Using CIR can lengthen the life of a road while saving money and providing environmental benefits.

RESEARCH SOLUTIONS

Selecting and repairing roads in Iowa suitable for cold in-place recycling

Iowa DOT and counties repair some roads using cold in-place recycling (CIR), a process in which 3 to 4 inches of the road is milled off, mixed with stabilizing agents, and reapplied. In most cases two lifts of hot-mix asphalt for a total of 3 to 4 inches are placed over the CIR layer. However, some CIR pavements have not met performance expectations, and the agency wanted to better understand where best to use CIR. A research project led to guidelines for improving project selection, construction, and maintenance for future CIR projects.

THE NEED

Iowa's cold winters and hot summers can negatively impact the performance and service life of its roads. Maintenance is expensive, and the costs of road reconstruction continue to rise due to the limited availability of virgin paving materials. But not all roads need to be reconstructed. CIR offers an alternative rehabilitation option that can reduce the use of virgin aggregates.

While CIR is primarily used on low-volume roads in Iowa, in a few cases, its performance has been disappointing. The performance of a CIR project greatly depends on the existing road conditions, such as pavement thickness and materials, subgrade support, and traffic loading. To ensure pavement performance and provide long-lasting roads, Iowa DOT sought guidance to better select CIR project locations and strategies to improve performance.

RESEARCH APPROACH

Numerous steps were taken to better understand the factors associated with successful CIR projects. Collecting and analyzing information and data from 44 CIR projects completed in Iowa from 1998 through 2019 provided insight into the factors leading to pavement deterioration. For example, an analysis of performance regarding rutting and cracking across

(continued)

"The guidance developed in this project will help Iowa DOT select good candidates for CIR treatments. Understanding how the existing pavement condition and materials influence the performance of CIR is key in designing sustainable materials that are resistant to both cracking and rutting."

— **ASHLEY BUSS,**
Iowa DOT Bituminous Materials Engineer

these projects helped to determine how, when, and in which way CIR pavements deteriorate.

Laboratory testing of field core samples collected from selected CIR projects evaluated the thickness, cracking resistance, binder contents, and gradation of both the CIR and asphalt top layer. Using these results, researchers were able to infer the flexibility of each layer.

Further, two underperforming CIR projects were analyzed as case studies to determine the factors that may have attributed to underperformance. In this step, investigators analyzed core samples, collected data with a falling weight deflectometer, and reviewed each project design. Using this information, they determined a structural strength index for each project and compared it to indices associated with good and poor pavement performance.

WHAT IOWA LEARNED

Research results showed that a road often deteriorated 10 to 15 years after a CIR project was completed, with thicker CIR layers performing better than thinner layers. Rutting often occurred first followed by cracking later. The data was consistent with a deterioration process where the more flexible middle CIR layer compacts and ruts in the wheel tracks under heavy loads and the less flexible top layer of hot-mix asphalt cracks as it conforms to the ruts that develop in the CIR layer.

Strategies suggested to address these issues included using a top layer that is more flexible and less prone to cracking, smoothing out ruts after they form, and limiting the use of CIR on roads that carry heavy wheel loads.

The results of the case studies of the underperforming projects indicated that pavement layer thicknesses as constructed were less than required in the plans and that the subgrade support inferred from the falling weight deflectometer testing was inadequate for the designed pavement thicknesses.

To increase the probability of a successful CIR project, researchers developed technical guidance that would ensure the decision-making process considers all relevant factors. The guidance provides practices for selecting appropriate locations for CIR projects along with technical design directions and strategies for completing the project, such as specifying the gradation of milled materials and ensuring adequate drainage.

PUTTING IT TO WORK

The guidance developed in this project will allow pavement engineers to employ the right CIR strategies on the right roads in Iowa. This approach will mean more targeted and more successful pavement rehabilitation across the state and more effective use of public funds.

ABOUT THIS PROJECT

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