

Recommend Approval: <u>Robert A. Vellel</u> 12/18/14 Assistant Division Chief Date <u>[Signature]</u> 12/18/14 Division Chief Date	Maryland Department of Transportation State Highway Administration Office of Materials Technology MARYLAND STANDARD METHOD OF TESTS	
Approved: <u>Tim Smith</u> 1/2/2015 Director Date	<b>DESIGN PROCEDURE FOR ASPHALT MIXES CONTAINING RECLAIMED ASPHALT PAVEMENT (RAP) AND/OR RECLAIMED ASPHALT SHINGLES (RAS)</b>	<b>MSMT 412</b>

**SCOPE:**

This method is used for the design of asphalt mixes which contain reclaimed asphalt pavement (RAP) and/or reclaimed asphalt shingles (RAS) from manufacturing waste. The allowable proportion in the mix is predicated on an evaluation of the quality of the RAP and/or RAS, the type of virgin asphalt binder selected for the mix, and the consistency of the RAP and/or RAS stockpile.

**REFERENCE DOCUMENTS:**

- D5404 Recovery of Asphalt from Solution Using the Rotary Evaporator
- T2 Sampling of Aggregates
- T11 Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
- T27 Sieve Analysis of Fine and Course Aggregates
- T164 Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA)
- T209 Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)
- T308 Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method
- T312 Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyrotory Compactor
- T315 Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
- T316 Viscosity Determination of Asphalt Binder Using Rotational Viscometer
- T 342 Determining Dynamic Modulus of Hot Mix Asphalt (HMA)
- M320 Performance Graded Asphalt Binder
- M323 Superpave Volumetric Mix Design
- M332 Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR).

- PP61      Developing Dynamic Modulus Master Curves for Asphalt Mixtures Using the Asphalt Mixture Performance Tester (AMPT)
- PP78      Design Considerations When Using Reclaimed Asphalt Shingles (RAS) in Asphalt Mixtures
- TP79      Determining the Dynamic Modulus and Flow Number for Asphalt Mixtures Using the Asphalt Mixture Performance Tester (AMPT)
- R59        Recovery of Asphalt from Solution by Abson Method
- R 62        Developing Dynamic Modulus Master Curves for Asphalt Mixtures

**DEFINITIONS:**

**Reclaimed Asphalt Pavement (RAP)** – removed and/or processed pavement materials containing asphalt binder and aggregate.

**Reclaimed Asphalt Shingles (RAS)** – waste from the manufacturing of roofing shingles, not to include any material from building waste or other salvaging operations.

**Virgin Asphalt Binder** – new asphalt binder used in hot mix asphalt mixtures.

**Binder Replacement** – reclaimed asphalt binder from RAP and/or RAS that replaces virgin binder in asphalt mixes.

**Asphalt Blend Ratio** – the ratio of asphalt binder contributed by the RAP and/or RAS to the total asphalt binder used in hot mix asphalt mixtures.

**Standard Deviation (n-1)** – a statistical term used in to indicate the spread of a set of data or a population.

**Binder Selection Guidelines for RAP, RAP and RAS or RAS Only Mixes**

<b>Recommended Virgin Asphalt Binder Grade</b>	<b>Maximum Allowable % Binder Replacement</b>	
	<b>RAP or RAP/RAS</b>	<b>RAS Only</b>
No change in binder selection	≤30	≤20
Follow recommendations from blending charts	>30	>20

### **SIGNIFICANCE AND USE:**

The introduction of RAP and/or RAS can affect the virgin asphalt binder content requirements. The designer must determine the virgin asphalt binder content of the new asphalt mix as part of the volumetric design procedure. During the production of the asphalt mix, the binder present in the RAP and/or RAS will mix with the virgin asphalt binder to produce a final blended binder. The properties of the asphalt binder can be considerably different from those of virgin asphalt binder.

### **PROCEDURE:**

Collect a representative sample of the RAP and/or RAS in order to determine the physical properties of the material. A RAS stockpile, composed of manufacturer's waste, shall be treated the same as a RAP stockpile. Based on the properties of the asphalt binder recovered from the RAP, RAP/RAS samples, the allowable percentage of the recovered binder shall not be greater than 30 percent of the asphalt binder of the mix without further evaluation according to this test method. For mixes containing RAS, the allowable maximum percentage of the recovered binder contributed from RAS shall not be greater than 20% of the asphalt binder of the mix without further evaluation according to this test method. The use of RAS is not allowed in gap-graded mixes or mixes requiring elastomer type polymer binder.

The materials are proportioned for fabrication into gyratory specimens. The RAP, RAS or RAP/RAS are heated in an oven at 60 C. The virgin aggregate is heated in an oven at a temperature which, when combined with the RAP, RAS or RAP/RAS, should provide a mixing temperature within the mixing temperature range. The materials shall be mixed and fabricated as specified in T 312.

Values exceeding the maximum binder thresholds are used to develop a blending chart meeting the requirements of M 323. Blending of RAP and/or RAS binders can be accomplished by knowing the desired final grade (critical temperature) of the blended binder, the physical properties and critical temperatures of the recovered RAP and /or RAS binder, and either the physical properties and critical temperatures of the virgin asphalt binder or the desired percentage of the RAP and/or RAS in the mixture.

For mixes consisting of greater than 30 percent binder replacement, test and evaluate mixes in accordance with PP 61 or R 62 to determine plant mixing capabilities to determine a maximum RAP percentage the plant can effectively process. This is a one-time, plant specific test, unless a plant makes a change to their plant mixing process or at the direction of the Office of Materials Technology/Asphalt Technology Division (OMT/ATD). All PP 61 or R62 testing will be done at a production rate agreed upon by OMT/ATD and Asphalt Producer. Notify OMT/ATD at least two working days in advance of the Field Verification of Mix Design as specified in 904.04.05.

RAP, not exceeding 15 percent by weight of mix, may be considered for use in mixes requiring elastomer type polymer binder. See MSMT 416 requirements for high polish mixes.

Do not use crushed glass in surface mixes.

## MATERIALS EVALUATION

- (1) The producer shall obtain a minimum of 10 samples; approximately 7 kg each of the RAP and/or RAS stockpile, as specified in T2 regardless of stockpile size. All samples are to be split with the Administration.
- (2) Determine the maximum specific gravity on 5 of the 10 samples per T209 using approximately 2 kg for each determination. Sample size is based on the nominal maximum aggregate size of the RAP and/or RAS.
- (3) Determine the asphalt binder content of each of the 10 samples as specified in T164 or T308. Approximately 2 kg of the RAP and/or RAS is required for each determination. The aggregate correction factor required T308 should be approximated based on experience with similar aggregate types or based on companion samples tested per T164.
- (4) Determine the gradation of the aggregate portion of each sample obtained from Step 3 as specified in T27 and T11. If T164 is used, include the amount of material passing the 0.075 mm sieve and remaining on the filter paper and in the extract when calculating the gradation.
- (5) If additional binder properties are required, recover the binder as specified in T319 or R59, using the extract obtained from T164.
- (6) Determine the viscosity of the recovered RAP and/or RAS asphalt binder to be used in the mix as specified in T316.
- (7) Determine the viscosity of the virgin asphalt binder to be used in the mix as specified in T316.
- (8) The values for the maximum specific gravity, asphalt binder content, and gradation of the stockpile are expressed as the numerical averages of the data obtained from the 10 representative samples.
- (9) Calculate the standard deviation of the asphalt binder content of the RAP material using n-1.

### NOTE:

**Mixes containing less than the maximum binder replacement limits:** The producer shall determine asphalt content, gradation and maximum specific gravity from representative samples taken from the stockpile and submit the results to the Administration every 5 days of SHA plant production when RAP stockpile has been utilized or increased. Administration may request periodic split samples for testing.

**Mixes exceeding the maximum binder replacement limits:** The producer shall determine asphalt content, gradation and maximum specific gravity from representative samples taken from the stockpile and submit the results to the Administration every 5 days of SHA plant production when RAP stockpile has been utilized or increased.

Testing for recovered binder properties shall be conducted every April, July and September with results due to OMT by the end of each respective month. All samples are to be split with the

Administration. This information will be used for informational purposes only. The producer shall retain samples for ten business days after submission of the test data.

### MIX DESIGN

- (1) After the percentage of RAP and/or RAS has been determined, the remaining cold feed aggregate proportions and job mix formula gradation shall be established and verified as specified in M 323.
- (2) Mix all remaining RAP and/or RAS material together prior to blending samples for gyratory specimens.
- (3) A series of gyratory specimens shall be fabricated per T312 with the following exceptions:
  - (a) The virgin aggregate portion of the blend is heated to a temperature which, when combined with the RAP and/or RAS material, will yield a mixing temperature of approximately 150 C. Note: Warm mix considerations may be necessary according to Appendix A of M323.
  - (b) The RAP and/or RAS material is kept separate from the virgin aggregate until the time of mixing and is preheated in an oven maintained at 60 C. Preheating of the RAP and/or RAS material shall not exceed 4 hours prior to mixing.
  - (c) The amount of asphalt binder contributed by the RAP and/or RAS, expressed as a percent of the total mix is determined as follows:

$$B_R = \frac{\sum_{i=1}^n \{(RAC_i \times R_i) + (SAC_i \times S_i)\}}{100}$$

where:

- $B_R$  = Amount of asphalt binder in total mix contributed by RAP and/or RAS, percent,  
 $RAC_i$  = Effective Asphalt Content of RAP<sub>i</sub>, percent,  
 $R_i$  = RAP source i, percent,  
 $SAC_i$  = Effective Asphalt Content of RAS<sub>i</sub>,  
 $S_i$  = RAS source i, percent

- (d) The amount of virgin asphalt binder to be added at each increment is determined as follows:

$$B_V = B_T - B_R$$

where:

- $B_V$  = Amount of virgin asphalt binder, percent,  
 $B_T$  = Total asphalt binder for the selected increment percent,  
 $B_R$  = Amount of asphalt binder in total mix contributed by RAP and/or RAS, percent.

- (e) The ratio of asphalt binder contributed by the RAP, RAS or RAP/RAS to the total

asphalt binder used in asphalt paving mixes is determined as follows:

$$ABR = \frac{B_R}{B_T}$$

where:

$B_R$  = Amount of asphalt binder in total mix contributed by RAP and/or RAS, percent,

$B_T$  = Amount of total asphalt binder, percent,

ABR = Asphalt blend ratio

### **REPORT:**

**Submit all reports to:** [Superpave@sha.state.md.us](mailto:Superpave@sha.state.md.us) – RE: MSMT 412 Test Results/Reports

#### **For mixes containing less than the maximum binder replacement limits:**

Report the asphalt content, gradation, maximum specific gravity, standard deviation and percentage of binder replacement.

#### **For mixes exceeding the maximum binder replacement limit:**

Report the individual values of the stockpile analysis and results of T316 testing. M323 testing will report final blended binder grade, recovered RAP, RAS or RAP/RAS properties, percent recovered RAP, RAS or RAP/RAS binder, and all critical temperatures.

From this information, determine and report the properties of the virgin asphalt binder needed and the allowable RAP, RAS or RAP/RAS percentages that will satisfy all temperatures. Include a statement indicating that the combined binder meets the grade originally specified.