

# 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 emulsified recycling agent to use for recycling asphalt concrete when the cold method of recycling is used.

## 2. COLD MIX REQUIREMENTS

The recycled pavement mixture shall conform to the Mix Design Requirements as outlined in Table 1.

## 3. SAMPLING & PROCESSING OF EXISTING ASPHALT PAVEMENT MATERIALS

*Samples obtained by coring:*

Obtain sufficient RAP, approximately 400 lbs, to be used for mix design purposes. 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 shall be performed for each of the pavement segments.

Cut cores to the depth specified for the cold recycling project.

Obtain representative sample of the RAP to be recycled and determine asphalt content of the RAP according to CT362 or CT379 or ASTM D2172 Method B.

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 3.

1. **Table 3: 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

Determine gradation of the RAP after crushing and recombining by California Test CT 202 with the exception that drying of RAP samples to constant mass shall be performed at 104±4°F.

*Samples obtained by milling:*

Milled RAP from the areas to be recycled can be used as an alternative to cores.

Obtain sufficient RAP, approximately 400 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 ASTM D2172 Method B.

Perform one mix design by crushing material greater than 1-inch and recombining the RAP material in the laboratory.

Determine gradation of the RAP after milling and crushing by California Test CT 202 with the exception that drying of RAP samples to constant mass shall be performed at  $104\pm 4^{\circ}\text{F}$ .

#### **4. MIXING**

*Specimen size:*

Determine the amount that will produce a 2.4-inch to 2.6-inch tall specimen when compacting 4-inch diameter specimens with either the Marshall 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 be cured in an oven at  $140\pm 2^{\circ}\text{F}$  to constant weight but no more than 48 hours and no less than 16 hours. Constant weight is defined as 0.05% change in weight in 2 hours. Do not break any agglomerates that do 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 3.0 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 shall 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  $77\pm 4^{\circ}\text{F}$ . One specimen shall 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 of  $77\pm 4^{\circ}\text{F}$ .

Compact specimens with a Marshall compactor by applying 75 blows per side for stability testing using 4-inch molds or with a gyratory compactor at 30 gyrations for stability testing using 4-inch 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  $140\pm 2^{\circ}\text{F}$  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  $140\pm 2^{\circ}\text{F}$  to constant weight but no more than 48 hours and no less than 16 hours. Constant weight is defined 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 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  $77\pm 2^{\circ}\text{F}$  water bath for  $23\pm 1$  hours, followed by a 30 to 40 min soak at  $104\pm 2^{\circ}\text{F}$ .

## **7. MEASUREMENTS**

Determine asphalt content of the RAP material to be recycled according to CT362 or CT379 or ASTM D 2172 Method B.

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

2. 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  $104\pm 2^{\circ}\text{F}$  after 2-hour temperature conditioning in a forced draft oven or by immersing in water bath for 30 to 40 minutes. This testing shall 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 that optimizes the performance of the recycled asphalt concrete and meets the requirements listed in Table 1.

## **9. RAVELING TEST ON RECYCLED ASPHALT SPECIMENS**

Determine raveling potential on recycled asphalt specimens in accordance with ASTM D 7196.

## **10. REPORT**

The report shall 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.