TDOT Department of Transportation

Research Summary

100% Recycled Mixtures Using Cold In-Place Recycling (CIR), Hot In-Place Recycling (HIR) And Cold Central Plant Recycling (CCPR)

Project Number:
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TDOT Lead Staff:
Hong Park
Materials & Tests Division

Principal Investigator(s):
Dr. Baoshan Huang| PI
University of Tennessee, Knoxville

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WHAT WAS THE RESEARCH NEED?

The increasing costs of asphalt binder and aggregates have put much pressure on the highway maintenance budgets. Recycling has played a significant role in the pavement rehabilitation of state highway agencies. Pavement managers are seeking alternative cost-effective approaches to rehabilitate the roads. Current asphalt recycling techniques consist of two basic approaches: (a) inclusion of the milled reclaimed asphalt pavement (RAP) to replace a proportion of aggregates in hot mix asphalt (HMA) in asphalt plant, and (b) the in-place recycling, including cold in-place recycling (CIR) and hot in-place recycling (HIR). However, some concerns remain for the utilization of in-place recycling techniques in pavement rehabilitation

WHAT WERE THE RESEARCH OBJECTIVES?

The research team aimed to 1) conduct a comprehensive evaluation of using the in-place recycling techniques, 2) investigate the blending mechanisms and recycling efficiency of using HIR techniques, and 3) provide valuable recommendations to the TDOT for future constructions.

WHAT WAS THE RESEARCH APPROACH?

The research team participated in three HIR and two CIR field projects. The loose HIR and CIR materials were collected and compacted for performance testing. The HMA plant mixes from the same region were also collected for comparison. ME software was adopted to predict the pavement life after rehabilitation with in-place recycling

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techniques and traditional HMA milling & filling. Life cycle cost analysis (LCCA) was applied to evaluate the cost-effectiveness of the pavement with different rehabilitation techniques in the whole life cycle. Furthermore, the research team explored the blending mechanism of HIR mixes with 100% RAP and developed a method to quantify the mobilized RAP content in HIR mixes to evaluate the blending efficiency of HIR mixes. The influence of mobilized RAP binder content on the effective binder quality and mixture performances was also investigated in this project.

WHAT WERE THE FINDINGS?

Key findings include:

- Compared to HMA (D-mix), HIR mixes showed acceptable rutting and moisture resistance. Cracking resistance is the main issue that HIR mixes would encounter.
- Compared to the HMA (BM2-mix) for the binder layer, CIR mixes tended to encounter rutting and cracking problems. A sufficient curing period would improve the CIR mixes' stiffness, cracking resistance, and moisture resistance.
- The mobilized RAP content represented the recycling efficiency of the HIR mixes. Based on this research, the mobilized RAP content for HIR mixes located at a range of 20% to 30%.
- The effective asphalt content was considered a significant factor that dominated the cracking behavior of the HIR mixes.

IMPLEMENTATION AT TDOT

Key recommendations include:

- Increase the mixing and compaction temperature to 130° C (current is 110° C) for HIR construction since higher temperature would improve the binder mobilization and the cracking resistance of the HIR mixes.
- Increase the dosage of asphalt emulsion and primarily focus on the cracking resistance during HIR mix design. Based on the experimental results, HIR mixes would mainly encounter cracking issues. Hence, more dosages of asphalt emulsion could be added to improve the cracking resistance of HIR mixes. Additionally, a performance-based mix design (e.g., balance mix design) is recommended to focus more on the cracking resistance of the HIR mixes.
- If possible, increase the mix temperature to 150 ~160° C and use virgin asphalt during HIR construction, which could significantly improve RAP binder mobilization and the cracking resistance of HIR mixes.
- Apply the CIR technique only in a low-volume road and ensure the curing period after paving. For the CIR mix design, increase cement usage to improve the strength of the base layer.

MORE INFORMATION

Find the final report here: https://www.tn.gov/content/dam/tn/tdot/long-range-planning/research/final-reports/res2019-final-reports/RES2019-03_Final_Report_Approved.pdf.

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