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Specification Recommendations for Cold-in-Place Recycling Mixtures

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SPECIFICATION RECOMMENDATIONS FOR COLD IN-PLACE RECYCLING MIXTURES

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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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RECOMMENDED SPECIFICATION UPDATES

An extensive literature review on cold in-place recycling (CIR) mixture designs and requirements along with laboratory testing and pavement performance prediction was conducted in this project. Based on the findings and results from prior tasks, Table 1 shows the recommended CIR mixture design requirements, and Table 2 shows the recommended mixture testing for quality control, respectively. The updates are in ***bold italics***. While this project's activities focused primarily on materials for CIR, based on the literature and the findings in this project, Table 1 and Table 2 should also be appropriate for cold central plant recycled mixtures.

Table 1. Recommended CIR Mix Design Requirements.

Property	Criteria	Purpose
Maximum Density, Tex-113-E	***@ 4% Moisture content***	***Set Target Density***
Compaction effort, Superpave Gyratory Compactor	1.25° angle, 600 kPa stress, ***Target density-based***	Prepare mix design Specimens
Density*(1) (2) (3)*, Tex-207-F, Part I	Report	Compaction Indicator
Hamburg Wheel Tracking Test*(2) (3)*, Tex-242-F	5,000 passes (min.) *(4)* 15,000 passes (max.)	Rutting Resistance
Gradation for Design Millings, Tex-200-F, Part I	Report	
Indirect Tensile Strength (IDT) (1) (2) (3), Tex-226-F	***50 psi (min.)***	***Cracking Resistance***
Moisture Conditioned (IDT) (1) (2) (3) (5)	***30 psi (min.)***	***Moisture Resistance***
Raveling Test, 4-hour cure @ 10ºC and 50% humidity, ASTM D7196	2% (max.)	Raveling Resistance

(1) ***Specimens in 100 mm (4.0 in.) diameter and 50.8 mm (2.0 in.) height shall be prepared***
(2) ***Determine the weight of specimen needed to mold at target density***
(3) ***Tested on compacted specimens after 40°C (104°F) curing for 72 hours.***
(4) ***If results do not meet minimum requirements, consider using cement additive by 0.5% increment.***
(5) ***After curing, submerge specimens completely in water for 24±1 hours and run at 25°C (77°F)***

Table 2. Recommended Quality Control Tests.

Description	Test Method	Minimum Contractor Testing Frequency	Test Requirements
Hamburg Wheel Test	Tex-242-F	1 per day of production	5,000 passes (min.) 15,000 passes (max.) @ 12.5 mm (0.5 in.) rut depth
Dry Tensile Strength	***Tex-226-F***	1 per day of production	***50 psi (min.)***
Wet Tensile Strength	***Tex-226-F***	1 per day of production	***30 psi (min.)***
Density	Tex-207-F, Part I	1 per day of production	***95%***

In the literature, moisture content or water is differently accounted for across agencies. Cox and Howard (2013) suggested standardizing all moisture contents to total moisture content (i.e., added mixing moisture, water phase of asphalt emulsion, and existing moisture) for consistency.

The moisture content referred herein is the total moisture content. Across agencies, there is no standard method to determine the optimum moisture content for CIR mixtures, and multiple methods have been used in practice and research.

The Proctor test is one of methods used. However, this method generally yields high optimum moisture contents (i.e., 6 to 8 percent) for CIR mixtures, which cause moisture drainage during compaction. This project also observed this phenomenon during compaction. Alternately, fixed moisture contents for CIR mixtures are commonly documented and generally range from 2 to 5 percent. A moisture content of 4 percent is close to the average moisture content for CIR mixtures and widely used in the literature. Thus, it is recommended conducting the Proctor-style test to determine the target density at the fixed moisture content of 4 percent. Correspondingly, the weight of sample needed to fill cylindrical molds for mixture design is determined based on the target density. This requires target density-based compaction rather than 35-gyration compaction, which was the existing TxDOT requirement.

The Hamburg wheel tracking test is commonly used to evaluate the rutting potential and moisture susceptibility of asphalt concrete mixtures. In the literature, Hamburg wheel tracking testing on CIR mixtures does not appear common; however, TxDOT used this test in SS3254. The requirement in SS3254 is for 12.5 mm (0.5 in.) of rut depth to occur between 5,000 and 15,000 passes. Based on the results in this project, all CIR mixtures when treated only with asphalt showed poor rutting resistance and moisture susceptibility in the Hamburg test and did not meet the requirement. For this reason, use of cement additive in CIR mixtures is generally recommended if asphalt-only treatment does not produce a mixture meeting the minimum Hamburg requirements. Cox and Howard (2015) reported that 18 percent of CIR mixtures used a combination of binders. These blends are typically dominated by one binder with a small dosage of a secondary binder (e.g., 2.0 percent emulsion with 1 percent cement).

The most significant recommendation for mix design requirements is to use the indirect tensile strength (IDT) to determine the design binder content rather than the Marshall Stability test. Although many states still use the Marshall Stability test for the design purpose, the IDT test is recommended for the mix design because:

- It is a relatively simple procedure.
- It uses standard equipment available in typical TxDOT labs.
- Many recent recycling projects have documented successful use of the IDT test for binder content selection.
- Growing literature suggests the IDT test may also be useful in a performance-related context of predicting cracking performance.

Use of a raveling test in CIR mixture design is common practice across multiple agencies; the raveling test for CIR mix design remains unchanged.

REFERENCES

Cox, B.C., Howard, I.L. *Cold In-Place Recycling and Full-Depth Reclamation Literature Review.* White Paper Number CMRC WP-13-1, Construction Materials Research Center, Mississippi State University, Starkville, MS, 2013.

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