



Center for Transportation
Research and Education

Performance of Cold In-Place Recycled Roads

tech transfer summary

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RESEARCH PROJECT TITLE

Evaluation of Long-Term Field
Performance of Cold In-Place Recycled
Roads

SPONSORS

Iowa Highway Research Board (TR-502)
Iowa Department of Transportation
(CTRE Project 03-160)

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The mission of the Center for Transportation Research and Education (CTRE) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, and reliability while improving the learning environment of students, faculty, and staff in transportation-related fields.

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Cold in-place recycling is a popular method for rehabilitating asphalt roads, but research is needed to make performance more predictable.

Objectives

- Investigate the relationships between road performance and the following: age of the recycled pavement, cumulative traffic volume, and subgrade support conditions.
- Understand these relationships in terms of the aged engineering properties of the cold in-place recycled (CIR) materials.
- Consider changes that can be made to design, material selection, and construction to improve the performance of future recycled roads.

Problem Statement

Cold in-place recycling has become an attractive and popular method for rehabilitating asphalt roads that have good subgrade support and are suffering distress related to non-structural aging and cracking of the pavement layer. However, CIR pavement performance remains somewhat unpredictable. Transportation officials have observed roads recycled under similar weather and construction conditions perform very differently for no clear reason. Moreover, a rational mix design has not yet been developed, and there is no clear understanding of the cause-effect relationships between the choices made during the design/construction process and the resulting performance.

Research

Researchers from the University of Iowa and Iowa State University examined a sample of 24 CIR roads in Iowa that had been rehabilitated between 1986 and 2004: 17 were selected from a sample that had been previously studied in 1996, and 7 were selected from a group of roads that were rehabilitated after 1999. The roads were classified according to average annual daily traffic, CIR age, and subgrade support condition.

For each road, field investigations assessed actual CIR pavement performance and laboratory investigations assessed the CIR material properties associated with performance:

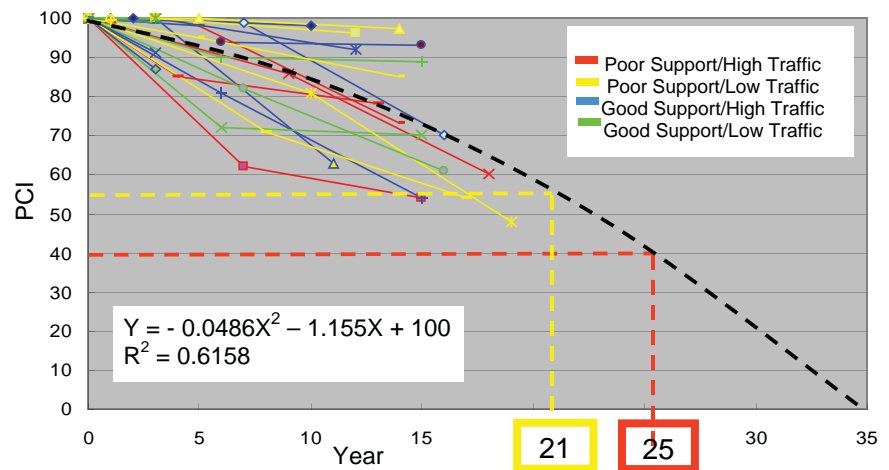
- A field distress survey was conducted by capturing digital pavement images, analyzing the images, and calculating a pavement condition index (PCI) value for each pavement. Rut measurements were collected manually. Distresses measured included rutting; patching; and transverse, longitudinal, block, and alligator cracking.
- The ISU researchers inferred structural support and layer stiffness from the results of falling weight deflectometer (FWD) testing and computer analysis.

Recommended Implementation

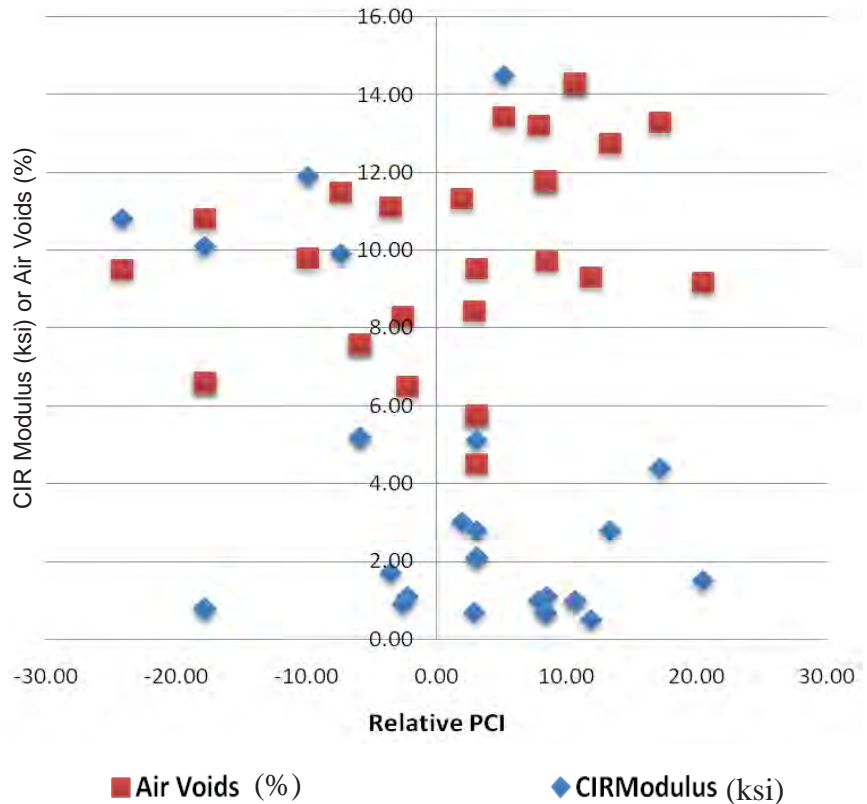
The results of this research project may be immediately implemented in the following ways:

- The service life predictions developed from this research can be used for economic analysis and network planning.
- Pavement rehabilitation selection and life-cycle cost analyses should reflect the CIR performance curves developed in this study.
- Special attention should be given to providing proper subgrade support and using proper CIR mixture materials on high-volume CIR roads. Decision makers should consider using FWD or dynamic cone penetrometer testing to evaluate the subgrade's ability to provide proper support.
- On lower volume CIR roads, additional efforts should focus on avoiding deterioration caused by environmental factors.
- Design and construction specifications and procedures should reflect the conclusion that a less stiff and more porous CIR layer performs very well. However, stiffness and air void values outside the ranges analyzed in this report will likely result in poor performance. Investigators should therefore develop preferred ranges of air voids and stiffness values. These ranges are likely to be different from those of HMA.

The results of this research will be distributed through the Iowa DOT and Local Technical Assistance Program, and the performance curves for the pavements studied will be shared with pavement design engineers and local systems engineers.



Performance curves for all pavements studied, showing upper (red) and lower (yellow) estimates for predicted service life



Selected material properties plotted against relative PCI

Recommended Refinements through Additional Research

- Future investigators should re-evaluate the required sample size necessary for refining the conclusions of this investigation. Data from more core samples, FWD tests, and performance surveys may provide statistically significant results in other areas of investigation.
- Further evaluation is needed before the proper mix design parameters can be specified. Field data from existing CIR layers need to be correlated with laboratory-prepared mix design data.
- The study's performance curves are based on sets of two data points per project. A third performance measurement in approximately 2009 will improve confidence in the performance curves.
- The effects of the CIR layer need to be isolated from the effects of the other layers in the pavement system. A study with a larger sample size will contain sufficient information to distinguish the effects of the various layers.
- The variables studied during this project could not explain the specific causes of rolled-down cracking and rutting; further research is needed on this issue.
- Remaining questions include the performance of CIR projects that experience higher truck traffic and the effectiveness of specific asphalt stabilization agents (emulsion, foamed, engineered emulsion).



Operation of the dynamic cone penetrometer



Photograph of a typical CIR recycling train