. The motor grader shall have a cross slope indicator.

(e) Compaction Equipment

The RBC shall be compacted using self-propelled rollers. The number, weight and types of rollers shall be as necessary to obtain the required compaction throughout the entire RBC thickness. The rollers may be used in any combination and may include a pneumatic tire roller, an 84 in. wide drum vibratory pad-foot roller equipped with a knockdown blade or a 10 t minimum single or double drum vibratory steel roller.

(f) Water Trucks

Water truck for supplying water to the reclaimer or roadway for addition of moisture during the reclaiming operation shall be provided. The water truck shall be capable of providing a controlled and consistent spray without eroding or otherwise damaging the compacted RBC.

307.08 Weather Restrictions

FDR operations shall not be performed when the soil, aggregate or subgrade is frozen, when the ambient temperature is below 40°F or when freezing temperatures are anticipated within seven days of the end of RBC placement. The Engineer may restrict work when the heat index is greater than 100°F. The FDR shall not be performed before May 1st or after October 1st.

307.09 Pulverization

The existing pavement shall be pulverized and stabilized in separate operations.

Corrective aggregate, when required, shall be spread onto the existing surface using a mechanical spreader, a conventional paver or by tailgating with end dump trucks and spread to a uniform thickness with a motor grader. The pre-determined full depth of asphalt pavement, base and subgrade materials shall be pulverized, along with the corrective aggregate, to a homogenous mixture. The mixture may be brought to the desired moisture content during this process by means of surface application or through the mixing or reclaiming equipment's integrated fluid injection system for dust control. The base course shall not contain roots, sod, topsoil, weeds, wood or any material deleterious to its reaction with the cement stabilizer.

For cement stabilized RBC, the pulverization shall produce a gradation that has 100% passing the 2 in. (50 mm) sieve and $\geq 55\%$ passing the No.4 (4.75 mm) sieve.

When a paving fabric is encountered during the pulverization operation, the Contractor shall make the necessary changes in equipment or operations so that incorporation of shredded fabric into the RBC does not affect the performance parameters or inhibit placement or compaction of the RBC. The Contractor shall be required to remove and properly dispose of oversized pieces of paving fabric. The Contractor shall make the necessary adjustments in equipment or operations so that the shredded fabric in the recycled material is no more than 5 sq in. No fabric piece shall have a dimension exceeding a length of 4 in.

Rubberized crack filler, durable pavement markings, loop wires, and other non-pavement materials shall be removed as observed from the roadway during the pulverization process. Residual materials that cannot be completely removed may be incorporated into the mixture if the Contractor can demonstrate that those added materials will not adversely affect performance.

Any such materials retained in the mixture shall be appropriately sized and blended so as to not adversely affect the strength of the RBC.

307.10 Stabilization

The cement used to stabilize the RBC may be dry powder or slurry and the Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used. The pulverized surface shall be scarified or knifed prior to applying materials in slurry form to prevent runoff or ponding. Any dry additives used shall be spread onto the pulverized surface using a mechanical spreader. The pulverized material shall be mixed with the stabilizer and additives as required by the mix design to create a homogeneous RBC.

The in-place moisture content of the material shall be within -1% to +2% of the design moisture content as determined by the mix design.

Cement stabilizing materials shall have an application tolerance determined by adding $\pm 0.5\%$ to the percent total cement content.

The cement shall be incorporated into the pulverized material at the initial rate determined by the mix design and approved by the Engineer. Sampling and mix design may determine different levels of cement at various portions of the project.

The Contractor can request the cement percentage to exceed the upper tolerance provided the mix design requirements are satisfied at the requested percentage. The request will be subject to approval by the Engineer.

307.11 Control Strip and Compaction

A minimum 500 ft long control strip shall be conducted on the first day of production to verify the construction process meets the requirements as specified. The control strip shall allow the Contractor to:

- (a) demonstrate the equipment, materials and processes proposed can produce a RBC layer in accordance with specification requirements;*
- (b) determine the optimal rates for the cement, water and any additives recommended for the reclaimed material;*
- (c) determine the sequence and manner of rolling necessary to obtain strength requirements in one uniformly compacted layer.*

The RBC density shall be achieved with the same equipment, materials, construction methods and density requirements used on the accepted control strip. A new control strip shall be constructed if changes are made outside the tolerances of the original mix design, equipment or construction methods.

The processed material shall be uniformly compacted in one layer to a minimum of 95% of the maximum density. Maximum density shall be determined in accordance with AASHTO T 180 at the required QC frequency from a representative sample collected after the cement has been added and mixed into the pulverized material but prior to compaction.

Compaction shall be monitored in accordance with AASHTO T 310 in the direct transmission mode and continue to reach a minimum of 95% of the established maximum density during the control strip and for the remainder of the compaction operation.

Compaction equipment shall be in accordance with 307.07(e). Initial compaction shall be within 500 feet of the reclaiming unit using either a vibratory pad-foot roller, a pneumatic tire roller or a combination of the two. The pass counts shall continue to increase until the cleat indentations from the pad-foot roller are no more than 3/16 in. in depth and light can be seen between the pad-foot and RBC interface or there are no wheel impressions from the pneumatic tire roller remaining in the RBC.

The cement stabilized material shall be bladed and shaped by a motor grader in accordance with 307.07(d) to remove any remaining roller marks or indentations then leveled in accordance with 301.07. The profile grade and cross section of the RBC shall

be finished within a tolerance of $\pm 1/2$ in. from the plan RBC elevation prior to profile milling.

Intermediate and final compaction shall be applied to the bladed and shaped RBC using either a pneumatic tire roller, a single or double drum vibratory steel roller or a combination of the two. Finish rolling shall not be performed in vibratory mode. The compaction operation shall be performed while the RBC remains in a workable condition and continued until roller marks no longer appear.

Any type of rolling effort that causes cracking, displacement or other type of pavement distress shall be discontinued until such time as the problem can be resolved and approved by the Engineer.

The QC technician shall be on site, observing all compaction efforts and approving areas as they reach minimum relative compaction. Care shall be taken not to over compact the mat.

All tests shall be conducted at the stated QC testing frequencies throughout FDR operations.

307.12 Opening to Traffic

Opening to traffic shall occur after sufficient cure time has been applied to the RBC so traffic will not initiate raveling or permanent deformation. All loose particles that may develop on the pavement surface shall be removed by a rotary power broom in accordance with 409.

After opening to traffic, the surface of the RBC shall be maintained in a condition suitable for the safe movement of traffic.

307.13 Maintenance

The Contractor shall maintain the RBC in a manner satisfactory to the Engineer until the surface course has been constructed.

Any damage to the completed recycled material shall be repaired by the Contractor prior to the placement of new HMA or final surface sealing. Patching shall be in accordance with 304. The excavated patch areas shall be filled and compacted with HMA or RBC material as directed by the Engineer. No direct payment will be made for damage or repair unless approved by the Engineer.

307.14 Curing

The planned method and duration of curing for cement stabilized RBC shall be in accordance with the QCP. The specified surface course shall be placed within two weeks of the RBC final cure, but no later than November 1.

Before placing the final surfacing, the cement stabilized RBC shall remain in-place for a minimum of three days.

Cement stabilized RBC shall be cured to minimize moisture loss from the surface for a time period that achieves the minimum required seven day unconfined strength.

307.15 Proofrolling

The cement stabilized RBC shall be proofrolled in accordance with 203.26 using a tandem or tri-axle dump truck loaded to the legal limit and operated between 2 to 4 mph over the RBC. The Engineer will determine the limits for any area that has deflection or rutting greater than 1/2 in.

The Contractor shall rework the areas failed in proofrolling by re-pulverizing and re-stabilizing the RBC in-place at no additional cost or by removing the RBC and stabilizing the subgrade with subgrade treatment Type IC in accordance with 207.

The process for achieving subgrade stabilization and replacing the RBC material shall be detailed in the QCP. The reworked areas shall be proofrolled for final acceptance.

In locations of failing subgrade the RBC shall be removed and subgrade treatment Type IC shall be placed in accordance with 207. HMA patching, type B shall be placed in accordance with 304.

307.16 Milling

The entire surface of the cement stabilized RBC shall be scarified in accordance with 306 to the specified cross-slope in preparation for the overlay. Construction engineering in accordance with 105.08(b) shall be provided.

307.17 Underdrain Installation

Underdrain installation in accordance with 718, when required, shall begin after having completed the proofrolling.

307.18 RBC Overlay

The overlay atop the RBC shall be as shown on the plans. The overlay shall be placed after having completed the proofrolling.

The RBC shall be swept of all loose material and standing water with a rotary power broom in accordance with 409 immediately prior to placing the surface. The RBC shall be swept lightly to avoid damage to the RBC.

A tack coat shall be required only for the HMA overlay and shall be applied to the RBC in accordance with 406 immediately following sweeping operations.

Monuments shall be reestablished in accordance with 615.10.

307.19 Method of Measurement

The RBC will be measured by the square yard complete in place. Cement will be measured by the ton. Subgrade treatment will be measured in accordance with 207.05. Aggregate to adjust the RBC gradation will be measured by the ton of material used. HMA patching, type B will be measured in accordance with 304.06. Milling will be

measured in accordance with 306.10. Re-established monuments will be measured in accordance with 615.13. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12.

307.20 Basis of Payment

The RBC will be paid for as full depth reclamation at the contract unit price per square yard, complete in place. Cement will be paid for at the contract unit price per ton, complete in place. Subgrade treatment will be paid for in accordance with 207.06. Aggregate used to adjust the RBC gradation will be paid for at the contract unit price per ton, complete in place. HMA patching, type B will be paid for in accordance with 304.07, of the thickness specified on the plans. Milling will be paid for in accordance with 306.11. Re-established monuments will be paid for in accordance with 615.14. Removal of snowplowable raised pavement markers will be paid for in accordance with 808.13.

Payment will be made under:

| Pay Item | Pay Unit Symbol |
|--|------------------------|
| <i>Corrective Aggregate, FDR</i> | <i>TON</i> |
| <i>Full Depth Reclamation</i> | <i>SYS</i> |
| <i>Stabilizing Material, Portland Cement</i> | <i>TON</i> |

The costs of the FDR mix design and QC testing shall be included in the cost of the full depth reclamation.

The costs associated with removal of grass and vegetation, rubberized crack filler, durable pavement markings, loop wires and other non-pavement materials shall be included in the cost of the full depth reclamation.

The costs associated with pulverizing, stabilizing, compacting curing and maintenance of the RBC shall be included in the cost of the full depth reclamation.

The cost associated with mixing water shall be included in the cost of the full depth reclamation.

The cost associated with aggregate when used to supplement material volume shall be included in the cost of the full depth reclamation.

The cost associated with aggregate when used to adjust the RBC gradation shall be included in the cost of the corrective aggregate pay item.

In the locations of failing subgrade, removal of the RBC shall be included in the cost of subgrade treatment.