

413-R-634 FULL DEPTH RECLAMATION, FDR

(Revised 05-19-16)

The Standard Specifications are revised as follows:

SECTION 413, BEGIN LINE 1, DELETE AND INSERT AS FOLLOWS:

SECTION 413 - ~~BLANK~~ FULL DEPTH RECLAMATION, FDR

413.01 Description

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

413.02 Quality Control

A quality control plan, QCP, shall be submitted to the Engineer a minimum of 15 calendar days prior to beginning the pulverization operation. The QCP shall include the proposed RBC 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 stabilized RBC and the stabilization process applied to the RBC or 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*</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>Asphalt Emulsion Content or Cement Application Rate</i>	<i>1 per 500 ft</i>
<i>Optimum Moisture and Maximum Dry Density</i>	<i>1 per 0.5 day of production</i>
<i>Compacted In-Place Field Density</i>	<i>1 per 1000 ft</i>
* <i>The Contractor shall perform all QC tests within the first 500 ft after startup or after any change in the mix design.</i>	

MATERIALS

413.03 Materials

RBC shall consist of a homogenous blend of asphalt pavement in addition to base and subgrade materials that are combined with asphalt or cement materials, water, additives and corrective aggregate, when required. The actual materials used are dependent on the mix design and project requirements.

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

- Asphalt EmulsionAs Defined**
- Aggregate to correct the RBC gradation:*
 - 1. Coarse or Dense Graded Aggregate, Class C or Higher904.03*
 - 2. Fine Aggregate.....904.02*

3. Reclaimed asphalt pavement, RAP, shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP coarse aggregate shall be processed so that 100% passes the 1 1/2 in. (37.5 mm) sieve.

Fly Ash, Class C.....	901.02
Lime.....	913.04(b)
Portland Cement, Type I.....	901.01(b)
Water.....	913.01

* The requirements for asphalt emulsion shall be in accordance with the following:

CHARACTERISTIC	TEST METHOD	MIN.	MAX.
Viscosity, Saybolt Furol @ 77°F (25°C), s	AASHTO T 59	20	100
Sieve Test, No. 20, retained on sieve, %	AASHTO T 59		0.10
Storage Stability Test, 24 h, %	AASHTO T 59		1.0
Distillation Test ¹ , Residue by Distillation, %	AASHTO T 59	64.0	
Oil Distillate by volume, %	AASHTO T 59		1.0
Penetration, 77 °F, 100 g, 5 s, dmm	AASHTO T 49	50	200
Note 1: Modified AASHTO T 59 – distillation temperature of 347 ± 9°F with a 20 minute hold.			

413.04 Mix Design

The mix design and all associated testing shall be performed, using samples of the existing pavement and underlying 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 or HMA and asphalt, depending on the stabilizing additive used. 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 of either type for approval at least 15 calendar days prior to beginning the pulverization operation. The maximum dry density and optimum moisture content of the final mix design shall be determined in accordance with AASHTO T 180. 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.

Asphalt stabilized RBC mix designs^{1, 2, 3} shall be comprised of asphalt emulsion and have a design gradation of 100% passing the 2 in. (50 mm) sieve, ≥ 35% passing the No.4 (4.75 mm) sieve and 2% to 20% passing the No.200 (75 μm) sieve.

The design strength shall be as follows:

Test	Procedure	Requirement
Indirect Tensile Strength ^{4, 5}	ASTM D 4867	45 psi, min., dry 30 psi, min., wet

- Notes:
1. Allowable ratio of asphalt stabilizer to total cementitious shall be 3:1 min.
 2. Allowable total cementitious shall be 1.0% max.
 3. 30 gyrations, 6 in. diameter specimens prepared in accordance with AASHTO T 312.
 4. Indirect tensile strengths shall be determined on fully cured specimens.
 5. Dry specimens tested at 25°C; wet specimens tested at 25°C at minimum 55% saturation after 24 h soak.

Cement stabilized RBC mix designs shall have a design gradation of 100% passing the 2 in. (50 mm) sieve, \geq 55% passing the No.4 (4.75 mm) sieve and 5% to 20% passing the No.200 (75 μ m) sieve. The 7-day unconfined strength shall be based on the overlay lay rate specified on the plans:

Test	Procedure	Requirement
7-Day Unconfined Strength	ASTM D 1633, Method A	see notes 1, 2, 3
Notes: 1. 300 psi minimum when a HMA overlay with a total lay rate \geq 330 lb/sq yd is specified on the plans.		
2. 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.		
3. 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.		

CONSTRUCTION REQUIREMENTS

413.05 Construction Requirements

Snowplowable raised pavement markers shall be removed in accordance with 808.11(e) and all areas of soft or yielding subgrade, as shown on the plans, shall be corrected prior to pulverization operations.

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

Adjustments may be made to the stabilizer, water, additives and corrective aggregate, when required, to produce a RBC with optimal performance that meets specification requirements.

The stabilizer used in cement stabilized RBC and the additives used in either asphalt or cement stabilized RBC may be dry powder or slurry with a minimum dry solids content of 30%. The Contractor shall address the application methods and fugitive dust control procedures in the QCP when dry powder materials are used.

413.06 Equipment

The equipment shall be capable of pulverizing the existing asphalt and underlying materials. The equipment used for mixing the pulverized materials with stabilizer, 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 to the lines, grades and guidelines provided herein and as shown on the plans.

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 a depth of 14 in. 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 and stabilizer injection system capable of introducing material 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 or stabilizer 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) Rollers

The RBC shall be compacted using self-propelled rollers, complete with properly operating scrapers. 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 and for curing 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.

413.07 Weather Restrictions

The work shall not be performed when the soil, aggregate or subgrade is frozen, when the ambient temperature is below 45°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 Engineer may restrict work when the weather is foggy or rainy.

413.08 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 HMA, base and subgrade materials shall be pulverized, along with the corrective aggregate, to a homogenous mixture. The mixture shall 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. The base course shall not contain roots, sod, topsoil, weeds, wood or any material deleterious to its reaction with the asphalt or cement stabilizer.

For asphalt stabilized RBC, the pulverization shall produce a gradation that has 100% passing the 2 in. (50 mm) sieve and $\geq 35\%$ passing the No.4 (4.75 mm) sieve.

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. Additionally, 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.

413.09 Stabilization

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.

Asphalt stabilizing materials shall have an application tolerance determined by adding $\pm 0.25\%$ to the percent total asphalt emulsion content.

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

The Contractor can request the stabilizing percentage to exceed the upper tolerance provided the mix design evaluated the RBC properties at or above the requested percentage. The request will be subject to approval by the Engineer.

The stabilized material shall be spread and 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 by using a motor grader or other mechanical means prior to profile milling.

The compaction operation shall be performed while the RBC remains in a workable condition and continued until roller marks no longer appear.

413.10 Control Strip and Compaction

A minimum 500 ft long control strip shall be conducted 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 to produce a RBC layer in accordance with specification requirements;*
- (b) determine the optimal rates for the stabilizer, water and any additives recommended for the reclaimed material;*
- (c) determine the sequence and manner of rolling necessary to obtain strength in one uniformly compacted layer.*

The optimum moisture content and maximum dry density of the RBC shall be determined in accordance with AASHTO T 180. The moisture content, at the start of compaction, shall be within - 1% to + 2% of the design optimum.

A control strip will be accepted when a five consecutive test average of 95% of the design maximum dry density with no single test below 94% of the design maximum dry density is demonstrated. A control strip that does not meet the density requirements shall be reworked at no additional cost.

The RBC density shall be achieved with the same equipment, materials and construction methods used on the accepted control strip and monitored in accordance with AASHTO T 310 in the direct transmission mode for the remainder of compaction operations.

All tests shall be conducted at the stated QC testing frequencies. A new control strip shall be constructed if changes are made to the original mix design, equipment or construction methods.

413.11 Curing

The stabilized RBC shall be cured for a sufficient time period to allow proofrolling.

Asphalt stabilized RBC shall be cured for a time period that achieves in-place moisture contents below 2.5% or the in-place moisture contents have stabilized at 50% or less of the design optimum moisture content for a continuous time period of five days.

Cement stabilized RBC shall be cured for a time period that achieves the minimum required seven day unconfined strength.

The planned method and duration of curing for asphalt or cement stabilized RBC shall be detailed in the QCP.

413.12 Asphalt Milling

The stabilized RBC shall be asphalt milled 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.

413.13 Proofrolling

The stabilized RBC shall be proofrolled in accordance with 203.26, after asphalt milling operations have been completed, 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 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 shall be placed in accordance with 207. HMA patching, type B shall be placed in accordance with 304.

413.14 Underdrain Installation

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

413.15 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 with a rotary power broom in accordance with 409 immediately prior to placing the overlay. 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.

413.16 Opening to Traffic

The FDR treated pavement shall be opened to traffic, in addition to local traffic and construction equipment, only after the overlay atop the RBC has been constructed.

413.17 Method of Measurement

The RBC will be measured by the square yard complete in place. Additional stabilizing material, when required, will be measured by the ton in accordance with 109.05(b) for the type specified. Subgrade treatment will be measured in accordance with 207.05. Aggregate, when used to correct the RBC gradation, will be measured by the ton of material used. Asphalt milling will be measured in accordance with 306.09. HMA patching, type B will be measured in accordance with 304.06. Re-established monuments will be measured by the number of units installed in accordance with 615.13. Removal of snowplowable raised pavement markers will be measured in accordance with 808.12.

413.18 Basis of Payment

The RBC will be paid for as full depth reclamation at the contract unit price per square yard, complete in place. The accepted quantities of additional stabilizing material will be paid for at the contract unit price per ton for the type specified, complete in place. Subgrade treatment will be paid for in accordance with 207.06. Aggregate used to correct the RBC gradation will be paid for at the contract unit price per ton, complete in place. Asphalt milling will be paid for in accordance with 306.10. HMA patching, type B will be paid for in accordance with 304.07, of the thickness specified on the plans. Re-established monuments will be paid for at the contract unit price per each complete in place 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
Corrective Aggregate	TON
Full Depth Reclamation	SYS
Stabilizing Material, Asphalt Emulsion	TON
Stabilizing Material, Portland Cement	TON

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

The costs of removing grass and vegetation, pulverizing, stabilizing, compacting and curing the RBC shall be included in the cost of the full depth reclamation.

The costs of the asphalt emulsion or portland cement stabilizing material shall be included in the cost of the stabilizing material pay item.

The costs of removing existing material to maintain profile shall be included in the cost of the asphalt milling.

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