DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Investigation of the Effect of Reclaimed Asphalt Pavement and Reclaimed Asphalt Shingles on the Performance Properties of Asphalt Binders: Phase 1 Laboratory Testing

A literature review and preliminary laboratory testing was conducted to understand all potential implications of using recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) as binder replacement in new mixes.

Pavement

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Project Title:
Recycling

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WHAT WAS THE NEED?

The California Department of Transportation (Caltrans) is reviewing the amount of recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) that can be used as binder replacement in new mixes. Caltrans is trying to understand what really happens above 15%. Although the benefits of using reclaimed asphalt as binder replacement are known, concerns about the effect of the aged binder on the aging rate of virgin binder and how this will influence cracking behavior and durability have been raised based on laboratory test results and observations of early cracking on field projects. The need for test methods for measuring the properties of the blended binder without having to do chemical extractions has also been identified due to concerns that chemical extraction force-blends old and new binders.

WHAT WAS OUR GOAL?

The objective of this project is to develop guidelines for minimizing the risk of using high RAP and/or RAS contents in asphalt concrete mixes, which is above 15%.

WHAT DID WE DO?

The research team completed the following:

- Literature review on research related to the topic, with special emphasis on the work of Federal Highway Administration (FHWA) and recent National Cooperative Highway Research Program (NCHRP) projects.

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- Development of a testing matrix followed by a preliminary evaluation of the rheological and engineering properties of a range of asphalt binders, asphalt mastics, and asphalt mixes
- Development of an experimental plan for additional laboratory testing if required, and full-scale field testing, accelerated wheel load testing (if deemed appropriate), and associated laboratory testing.
- Preparation of a summary report detailing the study.

WHAT WAS THE OUTCOME?

Including reclaimed asphalt in new asphalt concrete mixes, used on pavements, has attracted considerable interest from Departments of Transportation (DOTs) and other agencies mainly because of the cost savings and environmental benefits associated with substituting reclaimed binder for some virgin binder. However, the laboratory testing in this study, which was all undertaken on unaged asphalt specimens, has clearly shown that although adding reclaimed asphalt to new mixes is likely to increase mix stiffness, which in most instances is likely to improve its rutting resistance, the cracking resistance properties could be diminished.

Preliminary findings from this study indicate that:

- The asphalt binder in RAS may not effectively mobilize and blend with virgin asphalt. If used as a binder replacement, this recycled asphalt could reduce the actual effective binder content in the mix, which could in turn lead to early cracking and raveling.
- The results of tests on the properties of blended virgin and reclaimed asphalt binders can be influenced by the chemistry of the solvent used to extract and recover the binders. Fine aggregate matrix (FAM) mix testing was found to be a potentially appropriate alternative procedure for evaluating the properties of blended asphalt binder in mixes containing relatively high quantities of reclaimed asphalt.
- Although considerable laboratory testing has been undertaken to evaluate the performance of mixes in which reclaimed/recycled asphalt binders are a partial replacement of virgin binders, only limited longer-term, full-scale field testing has been undertaken. Consequently, any potential effects of accelerated aging of these mixes caused by the presence of the aged reclaimed binder and its effects on long-term performance are not fully understood.
- Reclaimed/recycled binder cannot be considered as a generic material with consistent properties, and some form of mix performance testing (FAM or full-grading) needs to be undertaken to assess the influence of the reclaimed/ recycled binder replacement on longer-term performance.
- The known benefits of adding polymer to asphalt binders may be compromised if some of the virgin binder is replaced with binder from RAP or RAS.
- The use of a softer virgin binder to compensate for the stiffening effect of high RAP/RAS binder replacement rates (i.e., above 25 percent) appears to be justified.

WHAT IS THE BENEFIT?

The research identified a number of issues that could influence decisions that Caltrans makes about binder replacement from RAP. The primary concern is the potential for early cracking due to accelerated aging of the binder. This phase of research has identified key issues that require further investigation in later phases, including the use of rejuvenators, validation of blending charts, the effect of mix production with warm mix additives at warm mix production temperatures, and understanding the aging of high RAP mixes in the field and accurately simulating this in the laboratory.

LEARN MORE

View the Final Report
https://dot.ca.gov/-/media/dot-media/programs/research-innovation-system-information/documents/final-reports/ca16-2676-finalreport-a11y.pdf

IMAGES

Image 1 Fine aggregate matrix testing as an alternative to chemical extraction for assessing properties of blended binders

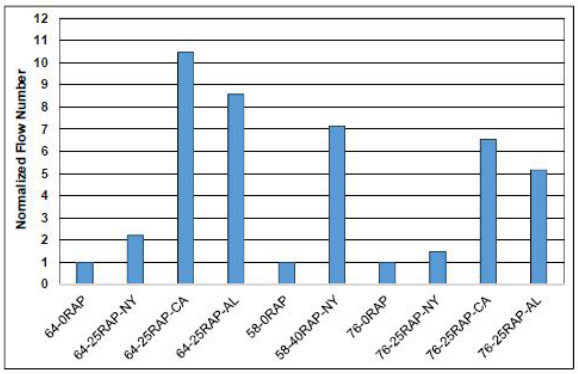

Image 2: Effect of RAP source and RAP quantity on rutting performance (results are normalized for comparison against the control mixes).

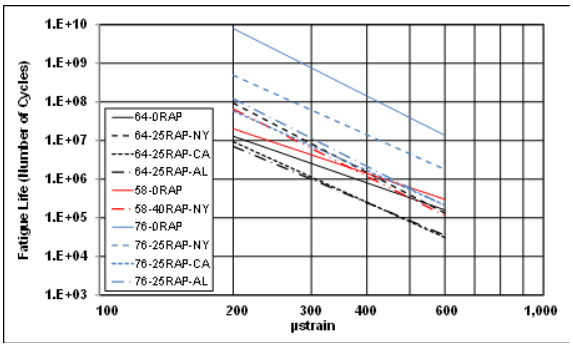

Image 3: Effect of RAP source and RAP quantity on fatigue life (solid lines are control mixes, broken lines are mixes containing RAP).

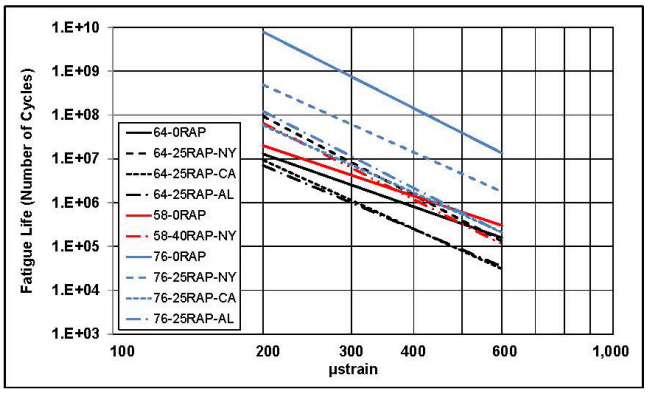

Image 4: Calculated fatigue life at 200, 400, and 600 μstrain

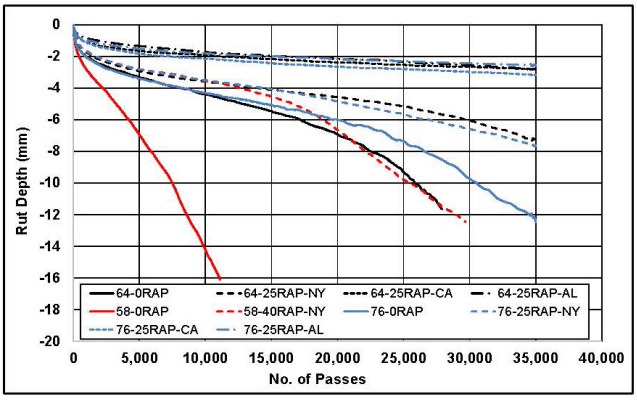

Image 5: Average Hamburg Wheel-Track Test rut progression for full-graded mixes