

# Research Summary

## Characterization of Reclaimed Asphalt Pavement (RAP) for HMA Surface Courses in Massachusetts

### Research Need

Reclaimed Asphalt Pavement (RAP) is a valuable recyclable material. It comprises aged asphalt binder and aggregates that can be utilized in new asphalt paving mixtures. The purpose of this study was to determine the RAP properties available throughout Massachusetts and to develop a guideline to safely maximize the use of RAP without negatively impacting the performance of an asphalt paving mixture.

### Goals/Objectives

The goal of this project was to evaluate the characteristics of RAP available in Massachusetts and develop a guideline and methodology for increased RAP use in asphalt mixture surface courses. The project had four objectives:

1. Sample RAP being used throughout Massachusetts and characterize the RAP binder and aggregates.
2. Sample and characterize the properties of the standard virgin binders being used throughout Massachusetts to determine their ability to accommodate additional RAP.
3. Determine if higher RAP contents can be used in surface course mixtures in Massachusetts.
4. Measure the stiffness and performance characteristics of hot mix asphalt surface course mixtures produced with higher RAP contents in terms of fatigue cracking, thermal cracking and rutting.



### Methodology

The experimental plan designed for this project included:

1. Sampling RAP from multiple locations throughout Massachusetts that represent the various MassDOT maintenance districts.
2. Testing the RAP obtained to determine the physical properties of the aged asphalt binder and aggregates.
3. Determine the properties of the standard grade virgin binder (PG 64-28) used in Massachusetts asphalt paving mixtures.
4. Determine and validate the maximum allowable RAP percentage for surface course mixtures in Massachusetts.
5. Measure the change in performance characteristics of an asphalt paving mixture when incorporating the maximum allowable RAP percentage.

## Key Findings

The following key findings were determined:

- Analysis of the RAP property testing data indicated that no geographic trends in properties could be made.
- Significant variations were noted in the performance grades of the recovered RAP binders and the RAP binder contents. Year-to-year testing of RAPs from the same source also indicated variance in the performance grades of the recovered RAP binders.
- High variability in RAP aggregate gradation results for specific RAP stockpiles were noted.
- One of the four virgin binder sources tested had intermediate- and low- temperature continuous grades close to the specification criterion. This virgin binder can potentially have less capacity to accommodate RAP in any mixture.
- The current MassDOT specification, which allows up to 15% RAP in surface mixtures by dry weight of the mixture without using a softer grade virgin binder or blending equations, was not valid based on blended binder properties. One RAP percentage cannot be specified for all surface course mixtures in Massachusetts. The RAP percentage is dependent on the properties of RAP and virgin binder, which are a function of the source of these materials.
- For fatigue and thermal cracking performance of mixtures incorporating up to 35% RAP, a statistical analysis of the mixture test data indicated universally that virgin binder source significantly impacted all cracking performance measures. RAP source and percent RAP had a significant effect on only the fatigue cracking measures.
- Rutting performance testing indicated all mixtures tested exhibited acceptable performance while incorporating up to 35% RAP.

## Project Information

This project was completed as part of the Massachusetts Department of Transportation (MassDOT) Research Program with funding from Federal Highway Administration (FHWA) State Planning and Research (SPR) funds.

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### Key Words:

Reclaimed Asphalt Pavement, RAP, Specifications, Balanced Mixture Design, Rutting, Cracking

## Use of Findings

- Several recommendations were presented for using RAP in new asphalt surface mixtures in Massachusetts including: required RAP property testing and frequency, testing of the virgin binders, selection of a method to determine RAP aggregate specific gravity, and RAP aggregate gradation variability.
- A three-tiered approach was suggested to properly specify RAP in a mixture even at RAP contents  $\leq 15\%$ . This approach involves determining RAP and virgin binder properties, using blending charts equations to estimate the RAP amount to achieve the desired blended binder properties of the mixture, and fabricating and testing the mixture at the determined RAP content to ensure adequate performance after appropriate aging.

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