Unlocking the secrets of cold-in-place recycled asphalt pavements

Why do some cold-in-place recycled asphalt roadways perform better than others? Chuck Jahren and Hosin “David” Lee, associate professors of civil engineering at ISU and The University of Iowa, respectively, recently teamed up to identify key performance factors. The quality of subgrade support proved to be more important than traffic levels for predicting CIR asphalt pavement performance.

The project was sponsored by the Iowa Highway Research Board (TR-502).

What is CIR?

In Iowa, cold-in-place recycling (CIR) has been a popular rehabilitation method for asphalt roads since about 1986. Generally, asphalt (three to four inches) is milled off the surface of the existing pavement, then crushed and screened to size, mixed with a stabilizing and/or rejuvenating agent, and relaid and compacted near its original location.

The process may be accomplished with a recycling train (figure 1). A top surface consisting of hot-mix asphalt (HMA) or a seal coat may also be applied (figure 2).

The advantages of this rehabilitation process are self-evident: Agencies can build on a consistent structural layer that’s already in place, while reducing construction costs related to fuel usage, traffic disruption, and use of resources like aggregate and asphalt binder.

Performance

But in Iowa, some CIR pavements recycled under similar weather and construction conditions and experiencing similar traffic levels have had inconsistent performance records.

Jahren and Lee and their team examined 24 CIR roads rehabilitated between 1986 and 2004. The roads were classified according to CIR pavement age, subgrade support condition, and average annual daily traffic. All but two of the roads studied had traffic levels less than 2,000 AADT.

For each road segment studied, the team assessed pavement performance in the field and assessed materials properties related to performance in the laboratory. They calculated a pavement condition index (PCI) value for each pavement; inferred structural support and layer stiffness using falling weight deflectometer (FWD) testing and computer analysis; and tested indirect tensile strength and asphalt binder properties of core samples.

Key findings

Good subgrade support is a primary predictor of CIP recycled pavement performance.

- The average predicted service life for the roads studied in this project is up to 34 years for roads with good subgrade support; 22 years when subgrade support is poor.
- CIR pavements with poor subgrade support experience more rutting, patching, and edge cracking.
- Traffic level does not seem to affect CIR pavement performance as much as subgrade support. All pavements in the study with good subgrade support performed equally well under different traffic conditions.

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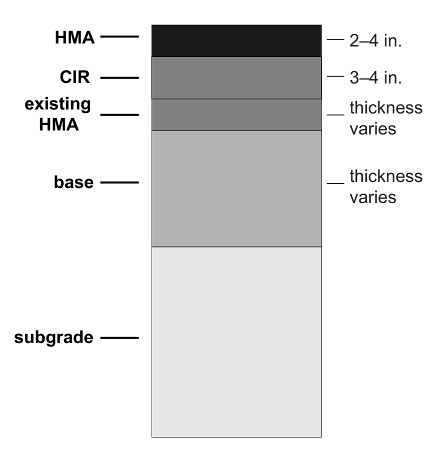

Figure 2. Typical pavement layers for a road rehabilitated with CIR

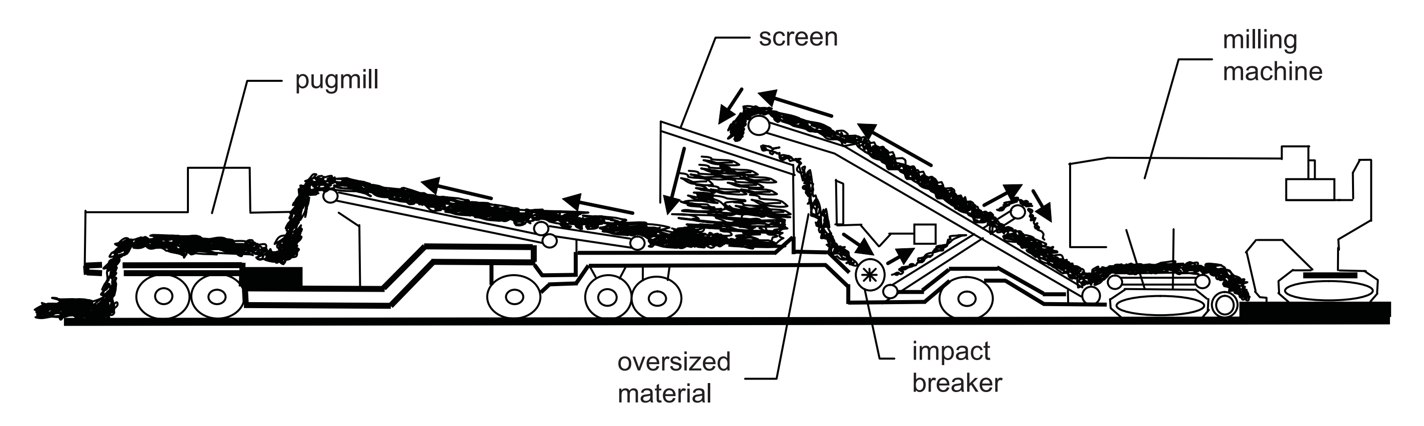

Figure 1. Diagram of a typical CIR milling, screening, crushing, and pugmill unit, traveling left to right; paving and compaction units not shown (from Jahren et al., 1998, *Review of Cold In-Place Recycled Asphalt Concrete Projects*, IHRB Project HR-392)

granulated shoulders continued from page 2

The field tests, along with data from corresponding lab tests, were used to develop charts for designing granular shoulders for minimum rutting and predicting the rutting behavior of existing ones. Variables include CBR values of subgrade and of granular layer, axle loads, and rut depth.

In both the lab and the field, stabilizing soft subgrades with fly ash or geogrid was effective at reducing rutting (figure 2).

In lab tests, stabilizing the granular shoulder materials with portland cement, polymer emulsions, or soybean oil showed promise for inhibiting edge rutting or drop-off.

Field results with these materials, however, were disappointing. Edge ruts redeveloped over a short time. The team hopes to conduct additional research, focusing on improved mixing and compaction methods and equipment.

To reduce rutting, the team recommends designing granular shoulders with appropriate CBR values for both the subgrade and granular layers, accounting for expected traffic level and loads.

The weighted average CBR value of the granular layer should be at least 10. The weighted average CBR value of shoulder fill and subgrade up to a depth of 20 in. should be at least 12. Dynamic cone penetrometer and Clegg impact tests can be used to assess in situ CBR values during shoulder construction.

The increased initial construction costs of these stabilizing techniques will not be totally offset by reduced maintenance activities. Stabilized granular shoulders have the potential, however, to enhance performance and safety, which can be difficult to quantify.

For more information

Contact David White, 515-294-1463, djwhite@iastate.edu. The full project report, including design charts, and a technical summary are online, www.ctre.iastate.edu/pga/detail.cfm?projectID=-28778605. ■

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The CIR pavement layer appears to act as a stress-relieving layer. Within the range of data analyzed, a less stiff and more porous CIR layer performs well. An appropriate range of values for stiffness and air voids has not been determined but will likely be different from those for hot-mix asphalt.

Recommendations

Decision makers are encouraged to use available tools for determining if a specific pavement is a good candidate for CIR.

In particular, consider using falling-weight deflectometer or dynamic cone penetrometer (figure 3) testing to evaluate the subgrade's ability to provide proper support.

Life-cycle cost analyses should reflect CIR performance curves developed in this study.

For more information

Contact Chuck Jahren, 515-294-3829, cjahren@iastate.edu. The full project report, including design charts, and a technical summary are online, www.ctre.iastate.edu/research/detail.cfm?projectID=1063747601. ■

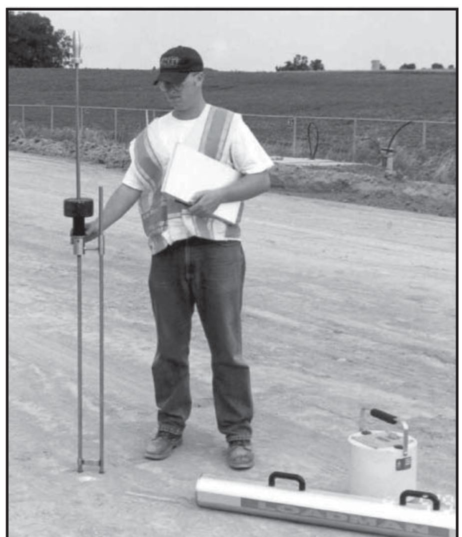

Figure 3. Operating dynamic cone penetrometer