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LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

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LRRB PROJECT COST:
$156,052

Road damage is still visible with top layers milled away.

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

Increasing Cold In-Place Recycling Efficiency for Pavement Rehabilitation

Researchers identified factors that affect asphalt curing when a CIR method is used. New tools will help local road engineers reliably estimate the curing time of a CIR layer and know when pavement is sufficiently hardened to minimize delays in road construction and reopening.

What Was the Need?

An increasingly popular alternative to asphalt replacement is cold in-place recycling (CIR). This cost-effective and sustainable pavement rehabilitation technique involves pulverizing the top layer of old pavement, mixing it with water and a stabilizing agent such as emulsified asphalt, and reapplying the mixture to fill in holes and cracks. An active filler such as cement may be used. A final layer is added to seal and preserve the recycled pavement layer.

CIR offers numerous benefits, and MnDOT and local transportation agencies are leaders in its use. By reusing existing asphalt, agencies minimize the need for new material, reduce costs and lower material transport to and from a construction site. Less construction traffic reduces congestion and vehicle emissions. The process itself uses water but little, if any, heat.

While CIR is a relatively quick asphalt rehabilitation process, the recycled asphalt layer must sufficiently harden before the top layer can be placed and the road reopened to traffic. Curing ensures the asphalt is structurally sound and can withstand traffic weight without damage. Current guidance on curing is based on a relatively arbitrary timeline and does not account for variations in materials used, weather, the condition of the pavement layers and specific construction techniques.

Knowing whether pavement is sufficiently cured and how long curing will take is necessary to make CIR cost-effective and to minimize traffic disruptions. A reliable and tailored prediction of the curing time will help city and county engineers optimize construction schedules and ensure maximum pavement strength to maximize longevity of CIR-treated pavements.

What Was Our Goal?

The goal of this project was to develop methods and guidance for agencies to monitor the strength gain of a CIR layer and estimate curing time.

What Did We Do?

Researchers combined the results of testing in the field with laboratory experiments to develop guidance for local transportation engineers to reliably predict the curing time of CIR pavement material so construction workers may place the final layer and open the road to traffic. Investigators began with a review of the current state of CIR curing knowledge, including the factors that impact the process, existing tools and methods to determine if the recycled layer is set, and CIR practices used by local agencies and MnDOT.

Then, working with the Technical Advisory Committee, investigators chose six sites for data collection and testing: four MnDOT-managed projects and two overseen by the Brown County Highway Department. The sites were chosen to consider different factors that affect curing such as the composition of the material mix and geographical location. The asphalt mix design and constituent materials, quality control data and existing pavement conditions were analyzed, and the curing process was monitored for pavement moisture level, stiffness and strength.

In the lab, researchers tested 26 material combinations and conditions under which asphalt maintenance may occur. The mechanical properties and decreases in moisture over time were measured, which allowed investigators to identify the attributes that impact curing time.

continued

"This project provides an equation-based prediction tool that gives us confidence in this pavement rehabilitation method and the time it takes to reopen roads for use."

—Wayne Stevens,
County Engineer,
Brown County

"We successfully developed methods for use on-site to ensure cold in-place recycling is sufficiently cured and a model to predict how long it will take based on several factors. This should help MnDOT and local agencies more efficiently utilize cold in-place recycling."

—Eshan Dave,
Associate Professor,
University of New Hampshire Department of Civil and Environmental Engineering

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The CIR process involves a convoy of equipment to finish a road surface, including tankers that hold emulsion material and water, milling or crushing and recycling machines, pavers and rollers.

Statistically analyzing the data gathered at the paving sites and in the lab, researchers constructed a model to predict curing times as a function of material properties and other conditions.

What Did We Learn?

Through comprehensive testing and analysis, researchers identified a reliable method to measure the strength and moisture content of a CIR layer as it cures and a model to predict the time necessary for the material to fully harden.

The investigations showed that after the first 24 hours, rain does not necessarily alter the moisture content and delay the hardening process. CIR, in fact, continues to gain strength after excess moisture has dissipated, suggesting that moisture alone may not be a reliable indicator of the extent of curing.

Analyzing data from the CIR pavement projects and the laboratory experiments, investigators isolated the most significant predictor variables in the curing process for inclusion in the model:

- Stabilizer type and amount.
- Use of an active filler.
- Initial moisture content.
- Density of compacted CIR material.
- Temperature at which curing occurs.

Finally, researchers developed a user-friendly spreadsheet tool and guidelines to implement the model, including steps to gather the required information.

What's Next?

Local transportation engineers will test this model and method on paving projects. Additional data gathered from a variety of sites will help to refine and further validate the model, ultimately providing increased confidence in CIR for asphalt rehabilitation.

This Technical Summary pertains to Report 2022-11, "Evaluation of Curing Effects on Cold In-Place Recycled (CIR) Materials," published April 2022. The full report can be accessed at mndot.gov/research/reports/2022/202211.pdf.