

Supplemental Technical Specification for Recycled Materials used in Asphalt Pavements

SCDOT Designation: SC-M-407 (01/22)

1. SCOPE

- 1.1 Use the following specifications for preparing and constructing asphalt pavements using recycled materials including recycled asphalt pavements (RAP), recycled asphalt shingles (RAS), and recycled crushed glass.

2. REFERENCED DOCUMENTS

- 2.1 SCDOT Standard Specifications
- 2.1.1 Division 300, 400, SC-M-402
- 2.2 AASHTO Standards
- 2.2.1 T27, T315
- 2.3 SCDOT Test Methods
- 2.3.1 SC-T-75, SC-T-76, SC-T-80, SC-T-95

APPROVED:

Division Administrator

By: _____

FEDERAL HIGHWAY ADMINISTRATION

3. COMPOSITION OF RECYCLED MATERIALS

- 3.1 Use recycled materials meeting all applicable requirements contained in the specifications, except as indicated herein. Submit samples of the recycled materials proposed for use in new asphalt pavement to the AME at least 30 days prior to the beginning of the work. Submit a minimum of 30 pounds of representative milled/processed material along with the stockpile records and the asphalt mix design approval request on forms approved by the AME.
- 3.2 RAP
- 3.2.1 If milled material from a project is not available, submit at least 10 cores that are between 6 and 8 inches in diameter, sliced at the proposed milling depth that is representative of the material to be milled. In addition, perform a minimum of 6 extraction tests on cored roadway samples from random locations before submitting an asphalt mix design approval request. Submit extraction test results and cores representing the material to be milled with the asphalt mix design request. Ensure that the number of roadway cores obtained is sufficient to represent the entire length of roadway to be milled taking into consideration the length of the project, changing roadway conditions, etc. (This procedure may only be used on Non-Fractionated RAP)

- 3.3 RAS
 - 3.3.1 Use shredded shingles that are produced primarily from a shingle manufacturer-processing facility or recycled from the construction of residential or commercial roofing sites. Use shingles that are sufficiently dry to be free flowing and to prevent foaming when blended with the hot binder. Ensure that the shingles are free of all chemicals, oils, or any other hazardous materials (e.g., asbestos). Only accept shredded shingles with a certification from the shingle supplier that the material conforms to these specifications.
 - 3.4 Do not use softening agents, asphalt modifiers, rejuvenators, or recycling agents.
 - 3.5 Samples submitted under section 3.1 may be subject to testing by SCDOT to check the recovered properties of the asphalt binder using **SC-T-95 and AASHTO T315**.
 - 3.6 Recycled Crushed Glass
 - 3.6.1 Use recycled crushed glass that is free and clean of any potentially harmful chemical residue or fumes when handled in stockpiles and introduced to extreme heat during the asphalt mixture production.
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4. STOCKPILE MANAGEMENT – RECYCLED MATERIALS

- 4.1 RAP Stockpiles
 - 4.1.1 Perform extraction tests at a rate of 1 per 1000 tons of RAP, with a minimum of 3 tests per stockpile. Process the RAP in such a manner that all particles pass a 2-inch screen before entering the plant, and are free of foreign matter or other contaminations. RAP particles retained on the 2-inch screen may be re-crushed in a manner that does not result in further degradation of the aggregates. Erect and maintain a sign satisfactory to the **AME** on each stockpile for proper identification. Ensure that no deleterious material is allowed in any stockpile.
 - 4.2 RAS Stockpiles
 - 4.2.1 Perform extraction tests at a rate of 1 per 200 tons of RAS, with a minimum of 3 tests per stockpile. All shingles must be processed using an ambient temperature grinding methods. It may be necessary to blend shingles together from multiple sources to ensure that the combined shingles conform to the gradation requirements in section 5.2.1. Ensure that all roofing shingles have no debris or particle size of greater than ½ inch. Provide delivered material at least 99.7% (by weight) free of any debris.
 - 4.2.2 If shingles are used, produce a uniform and reacted asphalt mixture of compatible paving grade binder, quality fine and coarse aggregates, anti-strip additive, and shredded shingles.
 - 4.3 Recycled Crushed Glass Stockpiles
 - 4.3.1 Perform gradation tests at a rate of 1 per 500 tons of Recycled Crushed Glass, with a minimum of 3 tests per stockpile.
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5. GRADATION - RECYCLED MATERIALS

- 5.1 RAP
- 5.1.2 Non-Fractionated RAP
 - 5.1.2.1 In addition to the limits below, further limit RAP to 20% maximum when introduced in the hot elevator in batch plants.
 - 5.1.2.2 RAP stockpiles may contain RAP from multiple sources and may be replenished.
- 5.1.3 Fractionated RAP
 - 5.1.3.1 Mechanically separate RAP materials into appropriate sizes using a high frequency separation device acceptable to the **AME**. Materials must be separated in a manner to have a coarse and a fine aggregate stockpiles. All coarse recycled materials must be separated in a manner to reduce the amount of material that passes the fine screen on the separation devise. It may be determined by the AME that the material may need to be rescreened to achieve a coarser product (45% passing on No. 4 sieve or less).
 - 5.1.3.2 RAP stockpiles may contain RAP from multiple sources and may be replenished.
- 5.2 RAS
 - 5.2.1 RAS stockpiles may contain RAS from multiple sources and may be replenished.
 - 5.2.2 Use RAS that meet the requirements in the following table when tested in accordance with **AASHTO T 27** (prior to extraction process).

Sieve Size	% Passing
3/8 inch	100.0
No. 4	95.0-100.0
No. 100	15.0 max.
No. 200	7.00 max.

- 5.3 Recycled Crushed Glass
 - 5.2.1 Recycled Crushed Glass stockpiles may contain material from multiple sources and may be replenished.
 - 5.2.2 Use Recycled Crushed Glass that meet the requirements in the following table when tested in accordance with **AASHTO T 27** (prior to extraction process).

Sieve Size	% Passing
3/8 inch	100.0
No. 200	8.0 max.

6. RECORDS

- 6.1 Maintain at the plant site a record system for all RAP, RAS, and Recycled Crushed Glass stockpiles. Include at a minimum the following:
 - 6.1.1 Stockpile identification and a sketch of all stockpile areas at the plant site.
 - 6.1.2 Extraction test results for each stockpile.

6.1.3

At the plant site, make available to the **RCE** and **AME** the stockpile records. The **RCE** or **AME** may reject by visual inspection any stockpiles that are not kept clean and free of foreign materials. Provide a Quality Control plan accepted by the **AME**, a fractionation device accepted by the **AME**, and sufficient cold feed bins (one per RAP fractionation size *if running both RAP sizes, RAS, or Glass simultaneously*) to handle the fine (passing No. 4 or ¼-inch sieve) and coarse material(s) generated during the fractionation process.

**7. RECYCLED ASPHALT PAVEMENT OR SHINGLES
MAXIMUM PERCENTAGE OF AGED BINDER**

Type of Mix	Maximum % Aged Binder from RAP and RAS	
	Non Fractionated RAP	Fractionated RAP
Surface A	-	15
Surface B	15	25
Surface C**	20	30
Surface D**	20	30
Surface E	-	30*
PMTLSC	15	30*
Intermediate A	-	15
Intermediate B	20	30
Intermediate C**	25	35
Base A**	30	35
Base B**	30	35
Base C	-	35*
Base D	-	35*
Shoulder Widening**	30	45

*Fractionated Fine Rap only

** RAS permitted

7.1 See SC-M-402 to determine which mix types permit the use of RAP, RAS, and Recycled Glass.

7.2 Limit the amount of the shingles used in each mix in accordance with the job mix formula requirements for that mix. When RAS is used, RAP may also be added, but the total percentage of aged binder will not be allowed to exceed the amount in the table found in section 7 above.

Type of Asphalt Mixture	% RAS Permitted
Surface C and Surface D	3.0
Base A, Base B, SWC, and Intermediate C	5.0

7.3 In addition to the limits indicated in the table in subsection 3.5, further limit RAP to 20% maximum when introduced in the hot elevator. If a RAP collar is used, additional quantities of recycled products may be added as permitted by the AME.

7.4 % Aged Binder Calculation

7.4.1 % Aged Binder from RAP and RAS = ((A x B) + (C x D)) / E X 100%

- A = RAP, % Binder Content
- B = RAP, % in Mixture (by weight of total mixture)
- C = RAS, % Binder Content
- D = RAS, % in Mixture (by weight of total mixture)
- E = New Mix Design, % Binder Content*

7.5 Limit the amount of recycled crushed glass to a maximum of 15% by total weight of aggregate in the asphalt mixture.

8. EXTRACTION

8.1 Perform the extraction process in accordance with the requirements described in these specifications. Follow the testing procedures described in **SC-T-75** to obtain the binder content of the mixture. Perform wash gradations using **SC-T-76** for design purposes to get accurate dust content on the extracted RAP or RAS in ensure that D/A Ratio requirements for the mix design are meet requirements set forth in **SC-M-402**. Ensure that the recycled glass does not burn off in the ignition oven process and check for degradation after the burn is complete with a mixture sample (not just the glass).
(Note- typically only 200 to 300 grams of RAS are needed for extraction testing)

9. MIX DESIGN

9.1 Ensure that the design binder content is verified by the design personnel so that the % aged binder does not exceed the allowable % of aged binder as stated in section 7.4.1e. *Design Recommendation: Estimate the binder content of the new mix design (E) as described above prior to making the mixture to ensure the specification is being met.*

9.2 Use the method of mix design described in **SC-T-80** for the design of asphalt mixture containing RAP and/or RAS. After heating the aggregates to the proper temperatures and approximately 1 hour before the addition of the binder, add the proper amount of the RAP or RAS (e.g., 15% of total weight of the aggregate or 0.150 x total weight of aggregate), mix thoroughly, and place the mix back in the oven. After approximately an additional 1-hour, add the required amount of the binder by weight of total mixture and mix until homogenous. No additional methods are necessary for using recycled crushed glass, treat material as conventional aggregate. Check the temperature of the mixture to ensure that it has reached the compaction temperature before applying the compaction effort with a gyratory compactor.

10. FIELD ACCEPTANCE

10.1 The **AME** will make random project inspections so that samples of recycled asphalt mixture can be obtained for checking the recovered properties of the asphalt binder. *This may be deemed necessary if problems exist with field production or placement of the finished asphalt mixture-pavement.* Recovery of asphalt binder will be performed by **SC-T-95**, and binder tests will be done to determine the viscosity and stiffness (PG grade) of the recovered asphalt binder using **AASHTO T315**. In the event that the binder is determined to be too stiff or viscosity is too high as determined by the **AME**, production will be suspended, and the contractor will be required to redesign a new asphalt job mix formula.