



College of Engineering | The University of Iowa

Tech Brief

DEVELOPMENT OF QUALITY STANDARDS FOR INCLUSION OF HIGH RECYCLED ASPHALT PAVEMENT CONTENT IN ASPHALT MIXTURES-Phase III

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RESEARCH PROJECT TITLE:

Development of Quality Standards For Inclusion of High Recycled Asphalt Pavement Content in Asphalt Mixtures – Phase III

SPONSOR:

Iowa Highway Research Board (TR-693)

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Background

Federal, state and local public agencies encourage the use of recycled asphalt pavement (RAP) in constructing pavements to the maximum extent possible with an equal performance. According to the recent NAPA's report, average percent used in asphalt pavement was 21%. 24% of RAP mixtures were estimated to be produced using softer binders whereas 7% of RAP mixtures produced using a rejuvenator.

Problem Statement

Aged binder becomes more brittle and less ductile, which negatively affects the performance of the high RAP mixes in the field. Low temperature cracking potential is a primary concern with high RAP mixtures, which is caused by the aging of asphalt through the oxidation. To minimize a low temperature cracking, various rejuvenators have been utilized in the past. However, there is no scientific method to effectively identify the most appropriate rejuvenators for Iowa's high RAP mixtures.

Objectives

The main objectives of this study are to provide the Iowa DOT with: 1) a screening method for approving rejuvenator products in asphalt mixtures and 2) a method of field evaluation for HMA containing rejuvenators.

Research

To achieve the main objectives, the following five tasks have been performed: 1) evaluate the effectiveness of various rejuvenators to soften aged binders by employing analytical technologies to examine different rejuvenators in the laboratory-aged asphalt, 2) perform rheological binder tests to determine the effects of rejuvenators on aged binder properties, 3) perform mechanistic mixture tests to assess the effect of rejuvenators on high RAP mixtures, 4) build test sections with selected rejuvenators and 5) perform laboratory tests of field loose mixtures and cores.

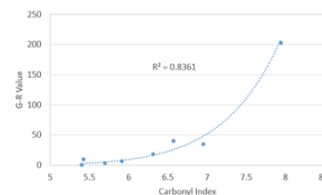
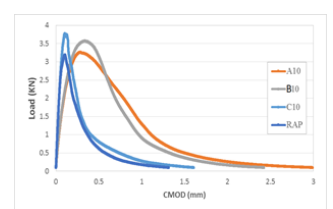
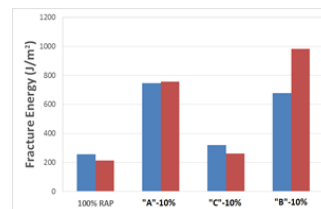
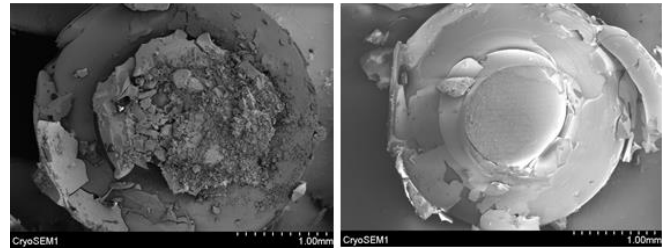
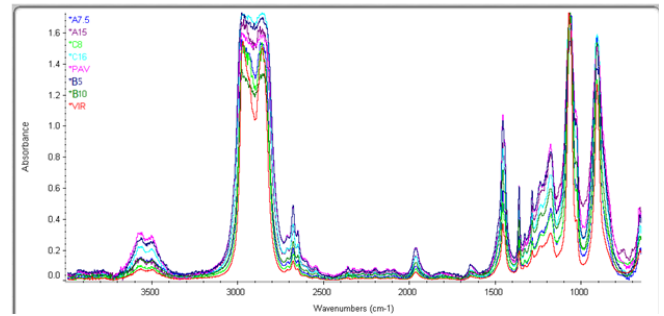
Benefits

The main benefit of this research is to help pavement engineers specify the most appropriate rejuvenator for the given condition by understanding complex chemical and physical interactions between aged binder and rejuvenators, which will improve the long-term performance of pavements in Iowa.

Key Findings

The following conclusions are derived:

1. Rejuvenators lowered both PG high- and low-temperature limits of aged asphalt binder.
2. Optimum dosage rate of each rejuvenator was identified using the Bending Beam Rheometer (BBR) test.
3. Fourier Transform Infrared (FTIR) test indicated rejuvenators were effective in restoring original properties of the aged binder.
4. Cryo-SEM was used to capture surface images of the rejuvenated asphalt binders at $-165\text{ }^{\circ}\text{C}$ and significantly less cracking was observed.
5. Rejuvenated asphalt binders exhibited G-R values between the aged asphalt and virgin asphalt. A significant correlation was observed between carbonyl indices and G-R values.
6. Based on the Disc-shaped Compact Test (DCT) result, it was concluded that high-RAP mixtures with rejuvenators were more resistant to a low-temperature cracking than the high-RAP mixtures without it.
7. Test sections using rejuvenators were successfully constructed in Crawford and O'Brien Counties in Iowa. DCT test result of field samples confirmed that rejuvenators improved a low-temperature cracking susceptibility.



Future Studies

1. Collect Recycled Asphalt Materials (RAM) from across the state to use for determining limits of multiple rejuvenators for a wide variety of mix designs.
2. Evaluate different equipment/methods for fractionating RAP materials and adding rejuvenators.
3. Apply FTIR for evaluating rejuvenators and DCT and HWT tests for RAM contents with various rejuvenators.
4. Build test sections using high RAM contents and fractionated RAP materials with various rejuvenators.
5. Monitor conditions of both existing and future test sections with high RAM contents and fractionated RAP materials.
6. Evaluate long-term oven aging of both laboratory and field rejuvenated high RAM mixtures.
7. Develop specifications for evaluating rejuvenators and high RAM contents and fractionated RAP



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