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Laboratory Guidelines for Cold-in-Place Recycling Mixture Design

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LABORATORY GUIDELINES FOR COLD-IN-PLACE RECYCLING MIXTURE DESIGN

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The researcher in charge of the project was Stephen Sebesta.

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INTRODUCTION

This guideline describes procedures for selecting and obtaining representative samples and the laboratory mix design procedures for cold in-place recycling (CIR) using the indirect tensile strength (IDT) test.

SAMPLING AND PROCESSING

Follow Tex-400-A for sampling stockpiled reclaimed asphalt pavement (RAP) materials. Follow the guidelines in Table 1 for sampling roadway materials.

Table 1. Sampling Roadway Materials.

Step	Recommended Approach	Acceptable Approach
1	Obtain historic plans. Conduct ground penetrating radar (GPR) survey.	Obtain plans and maintenance history.
2	Using plans and GPR survey, determine critical locations for sampling. Cover expected range of different types and thicknesses of asphalt concrete pavement.	Unless otherwise determined from plans and maintenance history, perform coring at 1 mi. spacing. For short projects (< 1 mi.), perform coring at a minimum of three locations.
3	Perform drill logs at each location of the pavement structure including at least the top 10 in. of subgrade.	Review core logs. Select locations representing significantly different types and thicknesses of asphalt concrete pavement for follow-up bulk sampling.
4	At each location of significantly different asphalt concrete materials, use a small recycler, auger, or core drill to obtain samples of the materials expected in the depth of the CIR road-mix.	At each location of significantly different asphalt concrete materials, use a small recycler, auger, or core drill to obtain samples of materials expected in depth of the CIR road-mix.
5	Collect approximately 400 lb of sample for each set of different materials requiring a mixture design.	Collect approximately 400 lb of sample for each set of different materials requiring a mixture design.

Cores, when used for obtaining bulk roadway sample, shall be cut in the laboratory to the anticipated depth of CIR treatment. Cores shall be crushed in the laboratory.

Gradation of the millings shall be determined by Tex-200-F Part I (dried at no greater than 104°F). The gradation should fall into one of the categories in Table 2, and if significant field processing variability is expected a mix design should be performed using the medium gradation and a minimum of one of the fine or coarse gradations. Samples can be prepared with a sample splitter, or dry screened and the millings recombined in the laboratory to target gradation. Scalp oversize aggregate with a 1.0-inch screen.

Table 2. Master Gradation of Crushed Millings.
(% passing by Weight or Volume)

Sieve Size	Fine	Medium	Coarse
1″	100.0	100.0	100.0
¾″	95.0–100.0	85.0–96.0	75.0–92.0
#4	55.0–75.0	40.0–55.0	30.0–45.0
#30	15.0–35.0	4.0–14.0	1.0–7.0
#200	1.0–7.0	0.6–3.0	0.1–3.0

MIX DESIGN PROCEDURE

1. RAP Preparation.
    - Prepare an 8,000 gram sample of RAP materials recombined to the expected field gradation for a set of six gyratory specimens per asphalt content.

2. Mixing.
    - Place RAP materials into a mixer and pour in 4 percent moisture. Start the mixer, add emulsified asphalt or foamed asphalt, and mix thoroughly for 60 seconds.
    - For emulsified asphalt, recommended emulsion contents are 1.0 percent, 1.5 percent, 2.0 percent, 2.5 percent, 3.0 percent, and 3.5 percent. Choose a minimum of two emulsion contents for the mix design.
    - For foamed asphalt, determine the optimum foaming characteristics for a given asphalt binder according to the lab foaming system manufacturer's instructions. Recommended foamed asphalt contents are 1.5 percent, 2.0 percent, 2.5 percent, 3.0 percent, and 3.5 percent. Choose a minimum of two foamed asphalt contents for the mix design.

3. Compaction.
    - Determine the weight of sample needed to fill a 100.0 mm by 50.8 mm (4.0 in. by 2.0 in.) cylindrical mold at the target density determined following Tex-113-E at 4 percent moisture content.
    - Setup the SGC with an external angle of 1.25° and consolidation pressure of 600 kPa. Configure the SGC to compact to a specified height of 50.8 mm (2 in.).
    - Weigh out and compact a test specimen using a Superpave gyratory compactor (SGC).
    - Extrude the compacted specimen from the gyratory mold.
    - Measure the height of the specimen. When the height does not meet the requirements of 2 ± 0.06 in., determine a corrected weight of material for a height of 2 in.
    - Weigh the other samples from the mixed material and compact a total of six specimens.
    - Measure the weight to the nearest 0.001 lb and the height to the nearest 0.01 in. of each compacted specimen.

4. Curing.
    - Place the compacted CIR specimens in an oven or temperature chamber at 40°C.
    - Cure the specimens for a minimum of 72 hours.

5. Volumetric Characteristics.
    - Calculate bulk specific gravity of only the three CIR specimens that will be used for wet IDT following Tex-207-F.
    - Measure theoretical maximum specific gravity following Tex-227-F.
    - Calculate air void.

6. Indirect Tensile Strength Test.
    - Submerge three specimens for wet IDT completely in a water bath at 25°C for 24±1 hours.
    - Store the remaining three specimens at room temperature for 24±1 hours.
    - Perform the IDT test at 25°C following Tex-226-F.
    - Calculate the average IDT of three specimens for dry and wet conditions, respectively.

7. Optimum Asphalt Content Selection.
    - Proceed to Step 8 when the IDT results meet the specification requirements.
    - When the IDT results fail to meet the specification requirements, make modifications as deemed necessary and repeat steps 1–6.

8. Hamburg Wheel Test and Raveling Test.
    - Perform the Hamburg test and Raveling test in accordance with Tex-242-F and ASTM D7196, respectively.
    - When the results meet the specification requirements, report the minimum treatment rate to meet specification requirements.
    - When the results fail to meet the specification requirements, make modifications as deemed necessary and repeat steps 1–7.