DEPARTMENT OF TRANSPORTATION
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Lab Procedure # 8

METHOD OF TEST FOR DETERMINING THE PERCENT OF EMULSIFIED RECYCLING AGENT TO USE FOR COLD RECYCLING OF ASPHALT CONCRETE

1. SCOPE

This procedure is used to determine the percent and grade of recycling agent to use for recycling asphalt concrete when the cold method of recycling is used.

2. COLD MIX REQUIREMENTS

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The recycled pavement mixture shall conform to the following quality requirements shown in Table 1.

Table 1: Cold Mix Requirements

Design Parameters	Requirement
Gradation of Design Reclaimed Asphalt Pavement (RAP), CT202	Passing 25-mm (1")
Asphalt Content of RAP, CT362 or CT379 or CT382	Report
Bulk Specific Gravity of Compacted Samples [1] [2], CT308, Method C	Report
Maximum Theoretical Specific Gravity [2], CT309 with Provisions of Section J	Report
Air Voids of Compacted and Cured Specimens [2], CT367 Part B	Report
Marshall Stability, Cured Specimen [2], AASHTO T 245, 40°C (104°F)	5,560 Newton (1,250 Lb.) Minimum
Marshall Retained Stability, AASHTO T 245, 40°C (104°F) Based on Moisture Conditioning on Cured Specimen [2] [3]	70% minimum
Ratio of Emulsion Residue to Cement	1.8 Minimum
Raveling Test, Section 9 of this Document, 10°C (50°F)	Report

Note: 1 100 mm diameter mold compaction based on either 75 blow Marshall each side or gyratory compactor at 30 gyrations
2 Measurement on specimens after 60°C (140°F) curing to constant weight for no less than 16 hours and no more than 48 hours
3 Vacuum saturation of 55 to 75 percent, water bath at 25°C (77°F) for 23 hours, last 30 to 40 minutes in 40°C (104°F) water bath

3. PREPARATION OF SAMPLES

SAMPLING & PROCESSING OF EXISTING ASPHALT PAVEMENT MATERIALS

Obtain RAP samples from the areas to be recycled. It is recommended to take one core for each lane mile and where visual differences in the pavement are noticed.

If cores show significant differences in various areas, such as different type or thickness of layers between cores, then separate mix designs will be performed for each of these pavement segments.

Cores will be cut to the depth specified for the cold recycling project.

Milled RAP from the areas to be recycled or alternate means of obtaining RAP samples can be used as an alternative to cores.

Obtain sufficient RAP, approximately 156 kg (350 lbs), to be used for mix design purposes.

Obtain representative sample of the RAP to be recycled and determine asphalt content of the RAP according to CT362 or CT379 or CT382.

Perform two mix designs, one for each grading, by recombining the RAP material in the laboratory in order to meet the gradation criteria shown in Table 2.

Table 2: Cold Recycling Gradation Requirements

Sieve Size	Suggested Target	
	Medium Gradation	Coarse gradation
25-mm (1")	100	100
19-mm (¾")	95 ± 2	85 ± 2
4.75-mm (No. 4)	50 ± 2	40 ± 2
600-µm (No. 30)	10 ± 2	5 ± 2
75-µm (No. 200)	0.8 ± 0.3	0.3 ± 0.3

Gradation of the RAP after milling or crushing will be determined by California Test CT 202 with the exception that drying of RAP samples to constant mass shall be performed at 40±2°C (104±4°F).

4. MIXING

Specimen size:

Determine the amount that will produce a 61.0 mm to 66.0 mm (2.4" to 2.6") tall specimen when compacting 100 mm (4") diameter specimens with either the Marshal compactor based on 75 blows on each side or the gyratory compactor at 30 gyrations for stability testing.

Number of specimens:

Choose three emulsion contents that bracket the estimated recommended emulsion content for all stability testing outlined in Table 1. Select three emulsion contents in either 0.5% or 1.0% increments covering a range typically between 0.5% and 4.0% by dry weight of RAP.

Compact 6 samples at each emulsion content for stability testing, 3 for Marshall stability on cured samples and 3 for Marshall stability on cured samples for moisture conditioning.

Two specimens are required for Theoretical Maximum Specific Gravity according to CT309, Section J, with the exception that loose RAP mixture shall by cured in an oven at 60±1°C (140±2°F) to constant weight but no more than 48 hours and no less than 16 hours. Constant weight is defined here as 0.05% change in weight in 2 hours. Do not break any agglomerates which will not easily reduce with a flexible spatula. Test both specimens at the highest emulsion content in the design and back calculate for the lower emulsion contents.

Add moisture that is expected to be added at the milling head, typically 1.5 to 2.5 percent.

If any additives are in the mixture, introduce the additives in a similar manner that they will be added during field production.

Mixing of test specimens will be performed manually or with a mechanical bucket mixer or a combination of the two. Mix the RAP thoroughly with water first, then mix with emulsion. Mix at room temperature of 25±2°C (77±4°F). One specimen will be mixed at a time. Mixing time with emulsion should not exceed 60 seconds.

5. COMPACTION

Compact specimens after mixing. Compact specimens at room temperature 25±2°C (77±4°F).

Specimens will be compacted with a Marshall compactor by applying 75 blows per side for stability testing purposes using 100 mm (4") molds or with gyratory compactor at 30 gyrations for stability testing purposes using 100 mm (4") molds.

Do not heat molds or Marshall compaction hammer.

If paper disks are used, place paper disks on the top and bottom of the specimen before compaction and remove paper disks from specimens immediately after compaction.

6. CURING AFTER COMPACTION

Extrude specimens from molds after compaction without damaging the samples. Carefully remove paper disks if used.

Place specimens in 60±4° C (140±8°F) forced draft oven with ventilation on sides and top. Place each specimen in a small container to account for material loss from the specimens. Cure compacted specimens at 60±1° C (140±2°F) to constant weight but no more than 48 hours and no less than 16 hours. Constant weight is defined here as 0.05% change in weight in 2 hours. After curing, cool specimens at ambient temperature a minimum of 12 hours and a maximum of 24 hours.

Perform same oven conditioning and volumetric measurements on moisture-conditioned specimens as on other specimens.

Perform moisture conditioning on 3 compacted samples at each emulsion content by applying a vacuum of 13 to 67 kPa absolute pressure (254 to 660 mm of Hg partial pressure) for a time duration required to vacuum saturate samples to 55 to 75 percent. Saturation calculation shall be calculated by comparing saturated surface dry mass with dry mass in air determined. Soak moisture conditioned samples in a 25±1°C (77±2°F) water bath for 23±1 hour, followed by a 30 to 40 min soak at 40±1°C (104±2°F).

7. MEASUREMENTS

Determine asphalt content of the RAP material to be recycled according to CT362 or CT379 or CT382.

Determine bulk specific gravity of each compacted, cured and cooled specimen according to CT308, Method C.

Determine specimen heights according to CT308 Section D2e. Alternatively, the height can be obtained from the SGC readout if the gyratory compactor is used.

Determine maximum theoretical specific gravity, CT309, Section J, with the exception detailed in Section 4 of this document.

Determine air voids of the compacted and oven cured samples at each emulsion content according to CT367 Part B.

Determine corrected Marshall stability by AASHTO T245 at 40±1°C (104±2°F) after 2 hour temperature conditioning in a forced draft oven or by immersing in water bath for 30 to 40 minutes. This testing will be performed at the same time that the moisture-conditioned specimens are tested.

Determine Marshall Retained Stability. The average moisture conditioned specimen strength divided by the average dry specimen strength is referred to as retained stability.

8. EMULSION CONTENT SELECTION

Choose the design emulsion content such that the cold mix requirements listed in Table 1 are met.

9. RAVELING TEST ON RECYCLED ASPHALT SPECIMENS

Apparatus:

The apparatus used for the raveling test is a modified A-120 Hobart mixer and abrasion head (including hose) used in the Wet Track Abrasion of Slurry Surfaces Test (ISSA TB-100). The

rotation speed for the raveling test is not modified from ISSA TB-100. The ring weight is removed from the abrasion head for the raveling test below. The weight of the abrasion head and hose in contact with the specimen should be 600 +/- 15g.

The prepared sample must be able to be secured under the abrasion head, and centered for accurate results, allowing for free movement vertically of the abrasion head. The device used for securing and centering the sample must allow a minimum of 10 mm of the sample to be available for abrasion. The Hobart mixer will need to be modified to allow the sample to fit properly for abrasion. The modification may be accomplished by adjusting the abrasion head height, or the height of the secured sample. A Raveling Test Adapter can be purchased through Precision Machine and Welding, Salina, KS, (785) 823-8760. Please reference the Hobart Model number when ordering. The C-100 and N-50 Models are not acceptable for this test procedure due to differences in size and speed of rotation.

Procedure:

Split out two 2700 g RAP samples from the crushed core materials. 2700 g is an approximate weight to give 70 +/- 5 mm of height after compaction.

Place the 2700 g of RAP in a container of adequate size for mixing.

Field or design moisture contents should be added to each of the RAP samples and mixed for 60 seconds.

Add the design emulsion content and mix for 60 seconds.

Immediately following mixing, place samples into a 150 mm compaction mold and compact to 20 gyrations. If the sample height is not 70 +/- 5 mm, the RAP weight should be adjusted.

After compaction, remove samples from the compaction mold and placed on a flat pan to cure at ambient lab temperature (65-75°F) for 4 hours +/- 5 minutes.

Weigh the specimens after curing and just prior to testing.

Place the specimens on the raveling test apparatus. Care should be taken that the specimen is centered and well supported. The area of the hose in contact with the specimen should not have been previously used. It is allowable to rotate the hose to an unworn section for testing. The abrasion head (with hose) will be free to move vertically downward a minimum of 5mm if abrasion allows.

Abrade samples for 15 minutes and immediately weigh abraded samples.

Determine the Percent Raveling Loss as follows:

$$Percent\ Raveling\ Loss = \frac{(Weight\ prior\ to\ test - Weight\ after\ abrasion)\ x\ 100}{Weight\ prior\ to\ test}$$

The average of the results of tests on the two specimens will be reported as the Percent Raveling Loss.

There should not be a difference of 0.5% Raveling Loss between the two test specimens for proper precision. A difference of greater than 0.5 percent will require the test to be repeated. If both of the samples have a Raveling Loss of greater than 10%, the precision requirement will be waived and the average of the two tests will be computed regardless of the difference between the two tests.

10. REPORT

The report will contain the following minimum information: gradation of RAP, RAP asphalt content, recommended water content range as a percentage of dry RAP, optimum emulsion content as a percentage of dry RAP, amount of additive as a percentage of dry RAP, ratio of emulsion residue to cement, and corresponding density, air void level, Marshall stability, retained stability, compaction method used to determine any reported stability, and raveling at recommended moisture and emulsion contents. Include the emulsion and additive designation, company name and location; and residue content; and the additive designation, company name and location; and certificates of compliance for both.