Standard Method of Test for

Full Depth Reclamation Using Asphalt Emulsion – Job Mix Formula Preparation

SCDOT Designation: SC-T-99

1. SCOPE

1.1 This procedure provides instructions for preparing a Job Mix Formula (JMF) for a stabilized base using reclaimed asphalt material with emulsified asphalt binder, water and other additives.

2 REFERENCED DOCUMENTS

2.1. AASHTO Standards

2.1.1. AASHTO T11, Materials Finer Than 75µm Sieve in Mineral Aggregates by Washing

2.1.2. AASHTO T27, Sieve Analysis of Fine and Coarse Aggregate

2.1.3. AASHTO T49, Standard Method of Test for Penetration of Bituminous Materials

2.1.4. AASHTO T59, Standard Method of Test for Testing Emulsified Asphalts

2.1.5. AASHTO T84, Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate

2.1.6. AASHTO T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate

2.1.7. AASHTO T100, Standard Method of Test for Specific Gravity of Soils

2.1.8. AASHTO T166, Standard Method of Test for Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens

2.1.9. AASHTO T176, Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

2.1.10. AASHTO T180, Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

2.1.11. AASHTO T245, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

2.1.12. AASHTO T255, Total Evaporable Moisture Content of Aggregate by Drying

2.1.13. AASHTO T 283, Resistance of Compacted Asphalt Mixtures to Moisture - Induced Damage

2.2. ASTM Standards

2.2.1 ASTM D2950, Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

3 APPARATUS

3.1 Calibrated gyratory compactor, Marshall stability/flow tester, thermometers, balance, oven and other necessary equipment.

4 PROCEDURE

4.1. Asphalt Emulsion Selection

4.1.1 Select an asphalt emulsion that meets the requirements as specified in the SCDOT Standard Specifications for Highway Construction and also meeting the requirements as per AASHTO T59. In addition, asphalt emulsion shall meet the following requirements:

Test	Specifications	Minimum	Maximum
Residue from Distillation, percent	AASHTO T59	63	None
Oil distillate by Distillation, percent	AASHTO T59	None	0.5
Sieve Test, percent	AASHTO T59	None	0.1
Penetration @ 25^{o}C, dmm	AASHTO T49	55	95

4.2. Full Depth Reclamation (FDR) Processing

4.2.1 The existing pavement or any recycled asphalt pavement (RAP) material shall be crushed to meet below gradation before blending.

4.2.2 Washed gradation shall be performed in accordance with AASHTO T11 and T27 on the composite base material. The material will include any or all of the existing base, the materials produced in 4.2.1 and/or virgin aggregates. The materials will be blended in the proportions that are representative of the project depth and cross section. Determine if the material to be reclaimed meets the following gradation:

Sieve Size	Percent Passing by Weight
2.0 in.	100
1.75 in.	97-100
No. 200	0-20

4.2.3 The base rock shall have a sand equivalent performed and reported in accordance with AASHTO T176. RAP shall have a sand equivalent performed. Report the washed gradation and sand equivalent on the blend

4.2.4 If needed, virgin aggregate shall be blended with the FDR material to meet the required gradation in Section 4.2.2. If reclaimed material does not have a sand equivalency greater than 30 and/or and washed gradation of less than 20% passing the No. 200 sieve, then virgin aggregate or RAP shall be added so that those conditions are met.

4.3 Selection of Water Content for Design

4.3.1 A modified Proctor compaction shall be conducted in accordance with AASHTO T180 to determine the optimum moisture content at peak dry density. Material containing 20% or more passing No. 200 shall be mixed with target moisture, sealed, and set aside a minimum of 12 hours. All other material shall be set aside a minimum of 3 hours. If a material contains a significant amount of RAP or coarse material and does not produce a well defined moisture-density curve, then the moisture content shall be fixed at 3%.

4.3.2 Select the water content of specimens, not including water in the emulsion, based on:

- 60 to 75 percent of OMC if SE $\leq$ 30
- 45 to 65 percent of OMC if SE > 30

Sand equivalent value (SE) is from the combined materials.

If a material contains less than 4 percent passing No. 200 or if no peak develops with the OMC curve, then fix the moisture content between 2 and 3 percent. Specimens shall be mixed with the required amount of water before the addition of emulsion. Specimens shall be mixed with the appropriate amount of water and allowed to sit sealed according to the same guidelines as used for Modified Proctor specimens.

4.4. Preparation of Test Specimens

4.4.1 Sufficient samples shall be taken before addition of water and emulsion to produce at least 95±5 mm height and 150 mm diameter compacted specimens.

4.4.2 Specimens shall be mixed with the required amount of water for 60 seconds before addition of asphalt emulsion. These specimens shall be allowed to sit sealed as specified in Section 4.3.1.

4.4.3 Four emulsion contents shall be selected.

Notes: Four emulsion contents of 3%, 4%, 5% and 6% by weight of total mix are typically used, but other ranges or narrower bands (0.5%) can be selected.

4.4.4 The following number of specimens shall be produced for each test method in the laboratory at each emulsion content:

Test	No. of Specimens/ Emulsion Content
Maximum Specific Gravity*	2
Gyratory Compacted Stability	3
Initial Gyratory Compacted Stability	3
Indirect Tensile Strength	6

*Uncompacted

4.4.5 Aggregate material and emulsion shall be mixed in a mechanical mixer at a temperature of 20^0C to 26^0C for 60 seconds.

4.4.6 Specimens after mixing shall be cured individually at 40^0 C for 27 to 33 minutes.

4.4.7 If other materials are added, such as lime or cement, then they shall be introduced in a similar manner as they will be on the project. For example, if lime is incorporated a day or more before emulsion addition, then it shall be added to

the wet aggregate a day or more before mixing with emulsion. If lime is incorporated as a slurry, then it shall be incorporated as a slurry in the laboratory.

Notes: Usually addition of 1% lime or cement is sufficient.

4.5. Compaction

4.5.1 Specimens shall be compacted in a gyratory compactor at a vertical pressure of 600 kPa at an angle of 1.25^0 and a mold of 150 mm for 30 gyrations at a temperature of 20^oC to 26^oC. After the last gyration, 600 kPa pressure shall be applied for 10 seconds. The mold shall not be heated.

4.5.2 Specimens, except initial gyratory compacted stability, shall be cured in a forced draft oven for 48 hours at 60^oC to a constant weight. After curing, the specimens shall be cooled at room temperature for 24 hours.

4.5.3 For initial gyratory compacted stability, after compaction, samples shall be cured at room temperature (25°C) for a minimum of 24 hours.

4.5.4 Specimens for maximum specific gravity shall be in loose form and cured at the same conditions as the compacted specimens, except they can be tested after cooling a maximum of 24 hours.

4.6. Volumetric Measurements

4.6.1 Determine and average the Maximum Specific Gravities of two samples at each emulsion content using AASHTO T209.

Notes: use supplemental dry-back procedure

4.6.2 Prior to testing for stability and flow, determine and average the Bulk Specific Gravities of all compacted specimens at each emulsion content using AASHTO T166.

4.7. Stability and Flow

4.7.1 The gyratory compacted stability and flow test is conducted to determine the Quotient value. The Quotient gives an indication of mixture stiffness. (While stiff mixtures are desirable to resist permanent deformation, it is not suitable to have mixtures so stiff that they are likely to crack under heavy and repeated loads.)

4.7.2 Prepare three specimens at each emulsion content. These specimens shall be prepared according to Sections 4.4 and 4.5.

4.7.3 The dry samples shall be tested at room temperature for stability and flow using a 6 in. (152 mm) diameter Stability Breaking Head.

4.7.4 Determine the Quotient by dividing the peak stability value by the flow value reached at the point of peak stability.

4.7.5 For stability report the average value of the three specimens for stability, flow, and Quotient.

4.7.6 Repeat steps 4.7.2 through 4.7.5 for initial stability, reporting only the stability.

4.8. Indirect Tensile Strength (ITS)

4.8.1 Prepare six specimens at each emulsion content. These specimens shall be prepared according to Sections 4.4 and 4.5.

4.8.2 Test specimens according to AASHTO T283, excluding section 10.3.7 (in AASHTO T283-07) – do not perform freeze/thaw test on the specimen.

4.9. Selection of Emulsion Content

4.9.1 A design emulsion content shall be selected to produce a FDR mixture that meets the following design criteria. If more than one emulsion content produces mixtures which meet the criteria, then select the emulsion content that produces a mixture with the highest stability.

For 152mm diameter specimens using Gyratory Compactor	
Properties	**Criteria**
SGC, 1.25^{o} angle, 600 kPa	30 Gyrations
Final cured stability, AASHTO T245, 25°C, lbs	3,000 min.
Final cured flow, AASHTO T245, 25°C, in.	0.10 – 0.25
Gyratory quotient, lbs/in.	35,000 max.
Initial stability after 24 hours, AASHTO T245, 25°C, lbs	1,500 min
ITS of control samples, AASHTO T283, psi	45 min.
ITS of conditioned samples, AASHTO T283, psi	25 min.

4.10. REPORT

The report for the JMF shall be as follows:

- Physical address of the road and project information.
- Penetration of the emulsion residue used in the mix design.
- General description of the materials received, their locations, and sampling procedure.
- Average thickness of hot mix asphalt.
- Thickness to be reclaimed.
- Density and optimum moisture content from Proctor compaction.
- Moisture content used in mix design.
- Indirect tensile strength.
- Level of saturation and conditioned indirect tensile strength.
- Gyratory stability, flow and quotient
- Initial gyratory stability
- Design emulsion content as a percent, in gallons per square yard, and in gallons per foot (with assumed width reported).