



Caltrans Division of Research,  
Innovation and System Information

# Research

# Notes

Pavement

JULY 2020

Project Title:  
PPRC 20 Recycling

Task Number: 3189

Start Date: July 1, 2017

Completion Date: June 30, 2020

Task Manager:  
Junxia Wu  
Transportation Engineer  
junxia.wu@dot.ca.gov

## Binder Replacement in High RAP/ RAS HMA and RHMA Mixes

Develop guidelines for determining binder replacement using high RAP/RAS contents in asphalt concrete mixes in California.

### WHAT IS THE NEED?

The California Department of Transportation (Caltrans) has increased the allowable binder replacement from recycled asphalt pavement (RAP) to 25 percent in asphalt mixes. Potential concerns associated with the use of RAP/ recycled asphalt shingles (RAS) include the influence of the aged binder from the RAP/RAS on the virgin binder aging properties and the degree of blending that actually 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.

To date, solvent extraction and recovery is the only method that physically separates the RAP/RAS binder from the aggregate for characterization. The process has long been questioned because of the force-blending of the virgin and RAP binders, the potential for altering the rheological properties of the binder, the method followed for recovering the binder, and health risks to workers and hazardous waste disposal issues.

Non-representative blending and rheology results can have significant implications in terms of understanding both hot and cold weather performance. These concerns are further complicated when rejuvenating agents used to soften the RAP binder and warm-mix technologies are used.



DRISI provides solutions and  
knowledge that improves  
California's transportation system

## WHAT ARE WE DOING?

This study focuses on continued development of guidelines for determining binder replacement in high RAP/ RAS mixes. The research is carried out in three phases. Phase 1 was completed, and the Phase 2 investigation is underway. Depending on the results of Phase 2 accelerated wheel load testing with a Heavy Vehicle Simulator will be considered in Phase 3.

Phase 2 includes the following tasks:

- Literature review of recently completed research
- Development and validation of testing procedures. A suitable mix characterization test will also be identified for optimizing RAP/ RAS contents in mixes.
- Investigation of the blending mechanism and effectiveness of rejuvenating agents and warm mix technologies, and long-term performance of mixes with high RAP/RAS binder replacement rates.
- Investigation of the aging rates and aging profiles of mixes containing high RAP/RAS contents and, if required, the refinement of laboratory procedures to simulate this aging.
- Preparation of a research report.

## WHAT IS 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 in California.

## WHAT IS THE BENEFIT?

As the availability of asphalt and aggregates decline, it becomes more desirable to use higher quantities of RAP/RAS in asphalt mix designs and less expensive virgin materials. This research helps to better understand full effects of RAP/RAS on the performance grade of the composite binder which will allow Caltrans to design more durable pavements.

## WHAT IS THE PROGRESS TO DATE?

As of July 2020, the research team has made the following progress:

- Continuing Literature review
- Continuing preparation of Tech Memo covering Task 2 Testing and Findings
- Continuing laboratory testing and taking RAP samples from asphalt plants; collecting and testing virgin aggregate and virgin binder; extraction and recovery of the RAP binders and rheological testing of the different RAP/ virgin binder blends. Work is limited due to COVID-19.
- Continuing preliminary testing to assess effects of RAP binders on aging of blended RAP and virgin binders. Work is limited due to COVID-19.
- Collecting 4 to 5 mixes with more than 25% RAP that are being used for local government and private projects