Title
High Percentages of Reclaimed Asphalt Affect the Performance of Asphalt Binder

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RESEARCH BRIEF

High Percentages of Reclaimed Asphalt Affect the Performance of Asphalt Binder

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Research Question

More than 90 percent of the road and highway network in the United States is paved with asphalt concrete. Maintenance and periodic rehabilitation require a continuous supply of aggregates and asphalt binder, both of which are becoming increasingly scarce and expensive. Recycling and reusing these resources can reduce costs and improve sustainability. The most common recyclable material used in road construction is *reclaimed asphalt pavement (RAP)*, which is milled asphalt surface layers that have been removed from existing pavements before new asphalt overlay is placed. *Reclaimed asphalt roofing shingles (RAS)* are another potential source of asphalt binder.

At the time of this study, the California Department of Transportation (Caltrans) allowed RAP to replace up to 25 percent of virgin binder in surface course mixes and up to 40 percent of virgin binder in underlying layers. There is growing interest in allowing significantly higher percentages of RAP and RAS in asphalt mixes used on state and local roadways. However, making this change has raised concerns regarding how these composite binders may influence the performance and durability of asphalt mixes, depending on the blends of different virgin and reused binders.

Researchers at the UC Pavement Research Center investigated the use of higher percentages of RAP and RAS as a partial replacement for the virgin binder in new asphalt mixes and their effect on pavement performance in California. The researchers also investigated the effect of a petroleum-based rejuvenating agent on binder and mix stiffness. If the binder is too stiff, earlier cracking failure can occur in the thin- and medium-thickness asphalt concrete overlays typically used for maintenance and minor rehabilitation in California. Another important consideration is whether the reclaimed and virgin binders have blended, because if they do not fully blend then the overall active binder content is lower than designed, which can also lead to premature cracking and other distresses.

Key Research Findings

Adding RAP and RAS binder increases the stiffness of blended binders. The extent of increased stiffness in asphalt binders was dependent primarily on the RAP/RAS and virgin asphalt binder grades and, to a lesser extent, the source of asphalt binder. Asphalt binder extracted and recovered from the tear-off RAS source could not be tested due to its very high stiffness. This suggests that asphalt mixes with high percentages of RAP and/or RAS need to be tested for their performance-related properties; otherwise they run the risk of premature cracking.

Testing suggests that the RAS binder did not effectively blend with virgin binder. The fine aggregate matrix mixes containing RAS showed similar stiffnesses to the corresponding control mixes containing no reclaimed materials, suggesting that the RAS binder did not effectively blend with the virgin binder at the temperatures and mixing durations used in this study. This suggests that RAS may not be an effective binder replacement without a rejuvenating agent, leading to a potentially lower than design-effective binder content in the mix.

Adding a rejuvenating agent may improve the performance of a blended binder. Testing showed that the addition of a rejuvenating agent reduced the stiffness of the blended binder (Figure 1). Additional testing is required to evaluate the long-term behavior of mixes produced with rejuvenating agents to determine whether the benefits are limited to production and early life, or whether they extend through the design life of the layer.

A new testing procedure shows promise in measuring stiffness at different temperatures and frequencies. As part of this study, researchers developed a method of preparing and testing fine aggregate matrix specimens using a newly designed torsion bar fixture in a dynamic shear rheometer, a machine used to measure properties of asphalt binders. It appears that this approach produces representative results for characterizing the performance-related properties of composite binder at binder replacement rates up to 40 percent and possibly higher.

More Information

This research brief is drawn from "Evaluation of the Combined Effects of Reclaimed Asphalt Pavement (RAP), Reclaimed Asphalt Shingles (RAS), and Different Virgin Binder Sources on the Performance of Blended Binders for Mixes with Higher Percentages of RAP and RAS," a report from the National Center for Sustainable Transportation, authored by Zia Alavi, Yuan He, John T. Harvey, and David Jones. The full report can be found on the NCST website at https://ncst.ucdavis.edu/project/evaluation-combined-effects-recycled-asphalt-pavement-rap-recycled-asphalt-shingles-ras-and.

For more information about the findings presented in this brief, please contact David Jones at djjones@ucdavis.edu or John T. Harvey at jtharvey@ucdavis.edu.

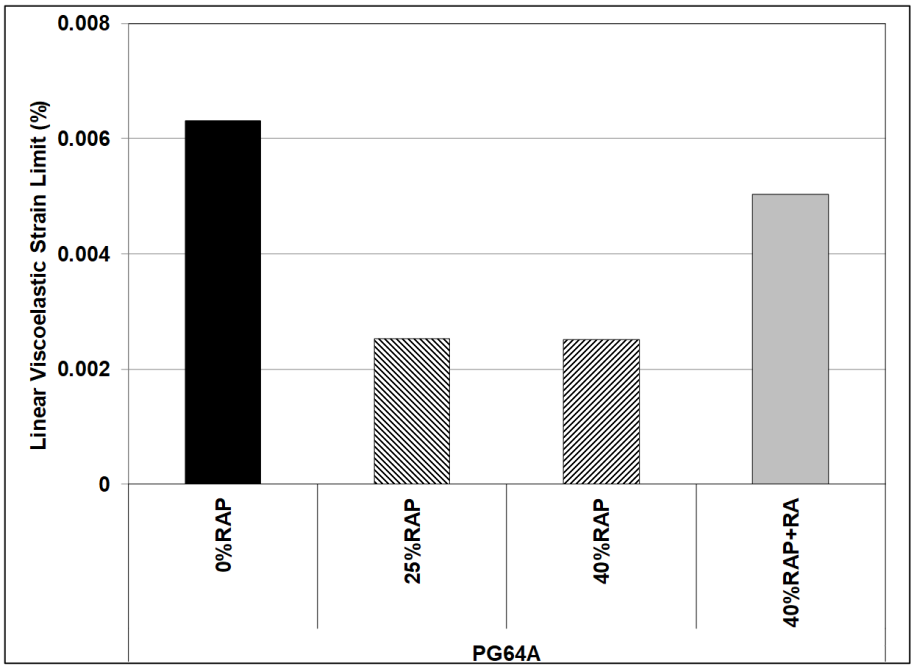

Figure 1. As higher percentages of RAP are added to replace virgin binder in a particular performance grade of asphalt binder (PG64-16), the linear viscoelastic strain limit, or resistance to cracking, drops. Adding a rejuvenating agent may improve performance.

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