Blending Efficiency of Asphalt Mixtures Containing Recycled Asphalt Pavement and Shingle (RES2013-32)

Purpose of the project

Like many other state Departments of Transportation (DOTs), the Tennessee Department of Transportation (TDOT) has been routinely used recycled asphalt pavement (RAP) in its asphalt mixtures and is now looking into the possibility of using recycled asphalt shingles (RAS). However, after a long service life, the asphalt binder in RAP or RAS has been severely aged and become much stiffer and harder than virgin binder. Therefore, one critical question remains to be answered, i.e., how much of the aged asphalt binder in RAP or RAS can be blended into virgin asphalt and thus become available to coat aggregate? If RAP or RAS binder is not 100% blended with virgin binder, the effective asphalt content in the mixture would be lower than the design asphalt content and the performance of asphalt mixtures be compromised.

The purpose of the study is to determine the blending efficiency of RAP or RAS in recycled asphalt mixtures. Specifically, the objectives of the research project are to:

(1) Fingerprint the liquid virgin asphalt, RAP, RAS, and recycled asphalt mixtures containing RAP/RAS using available chemical testing techniques.
(2) Develop a laboratory testing method to determine the blending efficiency of recycled asphalt mixtures containing RAP/RAS.
(3) Investigate the effects of different blending efficiencies on the laboratory performance of recycled asphalt mixtures containing RAP/RAS.

Significance of the project

With the increasing awareness of sustainability and the associated economic benefits with the use of RAP or RAS, many state DOTs have been trying to increase the RAP content in asphalt mixtures and attempting to incorporate RAS into the mixtures. However, if the aged binder in RAP or RAS cannot be fully mobilized and reused, the long term performance of asphalt pavement constructed with recycled asphalt mixtures will be compromised and the benefits of recycling RAP or RAS cannot be truly realized. Therefore, the blending efficiency issue is of paramount importance to state transportation agencies.

This project can also benefit the state of Tennessee through the following aspects:

(1) Use of RAP or RAS helps conserve natural resources;
(2) Significant cost savings for recycled asphalt mixtures containing RAP or RAS
(3) More RAP or RAS may be recycled with the warm mix asphalt (WMA) technology
(4) Beneficial to the environments in Tennessee due to the use of WMA and RAP/RAS technologies.

Expecting outcomes

Following are some of the major accomplishments achieved from the research project:

- A laboratory method has been developed and validated to determine the blending efficiency of RAP and RAS in recycled asphalt mixtures using gel permeation chromatography (GPC), which includes the following steps:
  (1). Generate a “blending chart” in terms of the percentage of large molecule size (LMS%) (Figure 1)
  (2). Test the asphalt blend for its LMS%

(3). Determine the RAP or RAS binder content of the binder blend
(4). Calculate the mobilization rate of RAP or RAS using its equation.

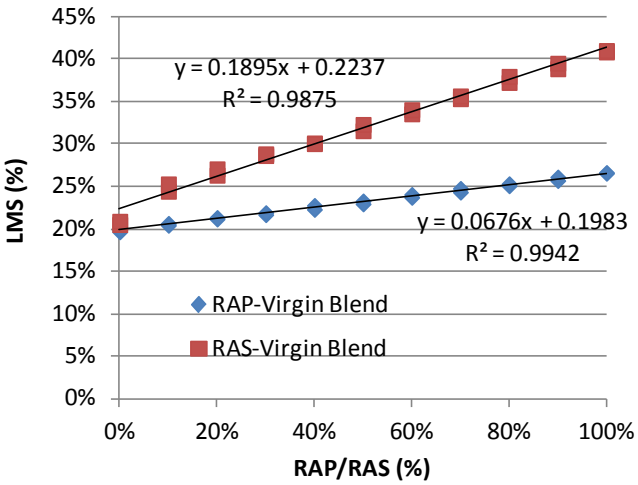
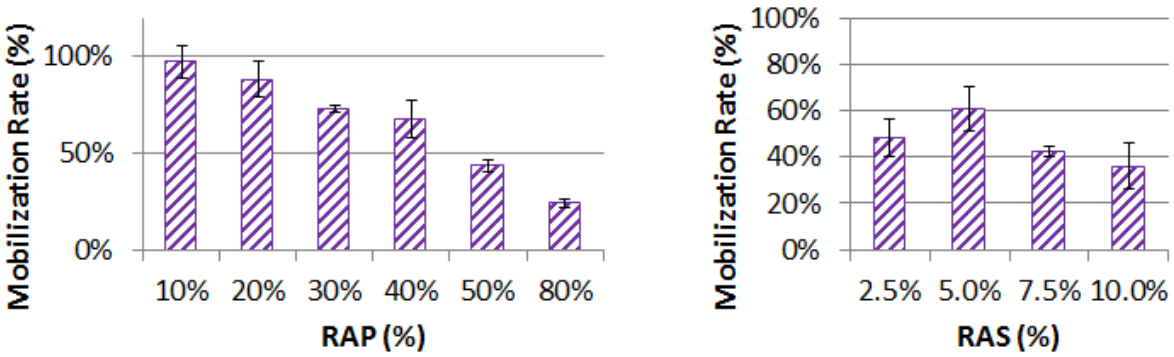


Figure 1. Blending Chart

- The blending efficiency of recycled asphalt mixtures determined with the laboratory-prepared mixtures containing different RAP or RAS contents, as shown in Figure 2. The results show that close to 100% of aged binder in RAP could be utilized at 10% to 20% RAP contents, while the percentage dropped from 73% to 24% at RAP contents ranging from 30% to 80%. For RAS, the peak percentage of utilization was reached at 5% RAS content and the rate was about 60%.



(a) RAP mixes (b) RAS mixes

Figure 2. Mobilization rates for RAP and RAS mixes

- In addition, the factors affecting the blending efficiency were explored in the study, which include mixing temperature, mixing time, rejuvenator, and WMA technology.

Time periods and status of the project

The project started on September 1, 2013 and is now in its final stage. The research team is now working on the draft final report, which will be submitted to TDOT for comments and suggestions.

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