

Semi-Year Progress Report:

Project Number and Title: 2.1 Asphalt Mixtures with Crumb Rubber Modifier (CRM) for Longevity and Environment

Research Area: NEW MATERIALS FOR LONGEVITY AND CONSTRUCTABILITY

PI: K. Wayne Lee, University of Rhode Island (URI), Civil and Environmental Engineering

Co-PI(s): George E. Veyera, Professor of Civil and Environmental Engineering, URI

Reporting Period: April-September 2019

Date: 10/2/2019

Overview:

Provide overview and summary of activities performed during previous six months....

In 1990s, a research team at the University of Rhode Island (URI) conducted a research program to evaluate the feasibility of using Crumb Rubber Modifier (CRM) in hot mix asphalt (HMA). Results showed that the addition of CRM to the paving asphalt mixtures provided similar or better performance for rutting and fatigue cracking resistance in comparison with conventional HMA. Therefore, to confirm the benefits of CRM and to develop the experimental design, a literature review was conducted. Tests were also performed to evaluate the rheological properties of asphalt binder containing CRM and to compare with straight asphalt binder. Since the addition of Reclaimed Asphalt Pavement (RAP) to paving mixtures has become common, CRM was added to HMA containing RAP. An Asphalt Mixture Performance Tester (AMPT) was used for the pilot study, and master curves were developed. Furthermore, CRM will be added to the Warm Mix Asphalt (WMA) mixtures with and without RAP.

Provide context as to how these activities are helping achieve the overarching goal of the project...

The project goal is to develop high performing asphalt mixtures with CRM, and to consequently provide durable and sustainable pavements compared with the traditional ones with HMA. Therefore, the URI team began investigating a new generation of asphalt mixtures with CRM for improved pavement longevity. Figure 1 shows the research flowchart for the WMA containing CRM and RAP to develop durable and sustainable asphalt pavements.

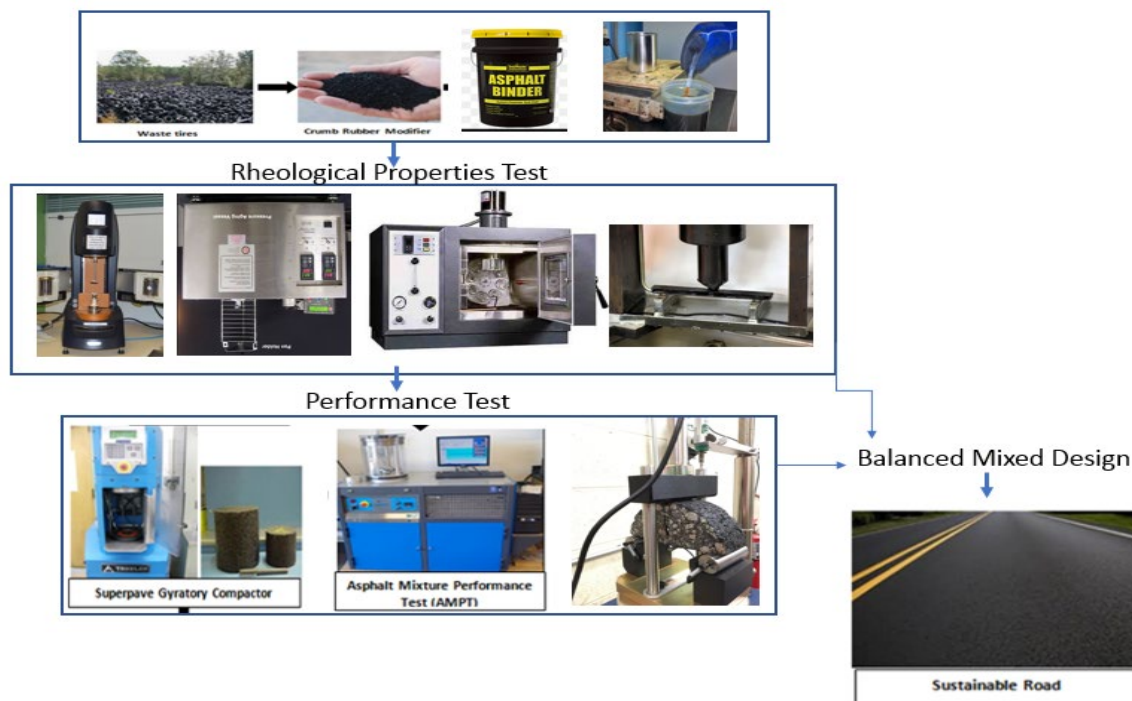


Figure 1. Flowchart of the Research Project

Describe any accomplishments achieved under the project goals...

Adding CRM to asphalt binder increases the viscosity. As a result, the compaction temperature of asphalt rubber mixture should be higher. However, it was found that WMA was shown to lower the viscosity, and also the compaction and mixing temperatures.

Therefore, a preliminary study was conducted with a WMA additive, i.e., Evotherm. to examine whether or not utilizing the Evotherm additive improves both the short-term and long-term pavement performance in comparison with the traditional asphalt binder. Evotherm is a promising additive approved by New England Asphalt User and Producer Group (NEAUPG). HMA and WMA specimens containing RAP were prepared at the Optimum Binder Content (OBC) and Indirect Tensile (IDT) strength tests were conducted. Results showed that the HMA mixtures have about 13% higher tensile strength than WMA with same amount of RAP. Both HMA and WMA specimens with and without RAP were prepared to predict the asphalt pavement performance using the dynamic modulus and the master curves. The results indicated that the WMA-RAP mixtures can improve asphalt mixture stiffness and provide better performance in terms of rutting resistance in comparison with the HMA mixtures with and without RAP. It was also observed that WMA mixtures without RAP showed poor rutting resistance performance compared with the HMA with and without RAP.

Two RI Rt. 102 sections were reconstructed in 2015 using WMA-RAP mixtures, and the research team has been closely evaluating the field performance for both HMA and WMA sections since then. To date, no serious pavement distresses have been observed and both sections appear to be performing similarly.

Describe any opportunities for training/professional development that have been provided...

A graduate student, Ms. Neha Shrestha successfully completed her MS study, entitled “Performance Prediction of Warm Mix Asphalt Pavement Containing Reclaimed Asphalt Pavement in Rhode Island,” in August 2019 as attached. However, she decided to take one-year leave of absence from the research program for personal reasons.

Thus, two new Ph.D. candidates, Mr. Ali Sharai and Mr. Mohammed Alotaibi, began working on this project. They will utilize the TIDC research findings and results in their Ph.D. research programs in Civil and Environmental Engineering.

Describe any activities involving the dissemination of research results (be sure to include workshops, seminars, and conferences attended/held for dissemination of information regarding this project) ...

- Farahmarzi, M., Shrestha, N. and Schumacher, D. submitted a technical paper to 2018–2019 T&DI/ASCE-LTPP International Data Analysis Contest, entitled “Determining the Effect of Climate and Loading on Fatigue Cracking and Roughness of Asphalt Pavement Using InfoPave” on 7/1/19.
- Prof. Lee presented a technical paper entitled “Balanced Mix Design for Sustainable Pavement with Warm Mix Asphalt,” on behalf of the research team at the 11th International Committee on Pavement Technology (ICPT), at Seri Pacific Hotel, Kuala Lumpur, Malaysia, on 7/11/19.
- Submitted a technical paper to 2020 TRB Conference, entitled “Implementation of Warm Mix Asphalt contained Reclaimed Asphalt Pavement in Rhode Island,” by Shrestha, N., Lee, K., and Veyera, G. E. to Committee AFS80 - Stabilization of Geo-materials and Recycled Materials on 8/1/19.
- Prof. Lee presented a technical paper, entitled as “Investigation on Rheological Properties of Warm Mix Asphalt,” at the US-Korea Conference on Science, Technology, and Entrepreneurship (UKC 2019), in Chicago, on 8/15/19.

Participants and Collaborators:

What organizations have been involved as partners on this project?

- University of Rhode Island, Dept of Civil and Environmental Engineering
- Material Section of Rhode Island Department of Transportation

- Design section of Rhode Island Department of Transportation
- Connecticut Transportation Institute

Have other collaborators or contacts been involved? If so, who and how?

Name of Technical Champion: Paul C. Petsching, P.E.
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What students have participated in the project? (Include class standing, major, role in the research)

Neha Shrestha: Successfully completed her MS study, entitled “Performance Prediction of Warm Mix Asphalt Pavement Containing Reclaimed Asphalt Pavement in Rhode Island,” in August 2019

Ali Sahraei Joubani: CVE Ph.D. candidate. Initiated literature review, developing experimental design and setting up testing facilities to conduct Phase II study of WMA mixtures containing RAP, including AMPT and Creep Compliance testing.

Mohammed Alotaibi: CVE Ph.D. candidate. Initiated literature review, developing experimental design and setting up testing facilities to conduct Phase II study of WMA mixtures containing RAP, including Balance Mix Design (BMD).

Changes:

Discuss and changes in approach and the reasons for the change...

None

Discuss any actual or anticipated problems or delays and actions or plans to resolve them...

Since Neha Shrestha will take a leave of absence, it will be necessary to hire new graduate student researchers. Fortunately, Ph.D. candidates have been found who will continue and further develop Neha’s work.

Since Neha used a chemical additive, going forward, the plan is to use foamed asphalt for the Phase II. However, the purchase of the Laboratory Foamed Machine was not possible at this time, primarily due to cost. Fortunately, the Maine DOT plans to loan the equipment to URI for up to 5 years, for the research program. The arrangement details for the equipment loan are currently being worked out with both legal departments. The URI research team also plans to use AASTHOWare Pavement ME Design (PavementME) software, but there was a short delay in the purchasing process.

Planned Activities:

Description of future activities over the coming quarter (10/1 – 12/31/19).

CRM will be added to the WMA mixtures with and without RAP at different percentages. A series of performance tests will be conducted using the AMPT, Semi-Circular Bending Test (SCBT), and Asphalt Pavement Analyzer (APA), at various loading frequencies and temperatures. Then BMD will be developed for WMA asphalt mixtures containing CRM and/or additives, e.g., Evotherm. The URI research team will also explore WMA using the lab-scale foamed asphalt plant for the comparative study. The pavement performance prediction will be conducted using AASTHOWare Pavement ME Design (PavementME) software.