

New Jersey Department of Transportation
Bureau of Research

Technical Brief



Rejuvenating Agents with RAP in Hot Mix Asphalt

This project evaluated the potential use of rejuvenating agents for use with higher RAP asphalt mixtures. Various rejuvenating agents, preblended in the asphalt binder, were evaluated in asphalt mixtures with 25 and 40% RAP by weight of mix. Asphalt binder test procedures were developed to assess the degree of rejuvenating each rejuvenating agent provided. Asphalt mixture performance tests were used to ensure the final mixture performance balanced rutting and fatigue cracking performance under the NJDOT High RAP (HRAP) specification. Effectiveness of the rejuvenator types evaluated were provided.

Background

The New Jersey Department of Transportation (NJDOT) has been investigating various options to utilize higher percentages of recycled asphalt pavement (RAP) in hot mix asphalt (HMA). Research efforts ranging from controlled laboratory studies to field pilot projects have clearly indicated that RAP mixtures are stiffer and more prone to cracking than virgin asphalt mixtures. These efforts have also suggested that one of the major causes of the higher stiffness and cracking potential is the lack of blending between the RAP and virgin asphalt binders.

Another general issue found with increased RAP contents is ensuring the final PG grade of the mixture meets that specified by the NJDOT. Currently, the Superpave mixture design system recommends selecting a virgin binder grade one grade softer than normal when using 15 to 25% RAP, while blending charts are to be used when utilizing RAP at percentages greater than 25%. Obviously, different percentages of RAP used in conjunction with different NJDOT mixtures could require a variety of asphalt binder PG grades for the asphalt supplier to maintain. In most cases, this would not be practical.

One potential method to aid in the blending of the RAP and virgin binders, as well as the general softening of the RAP binder, is to utilize a rejuvenating agent. An asphalt rejuvenator is a manufactured product which has the ability to absorb or penetrate into the asphalt mixture/material and potentially restore those reactive components, or rebalance them, which have been lost due to oxidation. The benefit of utilizing the rejuvenating agent is that it can be either preblended with the virgin asphalt binder, or added during the mixing process, instead of requiring the use of a softer PG graded binder that would require an additional storage tank on site.

Research Objectives and Approach

The objectives of this research are to

- 1) Evaluate the effectiveness of various rejuvenating agents on high RAP asphalt mixtures using standard and experimental asphalt binder and mixture test procedures.

Findings

The following conclusions can be concluded from this study.

1. The typical means of introducing the rejuvenator to the asphalt binder is by preblending the rejuvenator in the virgin binder. This significantly softens the virgin asphalt binder. In the case of one of the rejuvenators, the dosed PG76-22 resulted in a final PG grade of PG58-34. A separate introduction and metering system that would allow dosing the asphalt binder on demand would provide the asphalt supplier greater flexibility when using rejuvenators.
2. The research study developed and introduced a new means for evaluating the maximum effectiveness of the rejuvenator on the RAP mixture using the shape of the master curve and determining the Rheological Index (R-value) and Cross-over Frequency can be determined from extracted and recovered asphalt binders.
3. The set of New Jersey mixtures were evaluated using the NJDOT High RAP specification. The results of the testing showed that only a few of the asphalt mixtures would have met the specification when conditioned in the oven for 2 hours at compaction temperature. Meanwhile, it was found that only 1 mixture would have met the minimum requirements if they mixture was conditioned loose for 6 hours at compaction temperature.
4. The R-value – Cross-over Frequency Space method, developed with the New Jersey mixtures, was able to show the reversal of aging that was occurring due to the addition of the different rejuvenators in the Massachusetts mixtures.
5. The Overlay Tester and Flexural Beam Fatigue tests ranked the fatigue cracking performance differently among the rejuvenator mixtures. On average, the paraffinic oil rejuvenator performed the best in the Flexural Beam Fatigue test. Meanwhile, the Organic Blend #1 resulted in the best results for the Overlay Tester.
6. The asphalt binder fatigue properties best correlated to the Overlay Tester crack propagation testing. This indicates that the larger straining involved with the Overlay Tester more closely mirrors the strain magnitudes associated in the binder tests, as the Flexural Beam Fatigue is most often used at lower strains.
7. In evaluating the two different sets of RAP mixtures using asphalt binder and mixture testing protocol, the testing indicates that the Paraffinic Oil rejuvenator provided the best rejuvenating properties.

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A final report is available online at: <http://www.state.nj.us/transportation/refdata/research/>.
If you would like a copy of the full report, send an e-mail to: Research.Bureau@dot.nj.gov.

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