DRISI

CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

Research Results

PPRC 17 REC-A: Binder Replacement in High RAP/RAS HMA and RHMA Mixes

Development of Guidelines for Determining Binder Replacement Using High RAP/RAS Contents in Asphalt Concrete Mixes in California

Pavement

NOVEMBER 2023

Project Title:
PPRC 17 REC-A: Binder Replacement in High RAP/RAS HMA and RHMA Mixes

Task Number: 3189

Start Date: July 1, 2017

Completion Date: September 30, 2020

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WHAT WAS THE NEED?

The California Department of Transportation (Caltrans) has increased the allowable binder replacement from RAP to 25 percent in asphalt mixes. Potential concerns associated with the use of Recycled Asphalt Pavement/ Recycled Asphalt Shingles (RAP/RAS) include the influence of the aged binder from the RAP/RAS on the virgin binder aging properties and the degree of blending that occurs during mix production and thereafter. The binder in existing pavements is known to oxidize and age-harden over time and hence significantly alter original binder properties. Studies have also demonstrated that the aged RAP/RAS binder can blend appreciably with the virgin binder, ultimately changing the binder properties, which could affect pavement performance (i.e., rutting, cracking, and raveling) especially when the mix contains higher percentages of RAP/RAS.

The aging inside the silo is not accounted for during the mix design process, and it is not strictly accounted for in quality assurance procedures. Moreover, high RAP or RAS mixes mostly include rejuvenators to restore the properties of the mix. These rejuvenators may undergo physical or chemical changes during the silo storage, leading to further changes in the mix properties.

WHAT WAS OUR GOAL?

The objective of this project was to develop guidelines for minimizing the risk of using high RAP and/or RAS contents in asphalt concrete mixes in California. This study included extensive performance-related testing to assess the effect of silo storage on the stiffness, rutting, cracking, and fatigue properties of high RAP or RAS mixes, including fine aggregate matrix mixes and full-graded mixes.

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WHAT DID WE DO?

The research was carried out in three different phases. Phase 1 was completed, and Phase 2 included the following tasks:

- Updated literature review
- Continued development and validation of testing procedures using fine aggregate matrix (FAM) mixes to determine the rheological properties of blended binders.
- Continued investigation into the blending mechanism and effectiveness of rejuvenating agents, warm mix technologies, and long-term performance of mixes with high RAP/RAS binder replacement rates.
- Continued investigation into understanding the aging rates and aging profiles of mixes containing high RAP/RAS contents and the development of laboratory procedures to simulate this aging.
- Collecting mixes with more than 25% RAP that are being used for local government and private projects, conducting performance related mix testing, and binder testing.
- Preparation of a research report.

WHAT WAS THE OUTCOME?

This study investigated the performance of four plant-produced high RAP or RAS mixes collected from different regions in California. The mixes were collected before silo storage and after hours in the silo. The results showed that silo storage time can increase stiffness on the order of 50% to 60%, with corresponding negative effects on fracture resistance and controlled-strain flexural fatigue life. The fatigue performance of the mixes reduced with increased silo storage, particularly at high strain levels, as measured by the flexural beam test. Use of a high rejuvenator dose could also potentially lead to rutting problems and poor fatigue performance. The FAM mix testing showed promising results in terms of characterizing fatigue. However, in its current form, it is not yet practical for use as a quality control/quality assurance test.

The recommendation is that the effect of aging and blending of high RAP or RAS mixes be further investigated to understand the full impact of silo storage on these types of mixes. Performance-related specifications should consider the variation in mix properties due to silo storage.

WHAT IS THE BENEFIT?

As the availability of asphalt and aggregates decline, it becomes more desirable to use higher quantities of RAP and/or RAS in asphalt mix designs and to use less of the expensive virgin materials. This research helps to better understand full effects of RAP and/or RAS on the performance grade of the composite binder which will allow us to design more durable pavements. Use of better designed AC mixes with higher quality will decrease maintenance costs and create savings by maintaining longer lasting pavements, which thus eventually improves system performance.

LEARN MORE

Here is a report published for this project:
https://escholarship.org/uc/item/24p1v6fd