

# Department of Transportation

## State of Georgia

### Supplemental Specification

## Section 403—Hot In-Place Recycled Asphaltic Concrete

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### 403.1 Description

This Section covers the hot in-place recycling of the existing surface in a continuous multi-step process which includes:

- Softening the existing surface with heat
- Hot milling to obtain the depth shown in the plan typical section or stated in the contract general notes
- Applying a tack coat
- Applying a rejuvenating agent
- Adding plant produced asphaltic concrete and virgin aggregate, if needed, prior to remixing
- Thoroughly remixing, leveling, and relaying the recycled mixture

#### 403.1.01 Definitions

General Provisions 101 through 150.

#### 403.1.02 Related References

##### A. Standard Specifications

[Section 106](#)

[Section 109](#)

[Section 400](#)

[Section 402](#)

[Section 800](#)

[Section 824](#)

##### B. Referenced Documents

AASHTO T-49

AASHTO T-209

AASHTO TP 4

AASHTO TP 5

ASTM D92

ASTM D2170

ASTM D2872

ASTM D4124

[GDT 38](#)

[GDT 42](#)

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[GDT 66](#)

[GDT 83](#)

[GDT 115](#)

[GDT 119](#)

[GDT 125](#)

[GDT 126](#)

[GSP 15](#)

### 403.1.03 Submittals

Submit the proposed mix design for approval. As a minimum, the design shall include the following:

- The proportional blend of in-place materials and rejuvenating agent
- The proportional percentage of virgin aggregate and plant-produced hot mix asphalt, if required
- The sources of all materials to be used in the mixture
- The theoretical maximum specific gravity of the final mixture determined by AASHTO T-209
- The air void volume of the mixture after compacting for 50 gyrations with a gyratory compactor according to AASHTO TP 5

Use an approved, qualified laboratory to perform the mixture design analysis. Ensure the final design mixture has an air void volume within 3-5%.

Submit to the Office of Materials and Research (OMR) representative samples of each ingredient to be used in the final in-place mixture for design verification and additional testing as needed. The Department will perform testing for moisture and rutting susceptibility. Adjust mixture proportions as needed to ensure the final mixture meets the following requirements:

- Average rut depth not to exceed 0.3 in (7 mm) when tested using [GDT 115](#).
- Minimum tensile splitting ratio of 80% and minimum individual stress results of 60 psi (415 kPa) when tested using [GDT 66](#).

<b>EXCEPTION: A tensile splitting ratio of no less than 70% is acceptable so long as all individual test values exceed 100 psi (690 kPa).</b>
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Allow the Department two weeks to verify the mix design after receiving the proposed mix design and material. Do not begin recycling operations until the Department has approved the design and accepted the mixture.

### 403.2 Materials

The materials to be used and their specifications are listed below:

#### A. Aggregate

Add virgin aggregate, if required, which is from an approved source and which meets requirements of [Section 800](#). Use the stone size and spread rate specified in the plans. Additional virgin aggregate from approved sources may be added based on the mixture design analysis at no additional cost to the Department.

#### B. Plant-Produced Hot Mix Asphaltic Concrete

Add the type and amount of plant-produced asphaltic concrete, if required, as specified in the plans. Additional asphaltic concrete may be added based on the mixture design analysis at no additional cost to the Department. Ensure the hot mix asphaltic concrete is produced according to [Section 400](#) and [Section 402](#).

#### C. Asphalt Cement Rejuvenating Agent

Obtain approval by the Office of Materials and Research for the source, amount, and type of rejuvenating agent to be used. The Department reserves the right to change, without a change in the contract unit price, the agent and amount being used in the mixture if it is determined by the Engineer that the rejuvenating agent is not performing satisfactorily.

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### D. Bituminous Tack Coat

Use a cationic asphalt emulsion CRS-2h, CSS-1h, or CQS-1h for the bituminous tack coat that meets [Section 824](#). Apply the tack coat with a system equipped with positive stop/start capabilities that will prevent tack puddles and which will uniformly distribute the tack across the full width of the surface being recycled. Apply tack after the existing surface has been heated, milled, and removed from the roadway and prior to replacing the material onto the roadway.

### E. Asphalt Modifier

Provide asphalt modifier as specified in the Plans. It shall be added at a dosage rate that will yield at least 3% solid polymer by weight of the asphalt cement of the in-place material. Asphalt modifiers shall be approved by the Office of Materials and Research prior to use in the work. The Department reserves the right to change the type modifier and amount to be used, without a change in the contract unit price, if the Engineer determines that the asphalt modifier is not performing satisfactorily.

## 403.2.01 Delivery, Storage, and Handling

### A. Aggregate Storage

Store or stockpile mineral aggregates in a manner that will prevent segregation, mixing of the various sizes, and contamination with foreign materials.

### B. Storage of Bituminous Material

Always keep clean all equipment used to store and handle bituminous material and operate it in such a manner to prevent contamination with foreign matter.

## 403.3 Construction Requirements

### 403.3.01 Personnel

General Provisions 101 through 150.

### 403.3.02 Equipment

The Engineer shall approve all equipment, tools, and machines used to perform this work. Do not attempt work with malfunctioning equipment. The Engineer may stop the work if equipment and tools are not sufficient to place the materials satisfactorily.

#### A. Heating and Milling Units

Ensure the heating unit meets the following requirements:

- Capable of heating the asphaltic concrete pavement to a temperature high enough to remove excess moisture and allow hot milling of the material to the designated plan depth without breaking aggregate particles
- Controls the heating process to prevent charring the existing surface, avoid producing undesirable pollutants, and prevent differential softening of the pavement
- Confine the heat application under a shielded, or enclosed, hood

**Make all efforts to** protect adjacent landscape from heat damage. Rebuild, repair, restore, and make good all injuries or damages to adjacent landscape, at the Contractor's expense. Equip the unit which contains milling heads with longitudinal grade controls as described in [Subsectin 403.3.02.C](#) which will consistently control the depth of the milling operation. Milling heads shall remove the heated existing pavement to the depth specified in the Plans for the full transverse width even if additional virgin aggregate or asphaltic concrete mixture is added at no cost to the Department.

Use a portable milling unit ~~or scraping unit~~ to ~~completely~~ remove heated material from around utility structures to the full plan depth just prior to placement of the recycled material. Do not attempt to remove heated material from utility structures with hand tools only and do not damage the structures. Repair any damage to structures at no ~~additional~~ cost to the Department.

#### B. Blending Unit

Provide a blending unit which meets the following requirements:

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- Capable of blending the removed material and rejuvenating agent (as well as virgin aggregate, asphalt modifier, and plant-produced hot mix asphaltic concrete, if required) into a homogeneous mixture
- Synchronizes application of all materials based on the volume of material being recycled to provide a proportional application at the predetermined application rate

Add the rejuvenator after milling has taken place and before or during the blending process with a positive start/stop mechanism that is automatically controlled by the volume of recycled material to be rejuvenated. Do not add rejuvenator based on linear distance travelled.

Add asphalt modifier, if required, at locations specified in the Plans or directed by the Engineer. Add modifiers during the blending process through a distribution system that will uniformly control the rate of application based on the volume of material being recycled and which contains a measuring system to verify the dosage rate.

### C. Screed

Ensure the screed meets the following requirements:

- Capable of collecting and distributing the recycled mixture over variable widths for the entire width being processed
- Capable of controlling transverse cross-slope as directed by the Engineer
- Provides a uniform cross-section without streaks or blemishes
- Controls longitudinal grade electronically in conjunction with a mobile reference or by a non-contacting laser or sonar type ski with at least four referencing stations mounted at a minimum length of 24 feet (7.2 m)

### D. Auxilliary Equipment

Provide suitable surface cleaning equipment, hand tools, rollers, and other support equipment necessary to perform the work. Ensure all other equipment meets requirements of [Section 400](#).

### 403.3.03 Preparation

General Provisions 101 through 150.

### 403.3.04 Fabrication

General Provisions 101 through 150.

### 403.3.05 Construction

#### A. Surface Preparation

Thoroughly clean the surface to be recycled of all dirt, vegetation, and other objectionable materials immediately prior to the affected area being recycled. Remove all metal raised pavement markers and thermoplastic paint markings prior to recycling.

#### B. Heat, Remove, and Blend Materials

Evenly heat the pavement at full lane width plus a minimum 3 in (75 mm) overlap onto adjacent pavement materials. Control the heating to ensure uniform penetration without differential softening of the surface, and so that the heated material has a temperature in the range of  $240 \pm 20$  °F ( $115 \pm 11$  °C) measured immediately behind the heating unit. If virgin aggregate is added, distribute the aggregate across the entire width being recycled prior to the last heat application.

Hot mill and rework the pavement to the width and depth shown in the plan typical section. Control the width of each pass to provide proper placement of longitudinal joints. Control the depth of loosened pavement to within 1/4 in (6 mm) of the depth specified. Ensure the milled material is heated sufficiently so that it is free of lumps. Milled particles shall not be greater than 1-1/2 in (40 mm) in size. **Accomplish the recycling by using milling heads capable of gathering the loose material and conveying it to a mixing chamber. The mixing chamber shall blend the material uniformly and create a windrow with the final mix. Do not use scrappers, scarifiers, or any mechanical means of removing the softened pavement other than milling heads.**

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Ensure the final blended mix in the windrow is uniform. All aggregate shall be consistently coated. There shall be no evidence of broken or fractured aggregate in the windrowed material. Inconsistency and or non-uniformity of the windrowed material prior to placement will result in the immediate cessation of recycling until a plan of corrective action is approved by the Engineer. After modifications to the equipment or adjustment to the additives proportions have been made and approved, the Contractor will be allowed to resume work in a 500 ft (152 m) test section to be evaluated by the Engineer prior to continuing recycling.

Blend the removed material with a rejuvenating agent (and virgin aggregate, asphalt modifier, or plant-produced hot mix asphaltic concrete, if needed) to produce a homogeneous mixture. Control the rate of application of the rejuvenator to ensure compliance with the mix design and Dynamic Shear Rheometer (DSR) values specified in [Subsection 403.3.06.A](#). Apply other materials as specified in the contract or as determined by the mix design analysis.

### C. Tack Coat

Apply tack coat uniformly over the milled area prior to placement of the blended materials. Control the application rate within 0.04 – 0.06 gal/yd<sup>2</sup> (0.18 – 0.27 L/m<sup>2</sup>). At any time during the recycling process it is observed that an adequate bond is not being achieved, three six-inch (150mm) cores may be obtained for testing. These cores will be evaluated for adequate bond strength using NCAT's bond shear device inconjunction with the Marshall Apararatus. A minimum shear strength of 100 psi shall be required.

### D. Application

Control placement of the mixture to produce a surface true to line, grade, and cross-slope with a uniform surface texture free of segregation, lumps, or other unacceptable streaks or blemishes as determined by the Engineer. Ensure the mixture meets the acceptance requirements for mixture quality, compaction, smoothness, and thickness as specified in [Subsection 403.3.06](#).

### E. Overlay

Overlay the recycled mixture, if required by the contract, by producing and placing a mixture that meets requirements of [Section 400](#) and [Section 402](#). Smoothness requirements for the hot in-place recycled mixture do not apply if the mixture is overlaid.

## 403.3.06 Quality Acceptance

### A. Mixture

Base acceptance of the materials used in the work on [Section 106](#) and [Section 400](#) except that pay factors for gradation and asphalt content will not apply. Take a minimum of one sample of mixture for each day of operation to determine quality acceptance of the mixture.

Take samples directly behind the paver according to [GSP 15](#) at the location determined by the Engineer. Perform extraction and gradation testing according to [GDT 83](#) and [GDT 38](#) or other suitable method approved by the Office of Materials and Research. Determine the laboratory density, stability and flow of the mixture at 50 gyrations with a gyratory compactor using AASHTO TP 4 using the 50 blow Marshal proceedure in AASHTO T-245.

Recover the extracted asphalt cement using [GDT 119](#) and test for dynamic shear according to AASHTO TP 5, Method for Determining the Rheological Properties of Asphalt Binder Using Dynamic Shear Rheometer (DSR). Adjust the amount of rejuvenator as necessary to maintain DSR results within a range of 800-2000 poises (80-200 Pa-s) when tested at 140 °F (60 °C). Do not continue the work until corrective adjustments are made if two consecutive samples exceed the range for DSR values.

Submit test results electronically to the Engineer and Office of Materials and Research within 24 hours after samples are taken.

### B. Compaction

Compact the recycled mixture immediately after placement so that the maximum Pavement Mean Air Voids is 7.8 7.0 percent or less based on the theoretical specific gravity measured daily using the T-209 method performed on mixture sampled directly behind the paver. Determine the mixture compaction using either [GDT 39](#) or [GDT 59](#). The compaction is accepted in lots defined in [Subsection 400.3.06.A "Acceptance Plans for Gradation and Asphalt Cement Content"](#) and

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is within the same lot boundaries as the mixture acceptance. Meet the compaction requirements of [Subsection 400.3.06.B](#), and [Subsection 400.5.01.C](#). The Department will perform all compaction testing.

### C. Smoothness

The Department will perform acceptance testing for surface course smoothness tolerance using the Laser Road Profiler according to [GDT 126](#). Smoothness testing will be performed on the mainline traveled way and on ramps more than one-half mile (kilometer) in length.

Clean the roadway of any debris and obstructions and provide traffic control to conduct the testing when requested by the engineer.

Ensure the pavement does not exceed a target smoothness index of 900. Do not continue the work until corrective adjustments have been made if the target value is exceeded. Perform corrective work at no expense to the Department by repeating the hot in-place recycling process, according to this Section, if the smoothness index exceeds 1025.

Maintain a 10 ft. (3 m) straightedge in the vicinity of the paving operation at all times to use in measuring minor surface irregularities and provide the labor for its use. Correct all irregularities in excess of 1/8 in (3 mm) in 10 ft. (3 m). Stop the operation until corrective measures are taken when irregularities such as rippling, tearing, or pulling indicate a continuing problem in equipment, mixture, or operating techniques.

### D. Mill Depth

Mill heated material to the thickness specified in the plan typical section or contract general notes. ~~The Department will take cores at a~~ **Take cores at locations determined by the Engineer at a** minimum frequency of one core per 1000 ft (300 m) per two lanes of roadway or five cores per day, whichever is less, to verify mill depth.

The Department will determine the average mill depth based on roadway core measurements according to [GDT 42](#). Mill depth will be determined based on total rejuvenated thickness less any thickness contributed by added virgin materials.

To receive full payment for mill depth, ensure the average milled depth is no less than 1/4 in (6 mm) of that specified in the plan typical section or contract general notes. Apply a pay reduction of 25% to the total square yards (meters) applied that day if the average depth is less than that specified, by more than 1/4 in (6 mm) but no more than 1/2 in (13 mm) of that specified.

Take additional cores to determine the area of deficient depth if the average depth is less than that specified, by more than 1/2 in (13 mm). ~~Correct any areas deficient in depth by more than 1/2 in (13 mm) by repeating the hot in-place recycling process at no expense to the Department. Stop the work until corrective measures are made if the average mill depth for two consecutive days is less than 1/4 in (6 mm) of that specified.~~

### E. Corrections

Correct any areas deficient in depth by more than 1/2 in (13 mm) by repeating the hot in-place recycling process at no cost to the Department. Stop the work until corrective measures are made if the average mill depth for two consecutive days is less than 1/4 in (6 mm) of that specified. No individual location shall be recycled more than 2 times. If after the second recycling process, the deficiency is still apparent, mill and in-lay this location with plant produced asphaltic concrete. The plant produced asphaltic concrete shall be equivalent to the Hot In- Place recycled design properties.

### F. Test Section and Acceptance

The contractor shall be granted a 1 lane mile (1600 m) test section at the beginning of construction to be evaluated by the Office of Materials and Research for acceptance prior to continuing recycling. If any specified requirement is not obtained, work shall be immediately stopped. If at any time during construction, it is determined that the Contractor's equipment and recycling techniques can not consistently meet requirements, the recycling operation shall be stopped until the Office of Materials and Research reviews and approves all modifications in equipment and recycling techniques. The Contractor shall place a 500 ft (152 m) test section to be evaluated and accepted by the Office of Materials and Research prior to resuming recycling.

### G. Rutting susceptibility test.

Cores taken each day for depth verification shall be tested according to [GDT 115](#). Maximum deformation shall be 5.0 mm (0.2 in).

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### 403.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

### 403.4 Measurement

Hot in-place recycled asphaltic concrete mixture is measured by the square yard (meter) of the surface area completed and to the depth specified. In computing square yards (meters), the lengths and widths used shall be as specified in [Section 109](#), Measurement and Payment.

Rejuvenating agent, virgin aggregate, and plant-produced asphaltic concrete shall be added as individual components of the recycled mixture as required in the mix design analysis. Include this cost in the unit bid price per square yard (meter). Bituminous materials for tack coat applied and accepted will be measured as outlined in [Section 109](#).

#### 403.4.01 Limits

General Provisions 101 through 150.

### 403.5 Payment

Hot in-place recycled asphaltic concrete is paid for at the contract unit price per square yard (meter). Payment is full compensation for furnishing all materials, all equipment, Work, and labor. Payment also includes removal of raised pavement markers and thermoplastic striping, if applicable, heating and hot-milling, adding rejuvenator, performing the mix design, performing project sampling and testing, and other incidentals necessary to complete the work. Aggregate and hot mix asphaltic concrete which may be added to meet requirements of the mix design analysis shall be included in the contract unit price.

Bituminous tack coat is paid for per gallon (liter) under separate payment. Hot mix asphaltic concrete specified for overlaying, if any, will be paid for under separate payment. Aggregate specified in the contract, if any, (excluding that required based on the mix design analysis) will be paid for under separate payment.

Payment will be made under:

Item No. 403	Hot in-place recycled asphaltic concrete	Per square yard (meter)
Item No. 403	Hot in-place recycled asphaltic concrete including polymer-modifier	Per square yard (meter)

#### 403.5.01 Adjustments

General Provisions 101 through 150.

Office of Materials and Research