

DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

SPECIAL PROVISION

Draft

Section 418—Cold in Place Recycled Mixtures

418.1 General Description

This work includes cold mill in-place recycling and crushing (reclaiming) of a portion of the existing layers of asphaltic concrete to the length, depth and width shown on the plans. Produce a recycled pavement by sizing the crushed asphaltic concrete pavement and blending with emulsified asphalt or other approved bituminous recycling agents to produce a recycled asphalt material layer meeting the approved Cold in Place Recycled Mix Design. Place and compact the recycled material in accordance with the plans and specifications. The recycled pavement shall conform with lines, grades, thicknesses, and typical cross sections shown on the Plans or established by the Engineer.

The compacted depth of the Cold in Place recycled Mixture shall be _____ inches as determined by the Engineer.

This section includes the requirements for all Cold in Place Recycled Mixtures regardless of the gradation of the aggregates, type and amount of bituminous recycling agent, or pavement use.

Acceptance of work is on a lot-to-lot basis according to the requirements of this Section and [Section 106](#).

418.1.01 Definitions

Cold in Place Recycling (CIR): A process of recycling asphaltic concrete pavements without the application of heat that consists of milling, crushing, remixing the recycled materials, placing and compacting the recycled materials.

Segregated Mixture: Mixture lacking homogeneity in CIR pavement constituents of such magnitude there is a reasonable expectation of accelerated pavement distress or performance problems. May be quantified by measurable changes in gradation, bituminous recycling agent content, in place density, or surface texture.

Reclaimed Asphalt Pavement (RAP): an excavated asphaltic concrete material that is obtained by cold milling and crushing or screening to produce a reprocessed material.

Acceptance sample: a sample of the CIR material obtained and tested by the Department that is used for acceptance or pay decision.

Independent Sample (Quality Assurance Sample): A sample taken by the Department to verify an acceptance decision without regard to any other sample that may also have been taken to represent the material in question.

418.1.02 Related References

A. Standard Specifications

[Section 106—Control of Materials](#)

[Section 109—Measurement and Payment](#)

[Section 802—Coarse Aggregate for Asphaltic Concrete](#)

B. Referenced Documents

AASHTO T 11

AASHTO T 27

AASHTO T 51

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AASHTO T 53

AASHTO T 59

AASHTO T 72

AASHTO T 180

AASHTO T 202

AASHTO T 209

AASHTO T 245

AASHTO T 301

AASHTO T 302

AASHTO T 312

ASTM D 5546 – 01

ASTM D 1557, Method C

ASTM D 2041

ASTM D 2726

ASTM D 6752

ASTM D 6857

ASTM 5581

ASTM D 7196

[GDT 38](#)

[GDT 42](#)

[GDT 66](#)

[GDT 73](#)

[GDT 83](#)

[GDT 119](#)

[GDT 125](#)

[GSP 15](#)

[GSP 21](#)

[QPL 1](#)

[QPL 2](#)

[QPL 7](#)

[QPL 26](#)

[QPL 39](#)

[QPL 41](#)

[QPL 45](#)

[QPL 67](#)

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[Department of Transportation Standard Operating Procedure \(SOP\) 15](#)

[Department of Transportation Standard Operating Procedure \(SOP\) 40](#)

[Department of Transportation Standard Operating Procedure \(SOP\) 41](#)

418.1.03 Submittals

A. CIR Mix Design

Submit the proposed CIR mix design for each distinct roadway section to the Office of Materials and Testing for approval prior to construction. The CIR mix design shall specify target blended gradation, source, type and gradation of any additional aggregate or RAP, source, and type of emulsified asphalt or other approved bituminous recycling agent. Actual materials (in-situ sampled by the Contractor and any new materials from GDOT approved suppliers) must be used for the CIR mix design.

Purchase emulsified asphalt or other approved bituminous recycling agent directly from a supplier listed on Qualified Products List 7 (QPL-7).

Provide copies of Bill of Lading(s) at the Department's request. Show the following on the Bill of Lading:

- Date shipped
- Quantity in tons (mega grams)
- Included with or without additives

B. Construction Work Plan

Before construction of a test section in accordance with [Subsection 418.3.04](#), submit a Construction Work Plan to the Engineer for approval. Include proposed equipment and recycling and compaction procedures. If the Engineer determined that the Work Plan is not satisfactory; revise the work plan and augment or replace equipment, as necessary, to complete the Work. As a minimum, include the following in the Construction Work Plan:

- Proposed starting date
- Location and proposed staging or work
- Plan to assure completed recycled pavement meets specified roadway geometry (slope, grade, etc...) and disposal of any created surplus CIR material necessary to meet Contract specified final pavement elevation
 - Sketch of the typical section showing the paving operation sequence for each placement operation
- Equipment Description
 - Recycling or Milling Machine
 - Screening/Crushing Unit
 - Pug mill/Mixing Unit
- Targeted milling speed for each recycling operation (feet, meter/minute)
- Paver or Screed Model and Type
- Mat Width for each recycling operation
- Number, type and weight (mass) of rollers for compaction operation
- Electronic controls used for each recycling operation
- Temporary pavement striping plan

If staged construction is designated in the Plans or Contract, provide a Construction Work Plan for each construction stage.

If segregation related raveling of the in-place CIR material is evident, submit a written plan of measures and actions to prevent segregation and correct segregated in-place CIR material. Work will not continue until the plan is submitted to and approved by the Department.

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C. Job Mix Formula

Submit to the Engineer a written job mix formula proposed for CIR mix design to be used based on an approved CIR mix design. Furnish the following information for each CIR mixture.

- List project number, PI number and/or Contract ID number and County
- Source and description of any additional materials (virgin aggregate or stockpile RAP) to be used
- Proportions and gradations of any raw materials to be combined in the CIR mixture
- Targeted gradation of CIR mixture by percent passing for each specified sieve
- Percentage of emulsified asphalt or other approved bituminous recycling agent determined in the CIR mix design by weight of the total CIR mixture
- Theoretical specific gravity of the CIR mixture at the designated emulsified asphalt or other approved bituminous recycling agent content
- Percentage of water as determined in Item 3, Table 3
- Name of the person or agency responsible for quality control of the CIR recycling operation during construction

Do the following to have the formulas approved in accordance with [SOP 40 “Approval of Contractor Job Mix Formulas”](#) and to ensure their quality:

1. Submit proposed job mix formulas for review at least one week before beginning the CIR operations.
2. Do not start work until the Engineer has approved the job mix formula(s).
3. After the job mix formula has been approved, assume responsibility for the quality control of the mixtures supplied to the Department according to [Subsection 106.01, “Source of Supply and Quantity of Materials.”](#)

D. Quality Control Program

Prior to construction, submit a Quality Control Plan to the Office of Materials and Testing for approval. As a minimum requirement, include in the Quality Control Program the following information:

- A detailed description of the Contractor’s Quality Control Organization, including the number of full time equivalent employees or sub-contractors with specific Quality Control responsibilities. Include an Organizational Chart showing the lines of authority and reporting responsibilities
- A listing, by discipline with the name qualifications, experience, duties, responsibilities and authorities for all persons proposed to be responsible for Construction Quality Control
- Quality Control Sampling, Testing and Analysis Plan detailing compliance with GDT 73, Georgia’s Random Selection and Testing Guidelines
- Identification and description (Accreditation) of the laboratory(s) to be used for testing
- Specify documentation of QC activities
- Procedures to meet contract requirements for corrective action should Departmental Acceptance criteria not be achieved
- Procedures to plan CIR operations to mitigate construction process from receiving excessive moisture from weather events (i.e. rain, fog, etc...) and corrective actions when criteria is not achieved

The Contractor is required to have a supervisory representative at the project site during mixing and placing operations at all times. At a minimum, this person must:

- Have two (2) years minimum experience with the CIR process
- Have supervised a minimum three (3) CIR projects
- Have experience in developing/designing CIR mix designs
- If directed by the Engineer, submit a list of references, with current phone numbers, of persons (agencies) who are able to verify the experience required herein

418.2 Materials

Ensure materials comply with the specifications listed in [Table 1](#).

Table 1—Materials Specifications

Material	Subsection
Asphalt Cement, Grade Specified (Note 1)	820.2
Coarse Aggregates for Asphaltic Concrete (Note 6)	802.2.02
Fine Aggregates for Asphaltic Concrete (Note 6)	802.2.01
Cationic Emulsified Asphalt (Note 1, 2)	824.2
Portland Cement (Note 3)	830.2
Water (Note 4)	880.2.01.A
Mineral Filler (Note 3)	883.1
Hydrated Lime (Note 3)	882.2.03

Note 1: Ensure emulsified asphalt or other approved bituminous recycling agent used in Cold in Place Recycling are approved on QPL-7, Georgia’s List of Approved Bituminous Materials Suppliers”.

Note 2: Ensure the emulsified asphalt or other approved bituminous recycling agent is selected for the project by the emulsified asphalt or other approved bituminous recycling agent producer based on the Contractor’s approved CIR mix design. Ensure the penetration of the supplied emulsified asphalt or other approved bituminous recycling agent is within $\pm 25\%$ of the penetration of that used in the original approved CIR mix design. A representative from the emulsified asphalt or other approved bituminous recycling agent supplier shall be on the CIR project site at the beginning of the project to monitor the characteristics and performance of the emulsified asphalt or other approved bituminous recycling agent. Additionally, a representative must be available to observe operations and recommend adjustments to the emulsified asphalt’s or other approved bituminous recycling agent’s formulation as directed by the Engineer.

Note 3: Ensure any additional additives are described in the submitted CIR mix design. Hydrated lime is required in all CIR mix designs at a minimum rate of 1.0 percent. Portland cement may be used at a small rate to increase the cohesion rate, to aid in curing, early strength gain and/or improve moisture susceptibility properties of the CIR mixture.

Note 4: Ensure any water used for mixing meets the requirements of [Sub-section 880.2](#) in the specifications.

Note 5: When included in the original CIR mix design, additional RAP material may be incorporated by the Contractor. Ensure the additional RAP material is from an approved source in accordance with SOP 41, Georgia’s Standard Operating Procedure for Approval of Recycled Asphalt Pavement for use in Asphalt Mixtures.

Note 6: When necessary to meet CIR job mix formula, the Contractor may request additional virgin aggregate provided the modified CIR mix design meets all specified requirements. Ensure that any additional aggregate meets the requirements of [Sub-section 802.2](#).

418.2.01 CIR Mix Design

Ensure the CIR Mix Design is submitted to the Office of Materials and Testing for approval no less than 30 calendar days prior to the proposed start of the CIR operations. More than one CIR mix design may be required depending on the project conditions. Ensure the gradation of each CIR mix design falls with the bands shown in [Table 2](#). The CIR mix design submitted for approval must include any additional ingredients such as virgin aggregate, or stockpiled RAP proposed for use during the actual CIR operations ([Table 1 - Note 5](#)).

Table 2 – CIR Mix Design Limits*			
Sieve Size	Fine Gradation	Medium Gradation	Coarse Gradation
	Percent Passing		
1" (25 mm)	100**	100**	100**

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$\frac{3}{4}$ " (19 mm)	95-100	93-97	83-87
No. 4 (4.75 mm)	60-70	48-52	38-42
No.30 (600 μ m)	25-30	8-12	3-7
No. 200 (75 μ m)	1-7	1-3	0.5-2
<p>* Based on crushed material, washed following AASHTO T 27 and T11, prior to mixing with emulsified asphalt or other approved bituminous recycling agent.</p> <p>**100% of CIR mixture must pass 1" (25 mm) sieve.</p> <p>***Maximum % water shall be determined in Item 3, Table 3.</p> <p>****All CIR mix designs require a minimum of 1.0 percent hydrated lime.</p>			

If a change in source of the virgin aggregate is requested during construction, a new CIR mix design must be submitted to the Office of Materials and Testing and approved prior to use on the project. The new CIR mix design must meet the requirements established in [Table 3](#).

Table 3 – CIR Mix Design Requirements				
Item	Design Parameter	Test Method	Fabrication/Condition Procedure	Criteria
1	Gradation for Design Millings (Crushed)	AASHTO T 27	Taken from full depth of proposed CIR pavement section	1" (25 mm) Maximum Size Table 2
2	Asphalt Content Of RAP	ASTM D 2172 Method D 5 or GDT 119	Taken from full depth of proposed CIR pavement section	Report
3	Optimum Moisture	ASSHTO T 180		Determined by Mix Design
4	Bulk Specific Gravity of Compacted Samples	ASTM D 2726 AASHTO T166	AASHTO T 312 30 gyrations	Report
5	Maximum Theoretical Specific Gravity	ASTM D 2041 AASHTO T 209		Report
6	Marshall Stability Test	ASTM 5581 AASHTO T 245 4" (100 mm) samples 6" (150 mm) samples	Three (3) specimens shall be produced at 75 blows per side or 30 gyrations (AASHTO T 312) and cured at 77 °F (25 °C) to constant mass, or >12≤24 hours prior to testing.	≥ 2500 lbs. for 6" (150 mm) specimens ≥ 1250 lbs. for 4" (100 mm) specimens
7	Retained Stability Test	ASTM 5581 AASHTO T 245 4" (100 mm) samples 6" (150 mm) samples	An additional three (s) specimens produced as detailed in Item 6, and cured at 140 °F (60 °C) to constant mass. Specimens are then vacuum saturated to 55 – 75%, 77°F (25°C) water bath for 23 hours and 104 °F (40 °C) water bath of one 1	≥ 70% of Item 6

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			additional hour immediately prior to testing.	
8	Raveling Stability	ASTM D 7196	Specimens produced using SP gyratory at 30 gyrations at a compaction temperature of 77°F (25°C) and cured at 50°F (10°C) for 4 hours ± 5 minutes at 50% humidity	Maximum 5 %
9	Diametral Tensile Strength of Bituminous Mixtures	GDT 66	Fabricate 6 specimens at the CIR mix design determined bituminous recycling agent content. Adjust the number of gyrations or hammer blows in order to fabricate specimens with air voids that fall within a range of 10-12 %. Determine the air voids of the specimens according to AASHTO T 269.	≥ 60psi ≥ 70% Retained Stability Note 1
10	Emulsified Asphalt or other Approved Bituminous Recycling Agent	AASHTO T 315 AASHTO T 49, AASHTO T 51, AASHTO T 53, AASHTO T 72	The critical cracking temperature must be ≤ the pavement temperature given for the project climate area and pavement design by LTPPBind	See Notes 2
11	Hamburg Wheel Tracking Test	AASHTO T 324	Produce specimens using the SP Gyratory to the required height. Cure to constant mass.	Report Results at 20,000 passes

Note 1: Incorporation of > 1.0 percent hydrated lime may be necessary to meet requirements established in [Item 9, Table 3](#).

Note 2: Ensure the base binder used in the emulsified asphalt other approved bituminous recycling agent meets Department specifications as required in [Section 820](#). Ensure the emulsified asphalt meets the requirements specified in [Section 824](#).

418.2.02 Delivering, Storage, and Handling

A. Vehicles for Transporting and Delivering Materials

Ensure trucks used for hauling any additional ingredients for CIR mixtures have light, and clean beds.

If the Engineer determines that a truck may adversely affect the quality of the work, remove the truck from the project.

B. Containers for Transporting, Conveying, and /or Storing Bituminous Recycling Agent

To transport, convey and/or store bituminous recycling agents, use containers free of foreign material and equipped with sampling valves. Bituminous material will not be accepted from conveying vehicles if material has leaked or spilled from the containers.

418.3 Construction Requirements

418.3. 01 Personnel

General Provisions 101 through 150.

418.3.02 Equipment

The Engineer will approve the equipment used to construct CIR mixtures. Ensure the equipment is in satisfactory mechanical condition and can function properly during recycling, placement and compaction operations. Place the following equipment at the project site or other approved location:

A. Laboratory Testing

Provide a laboratory testing according to [Sub-section 418.1.03.C](#)

B. Equipment at the Project Site

Ensure the CIR Construction Equipment meets the following minimum requirements:

1. Provide sufficient hand tools and power equipment to clean the roadway surface of any foreign material prior to beginning the CIR process. Use power equipment that complies with [Subsection 424.3.02.F, “Power Broom and Power Blower.”](#)
2. Multi-unit recycling trains are required on roadways with $ADT \geq 10,000$ VPD. Ensure the multi-unit train meets the following criteria
 - a. Includes of a self-propelled cold milling machine that is capable of pulverizing the existing asphaltic concrete pavement in a single pass to the depth shown on the plans and to a minimum width of not less than 12.5 feet (3.8 m). Ensure the milling machine has automatic depth controls to maintain the cutting depth to within $\pm \frac{1}{4}$ inch (6 mm) of that shown on the plans. Ensure the milling machine has a positive means for controlling grade and cross slope elevations. Use of a heating device to soften the existing asphaltic concrete pavement will not be permitted.
 - b. Includes a material sizing unit having screening and crushing capabilities to reduce the cold crushed material to the appropriate size to meet CIR mix design requirements. Ensure the screening and crushing unit has a closed circuit system capable of continuously returning oversized material to the crusher. Ensure 100 percent of the crushed material is processed to the maximum size specified.
 - c. Includes a mixing unit equipped with a belt scale for the continuous weighing of the crushed and sized recycled material and is interlocked to the computer controlled liquid bituminous material metering device. Ensure that the mixing unit is an on-board completely self-contained pug mill. Ensure the liquid bituminous material metering device is capable of automatically adjusting the flow of emulsified asphalt or other approved additive to compensate for any variation in the weight of crushed material coming into the mixer. Ensure the metering device delivers the amount of emulsified asphalt or other approved additive to within ± 0.2 percent of the approved CIR mix design required amount by weight of the crushed asphaltic concrete material. Ensure the emulsified asphalt or other approved additive pump is of sufficient capacity to allow emulsified asphalt or other approved additive contents to meet the CIR mix design percent by weight of the crushed asphaltic concrete material. Automatic digital readings displaying both the flow rate and total amount of crushed asphaltic concrete material and emulsified asphalt or other approved additive in appropriate units of weight and time must be provided.
3. Single Unit Recycler

A single unit recycler may be used on roadways with $ADT < 10,000$ VPD. Ensure it meets the following criteria. Ensure it is a self-propelled cold milling machine/cold recycling machine with a down cutting cutter head capable of pulverizing and recycling the existing asphaltic concrete pavement to a maximum depth of 5 inches (125 mm). It must be capable of incorporating the emulsified asphalt or other approved additive and water, and mix the materials to produce a homogeneous CIR mixture. It must provide a minimum 900 hp. Ensure the recycler is capable of pulverizing and recycling a minimum width of 12.5 feet (3.8 m) in each pass. Ensure the machine has separate systems for adding emulsified asphalt or other approved additive and water. Each system must provide a full width spray bar with a positive displacement pump interlocked to the machine's ground speed and cutting depth to insure that the specified amount of emulsified asphalt or other approved additive and water is being added and adjusted volumetrically for any changes in cutting depth or machine's ground speed. Ensure that each additive system has its own spray bar equipped with adequate nozzles per foot of spray bar and is capable of incorporating the specified rate

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(gal/yd²) of emulsified asphalt or other approved additive and/or water. Ensure that individual valves on the spray bar are capable of being turned off as necessary to minimize emulsion or other approved additive content and water overlap on subsequent passes.

4. Calibration of Liquid Metering Device

Ensure the non-computer controlled liquid metering devices used for all liquid additives on the project site, is calibrated prior to beginning work. Notify the Engineer a minimum of 24 hours prior to equipment calibration and allow the Engineer to be present during the calibration for verification.

Ensure the accuracy of the computerized liquid metering device is verified at the frequency directed by the Engineer.

Note: Ensure that any additives such as water, approved bituminous recycling agent, etc...added by the recycling equipment at the mill head or mixing unit is controlled through liquid metering devices capable of automatically adjusting for variation in the weight of the crushed material going into the mixing unit. Ensure the metering device is capable of delivering the additive to within ± 0.2 percent of the CIR mix design required amount by weight of the crushed CIR mixture. It must be capable of adding up to 5 percent water by weight of crushed CIR mixture.

5. Portland Cement or Hydrated Lime Slurry Storage and Supply Equipment

Portland cement or hydrated lime slurry storage and supply equipment shall have agitators or similar equipment to retain the Portland cement or hydrated lime slurry in suspension when held in the slurry feed tank. Portland cement or hydrated lime slurry shall be kept in suspension during transport using agitator equipment. The meter system controlling the application of the slurry material shall apply the additive(s) within a tolerance of ± 10 percent of the approved CIR mix design content.

6. Materials Transfer/Pick-up Device

Ensure the material transfer/pick-up device is capable of removing the entire lift of crushed/milled material. Ensure the material transfer/pick-up device provides a continuous, uniform mixture flow to the screeding unit in multi-unit trains or mixing chamber in single unit recyclers.

7. Pressure Distributor

To apply the fog seal and other bituminous materials, use a pressure distributor complying with [Subsection 424.3.02.B, "Pressure Distributor."](#)

8. Bituminous Pavers/Screeding Units

To place CIR mixtures, use non-heated bituminous pavers or screeding units that can spread and finish courses that are:

- As wide and deep as indicated on the Plans
 - True to line, grade, and cross section
 - Smooth
 - Uniform in density and texture
- a. Automatic Screed Control System. Equip the bituminous pavers/screeding units with an automatic screed control system actuated from sensor-directed mechanisms or devices that will maintain the paver screed/screeding unit at a pre-determined transverse slope and elevation to obtain the required surface.
 - b. Transverse Slope Controller. Use a transverse slope controller capable of maintaining the screed at the desired slope within ± 0.1 percent.
 - c. Screed Control. Equip the paver/screeding unit to permit the following four modes of screed control. Ensure the method used is approved by the Engineer.
 - Automatic grade sensing and slope control
 - Automatic dual grade sensing
 - Combination automatic and manual control
 - Total manual control

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Ensure the controls are referenced with an approved ski-type device or mobile. Approved non-contacting laser or sonar-type skis listed on [OPL 91 “Georgia’s List of Approved Non-contacting Laser and Sonar-type Electronic Grade and Slope Controls”](#) may be used in lieu of conventional skis.

Automatic screed control is required on all Projects; however, when the Engineer determines that Project conditions prohibit the use of such controls, the Engineer may waive the grade control, or slope control requirements, or both.

- d. **Paver Screed Extension.** When the laydown width requires a paver/screed extension, use bolt-on screed extensions to extend the screeds, or use an approved mechanical screed extension device. When the screed is extended, add auger extensions to assure a length of no more than 18 inches (0.5 m) from the auger to the end gate of the paver. Auger extensions may be omitted when paving variable widths. Ensure the paver is equipped with tunnel extensions when the screed and augers are extended.

<p>NOTE: Do not use extendible strike-off devices instead of approved screed extensions. Only use a strike-off device in areas that would normally be luted in by hand labor.</p>
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9. Compaction Equipment

Ensure that the compaction equipment is in good mechanical condition and can compact the CIR mixture to the targeted density. Ensure a minimum number of three (3) rollers are used. The total weight (mass) shall be no less than 35 tons (32 mega grams) and must include a minimum:

- a. Self-propelled pneumatic tire roller having a minimum gross weight (mass) of 22 tons (20 mega gram).
- b. Double drum vibratory roller(s) having a minimum gross operating weight (mass) of 12 tons (11 mega grams).
- c. Properly functioning water system with no leaks

Ensure the compaction rollers do not sit on the finished mat.

418.3.03 Preparation

A. Prepare Existing Surface

Prepare the existing surface as follows:

1. Remove dirt, standing water, combustible materials, oils, raised pavement markers, traffic loop wires and other objectionable materials by sweeping, blading or other approved methods to the Engineer’s satisfaction.
2. Remove grass and other vegetation from the edge of the existing asphaltic concrete pavement to minimize contamination of the recycled material during the milling/crushing operation as necessary.
3. When specified, adjust affected utilities down and fill with approved material or accommodate utilities to the satisfaction of the Engineer prior to recycling.
4. In urban areas, when directed by the Engineer, cold mill along gutters and crosswalks as appropriate to prepare for any final overlay.
5. Areas with excessive crack filling/sealing materials should be pre-milled to a depth of ½” (12.5 mm) and hauled and wasted. If encountered during the CIR milling process, make necessary equipment, personnel and/or operation adjustments to ensure that crack filling/sealing material is shredded to provide 100 % passing the 1” (25 mm) sieve.
6. Correct any indicated areas of soft or yielding subgrade as directed by Engineer.

418.3.04 CIR Test Strip

- A. Prior to full production, ensure a 1,000 foot (305 m) Test Strip, one-lane width, at the specified designated CIR pavement thickness is constructed on the first day of CIR operations. Construct the CIR Test Strip within the project limits at the location directed by the Engineer. The Department shall use the Test Strip to determine if the Contractor’s CIR operations meet all specified requirements including:
 - Demonstrates that the equipment, materials and proposed process produces a CIR pavement material that conforms to requirements

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- Confirms the optimal mix design rates for emulsified asphalt or other approved bituminous recycling agent, water and any other additives
 - Determines the sequence and manner of compaction rolling necessary to meet density requirements
- B.** The Test Strip determines Target Density for the in-place density for the CIR pavement. Ensure a Target Density \geq 90 % of Maximum Theoretical Specific Gravity as detailed in [Item 5, Table 3](#) is achieved using a nuclear gauge in accordance with GDT 59. Ensure the materials used in the construction of the Test Strip conform to the requirements of the approved JMF as defined in [Sub-section 418.1.03.B](#). The density of the Test Strip, if accepted by the Department, is the target density for the remainder of the CIR pavement course it represents. The mean density of the Test Strip will be determined by averaging the results of five density tests taken at randomly selected sites within the Test Strip. The density shall be in accordance with GDT 59 backscatter measurement. The Department shall obtain in-place proctor testing results in accordance with AASHTO T 180. A minimum 98 % of the Target Density ([Item 3, Table 3, AASHTO T 180](#)) on the JMF is required.
- C.** Obtain depth checks for the CIR pavement to ensure the Contract specified CIR depth is achieved.
- C.** Construct the Test Strip using CIR construction procedures intended for the entire project. Cease CIR operations after construction of the Test Strip. The Department shall have three (3) business days to evaluate the Test Strip for acceptance. Proceed with full CIR operations at the direction of the Engineer provided the Test Strip meets all specified requirements.

418.3.05 Construction

Provide the Engineer at least one day's notice prior to beginning construction or prior to resuming production if operations have been temporarily suspended.

A. Patching Existing Surface:

When directed by the Engineer, deep patch existing areas identified to be patched prior to the CIR process. Ensure areas to be patched are cut out, trimmed to vertical and all loose material removed. Tack the area to be patched after cleaning. Ensure the compaction of the patch(s) is in conformance to GDOT specifications and to the satisfaction of the Engineer. Material for this work will not require a JMF, but must meet the appropriate gradation range shown in [Section 828](#).

B. Ensure the CIR milling and recycling process conforms to the following requirements:

- Mill the existing asphaltic concrete pavement to the required width and CIR depth (compacted) indicated herein.
- Ensure the milled/crushed material is sized to the maximum particle size specified, blended with the emulsified asphalt cement or other approved bituminous recycling agent, water, other approved additives, or as adjusted in the field (revised JMF) that produces a uniform and homogeneous CIR mixture.
- Screed the CIR mixture to the pavement design elevation and slope.
- Ensure the CIR mixture is spread to avoid segregation, tearing, pulling or other unacceptable texture deficiencies of the final compacted surface.
- Ensure the recycling does not disturb the underlying materials in the existing roadway.
- Conduct the milling operation to ensure that the amount of fines created along the vertical faces of the cut do not prevent bonding of the CIR materials.
- Process the crushed CIR material to the targeted gradation for the approved JMF within the specified Production CIR Mix Design Control Tolerances.
- Make necessary equipment and CIR operation adjustments to ensure that any pavement fabric encountered during the CIR process is shredded to provide 100 % passing the 1" (25 mm) screen.

C. Modify the CIR Job Mix Formula

Submit any changes to the CIR mix design or JMF due to CIR material changes, pavement texture or compaction related issues to the Engineer for approval.

D. Maintain Continuity of CIR Operations

Coordinate the CIR operations, transport of recycling ingredients, and placement operations to maintain a continuous operation. Mark all locations where water, any additives, and emulsified asphalt or other approved bituminous recycling agent have changed or connected. Additionally, mark locations where the recycling train or machinery stopped and started for any length of time.

E. Construct the CIR Joints

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Ensure there is no gap of un-recycled pavement material created between adjacent cuts, nor wedges of un-recycled pavement material created at the entry of the milling drum into the existing asphaltic concrete pavement. Ensure the CIR longitudinal joints are constructed to provide that adjacent CIR passes are overlapped $>3 \leq 4$ inches ($>75 \leq 100$ mm).

F. Compaction

The Contractor shall determine the proper time to compact the recycled mixture after it has been spread. Rolling patterns are to be established by the Contractor and verified by the Department to achieve maximum density as determined by the nuclear gauge in accordance with [GDT 59](#).

Ensure the CIR mat is monitored during the compactive efforts to prevent moisture or other compaction related cracking. Follow the established rolling pattern unless changes in the CIR mixture, materials or placement operations warrant a new rolling pattern. Ensure proper roller compaction techniques are used to prevent cracking, unacceptable mixture displacement or any other detrimental pavement distress.

G. Curing

After compaction has been achieved, and prior to opening the CIR pavement layer to traffic, fog seal the CIR pavement surface. Ensure the fog seal is applied to the CIR pavement surface at a uniform application rate of 0.015 to 0.05 gal/yd² (0.2 to 0.7 L/m²). The fog seal shall be composed of CSS-1h or CQS-1h emulsified asphalt. When directed by the Engineer, apply a sand blotter (2 to 3 lbs. /yd², 1 to 5 kg/m²) to the fog sealed CIR pavement prior to exposing to traffic. The Contractor shall determine the application rates for the fog seal and sand blotter to assure that a stable and safe roadway surface is maintained prior to overlaying with the subsequent asphaltic concrete layer(s). Ensure the sand is free of clay or organic material.

Protect sections of the newly completed CIR pavement from traffic, including construction related traffic, until it is demonstrated that traffic will not mar the surface or alter the surface texture. No traffic will be permitted on the completed CIR pavement for a minimum of two (2) hours or longer as directed by the Engineer. The cure time may be adjusted to assure that vehicle traffic will not initiate raveling of the CIR pavement. Once exposed to traffic, maintain the CIR pavement to ensure safe movement of traffic.

Prior to overlaying the CIR pavement with asphaltic concrete, the CIR pavement shall be allowed to cure for a minimum of three (3) days or until the moisture of the in-place material is < 2 % moisture content. Moisture Content shall be measured by the Department in accordance with AASHTO T 329 taken from two (2) random locations for each production day. Other methods and sampling rates may be used, if provided in the Contractor's Quality Control Plan and approved by the Engineer. Comparison Samples may be taken by the Department.

Ensure the CIR pavement is swept to remove any remaining sand blotter material using a mechanical broom prior to overlaying with the subsequent asphaltic concrete layer(s). Ensure that any damaged CIR pavement is repaired, at the Contractor's expense, prior to overlay with asphaltic concrete surface(s) as directed by the Engineer.

H. Observe Weather Limitations

Do not perform CIR of asphaltic concrete when directed by the Engineer due to general weather conditions being unsuitable. Perform the work when roadway surface temperature is 55 °F (13 °C) and rising. CIR work will not be allowed during foggy or raining weather, and the area weather forecast calls for freezing temperatures within 72 hours after the CIR operations.

418.3.06 Quality Acceptance

A. Acceptance Plans for Density, Depth, Gradation and Retained Stability

The Department will randomly sample and test CIR mixtures for acceptance on a lot basis. The Department will monitor the Contractor Quality Control program.

A lot shall consist of 5,000 linear feet, with 1,000 linear foot sublots for any recycling pass made by the paving train for the thickness of the course. Should a partial lot occur due to completion of the project or when directed by the Engineer because of a mechanical or material issue, the lot shall be accepted as follows:

- Partial lots < 3 sublots shall be added to the previous lot
- Partial lots with ≥ 3 sublots shall be redefined as an entire lot

CIR acceptance sampling shall be obtained in accordance with [Table 4](#). Sample locations will be determined by the Department using [GDT 73](#).

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Table 4 – Required Test, Sampling Frequencies and Specified Requirements

Test No.	Test Description	Test Method	Minimum Testing Frequencies	Acceptance Requirements
1	Compacted Density Nuclear Gauge	GDT 59	1 per Sublot	98% of Control Strip Target Density
2	Field Proctor	AASHTO T 180	1 per lot	98% of Target from CIR mix design
3	CIR Depth Check		1 per Sublot	Table 6
3	Hamburg Wheel Tracking Test	AASHTO T 324	1 per Lot	Report
4	CIR Mixture Gradation and Sizing	AASHTO T 27	2 per Lot	Maximum size < 1" (25 mm)
5	Retained Stability	ASTM 5581 AASHTO T 245	1 per Lot	70%
6	Emulsified Asphalt or Other Approved Bituminous Recycling Agent		1 Project Start-up and 1 per week thereafter	Section 820 Section 824

1. The Department shall conduct density testing for each Lot as detailed in Item 1, Table 4 using a nuclear gauge in accordance with [GDT 59](#). Three random locations within each subplot will be averaged for acceptance of the lot. Corrective action will be immediately initiated by the Contractor if two (2) consecutive sublots are determined to have density results < 98 % of the target density. The Department shall verify the results for each lot by performing a field proctor (AASHTO T 180). The field proctor results shall be at least 98 % of the optimum moisture density from the CIR mix design [Item 3, Table 3](#).

The square yards for each lot will be based on the lot's width and length and the mixture's application rates as designated in the Contract. Payment shall be made in accordance with [Table 5](#).

Table 5 – Density Acceptance Schedule

Percent of Control Test Strip Target Density	Pay Factor
≥ 98	1.0
97.9 – 97.0	.95
96.9 - 96	.90
95.9 – 95.5	.80
95.4 - 95	.75
< 95*	.60

*Note: At the Engineer's discretion, the Department may accept re-recycling the CIR pavement in lieu of a pay reduction. The re-recycled material must meet all specified requirements.

2. Depth check samples are obtained behind the screed after the CIR mixture has been compacted and cured enough to obtain 4" (100 mm) cores for measurement. Acceptance of the CIR course for depth will be based on the mean results of the measurements of samples taken from each lot of CIR pavement placed.
3. A lot's depth will be considered acceptable if the mean result of the tests is within the tolerance of the Contract's specified depth for the number of tests taken as shown in [Table 6](#).

Table 6 – Process Control for CIR Depth Checks					
Contract Specified Depth (inches)	Tolerance (inches)				
	1 Test	2 Tests	3 Tests	4 Tests	5 Test
< 4 " (100 mm)	.50 (12.5 mm)	.45 (11 mm)	.40 (10 mm)	.35 (9 mm)	.30 (8 mm)
≥ 4 ≤ 6 (≥100 mm ≤150 mm)	.75 (19 mm)	.70 (18 mm)	.60 (15 mm)	.50 (12.5 mm)	.40 (10 mm)

For an individual depth check that exceeds the tolerance established in Table 4 for one test, that portion of the lot represented by the test will be excluded from the lot. If an individual test result indicates that the depth of material represented by the test is more than the tolerance for one test for the specified depth, the Contractor will not be paid for the material in excess of the tolerance throughout the length and width of that portion of the lot represented by the test. If an individual test indicates that the depth of the material represented by the test is deficient by more than the tolerance for one test, correction of that portion of the lot of the CIR course represented by the test shall be made as specified hereinafter.

If the mean depth of a lot of CIR pavement is excessive, the Contractor will not be paid for those materials (emulsified asphalt or other bituminous recycling agent, virgin aggregate, hydrated lime, additional RAP, or other materials) in excess of the tolerance for the Contract's specified depth required throughout the length and width of the lot of material represented by the tests.

For excessive depth CIR courses, the rate of deduction for payment for the materials used for the CIR course will be calculated based on the CIR mix design/JMF weight per square yard per inch of depth in excess of the tolerance for the Contract's specified depth or the Department can require excessive material to be removed at the Contractor's expense.

If the mean depth of a lot of material is deficient by more than the allowable tolerance but < 1.00" (25 mm) for the Contract's specified depth required, the Contractor will be paid for the quantity of materials that has been placed in the lot.

For sections where the resulting pavement elevation is deficient in depth due to the CIR course, such as the pavement being widened or other construction operations, by more than the depth check tolerances established in Table 6 but less than 1.0" (25 mm), the Contractor may correct the deficiency by increasing the depth of the subsequent course of asphaltic concrete to correct the deficient pavement elevation resulting from the deficient CIR course depth to the Contract's specified pavement elevation. This additional material shall be placed at the Contractor's expense.

If the CIR course deficiency in depth is > 1.0" (25 mm), the Contractor shall submit a plan for corrective action to the Department for approval. Corrections for deficient CIR course depth shall be made in a manner to provide a finished pavement that is smooth and uniform.

4. Samples taken for Hamburg Wheel Tracking testing shall be taken of the CIR mixture from behind the paver prior to compaction. These samples are to be placed in sealed plastic containers to prevent loss of moisture and slow the curing process. These samples are to be mixed in the laboratory within 24 hours and tested as required in Item 11, Table 3.
5. Mixture composition samples will be sampled and tested in accordance to [Table 4](#).
 - a. Recycled Mixture Sizing and Gradation samples are to be obtained prior to adding the emulsified asphalt or other bituminous recycling agent. All mix design sized sieves will be reported. All CIR material must pass

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- a 1" (25 mm) sieve. Other reported sieve results shall be used for process control or as directed by the Engineer.
- b. Emulsified asphalt or other approved bituminous recycling agents are to be obtained from the sampling valve of the onsite tanker and testing in accordance with [Section 824](#) and/or [Section 820](#).
- c. Diametral Tensile Strength of Bituminous Mixtures testing samples shall be taken of the CIR mixture from behind the paver prior to compaction. These samples are to be placed in sealed plastic containers to prevent loss of moisture and slow the curing process. These samples are to be mixed in the laboratory within 24 hours and tested as required in [Item 9, Table 3](#).

B. Surface Tolerance

The completed CIR pavement shall be tested for smoothness in the wheel paths with a 10 foot (3 m) straightedge. For each variation in the CIR pavement that exceeds 3/8" (10 mm) in 10 feet (3m), the entire affected area shall be corrected by a self-propelled milling machine or as directed by the Engineer. Ensure the CIR pavement is swept with a mechanical broom to remove all loose material prior to opening to traffic.

C. Segregated CIR Mixture

Prevent CIR mixture placement that yields a segregate mat by following proper milling, recycling and placement procedures. If the CIR mixture is segregated in the finished mat, the Department will take action based on the degree of segregation. These actions will include, suspending the CIR operation until a written plan of corrective action has been submitted by the Contractor and approved by the Department. Severely segregated CIR areas may be required to be re-recycled or patched as directed by the Engineer.

418.3.07 Contractor Warranty and Maintenance

A. Contractor's Record

1. Emulsified Asphalt or Other Approved Bituminous Recycling Agent Dosage Rate

The Contractor shall verify the emulsified asphalt or other approved bituminous recycling agent's dosage rate by reading and recording the rate obtained from a calibrated meter at least once per subplot. The dosage rate shall be within ± 0.20 percent of the approved JMF. If the dosage rate is outside the tolerance of ± 0.20 percent, the CIR operations shall cease and the Contractor shall take corrective measures to bring the emulsified asphalt or other approved bituminous recycling agent's dosage rate within tolerance.

The Department will calculate the bituminous material yield at the end of each CIR operation day.

- 2. Maintain a dated, written record each emulsified asphalt or other approved bituminous recycling agent's dosage rate. Keep this record available for the Engineer's inspection at all times. As applicable, maintain records in the form of:
 - Graphs
 - Tables
 - Charts
 - Mechanically prepared data

418.4 Measurement and Payment

418.4.1 Measurement and Payment of Cold in Place Recycled Mixtures and Additives

Cold in Place Recycled Mixtures will be measured by the square yard (square meter) of the completed sections for the depth specified in the Contract and shall be paid for at the Contract Unit Price per square yard (square meter) of depth. The Contract Unit Price per square yard cost shall be full compensation for removal and processing of the existing asphaltic concrete pavement, for preparing, hauling, and placing all materials, mixing in the emulsified asphalt or other approved bituminous recycling agent, fog seal, sand blotter, all freight involved, for all preparation of the existing pavement, compaction, brooming completed CIR pavement, maintaining CIR pavement and for all labor and equipment.

Emulsified Asphalt or Other Approved Bituminous Recycling Agent shall be paid for at the Contract Unit Price per ton (mega gram)). The cost shall be full compensation for furnishing and incorporating the emulsified asphalt or other approved bituminous recycling agent into the CIR mixture. An emulsified asphalt or other approved bituminous recycling agent content of 3.0 % by weight of the CIR material shall be used for bidding purposes prior to the completed CIR mix design. The actual emulsified asphalt or other approved bituminous recycling agent content will be adjusted based on the quantity necessary to meet the CIR mix design requirements in Table 3.

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Additional RAP, if necessary to meet the contract requirements shall be measured and paid for at the Contract Unit Price per ton (mega gram). This price shall be full compensation for furnishing and incorporating the additional RAP in the CIR mixture. Weigh tickets in accordance with [SOP 15](#) must be provided for payment. The additional RAP must meet the requirements of [Subsection 418.2](#) herein for payment purposes.

Additional Virgin Aggregate, if required, in accordance with the JMF and other contract requirements, will be measured and paid for at the Contract Unit Price per ton (mega gram)). The price shall be full compensation for furnishing and incorporating the additional aggregate material into the CIR mixture. Weigh tickets in accordance with SOP 15 must be provided for payment. The additional virgin aggregate must meet the requirements of [Subsection 418.2](#) herein for payment purposes.

Asphaltic Concrete patching, as directed by the Engineer, will be measured and paid for at the Contract Unit Price per ton (mega gram).

Payment will be made under:

Item No. 418	____ inches (____ mm) Cold in Place Recycled Mixture	Per square yard (meter)
Item No. 418	Emulsified Asphalt or Other Approved Bituminous Recycling Agent	Per ton (mega gram)
Item No. 418	Additional RAP	Per ton (mega gram)
Item No. 418	Additional Virgin Aggregate	Per ton (mega gram)
Item No. 402	Recycled asphaltic concrete patching including bituminous materials and hydrated lime	Per ton (mega gram)

The CIR mixture is paid for by the square yard (meter); the thickness of the lift is subject to the Engineer's approval and is used to prorate the pay factor for the affected roadway section.

418.4.2 Determine Lot Payment

Determine the lot payment as follows:

1. When one of the pay factors for a specific acceptance lot is less than 1.0, determine the payment for the lot by multiplying the Contract Unit Price by the adjusted pay factor.
2. When two or more pay factors for a specific acceptance lot are less than 1.0, determine the adjusted payment by multiplying the Contract Unit Price by the lowest pay factor.

If the Engineer determines the material is not acceptable to leave in place, remove and replace the materials at the Contractor's expense.

Office of Materials & Testing