Optimizing the Sustainability of Asphalt Pavements through Incorporating Crumb Rubber in High-Modulus Asphalt Concrete (HMAC) Mixtures in Louisiana

Project Number:

22BLSU02

Start Date:

04/01/2022

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Lead Institution:

Louisiana State University

Funding Source(s):

Tran-SET

Louisiana State University

Total Project Cost:

$ 58,832

Developing HMAC incorporating Crumb Rubber in Louisiana

The proposed research study will build on the results of the authors' initial study, titled "Viability Assessment and Cost-Effectiveness of Using High-Modulus Asphalt Concrete (HMAC) as Base Course in Asphalt Pavements in Louisiana." In specific, this project aims to optimize the performance, cost-effectiveness, and sustainability of HMAC mixtures using crumb rubber and local materials in Louisiana. To achieve this objective, high-modulus asphalt mixtures mimicking the European approach will be prepared using the Superpave specifications. These mixtures will include different percentages of crumb rubber, two PG grades, and different binder contents. The dynamic modulus as well as the performance of these mixtures against rutting and cracking will be evaluated in the laboratory. In addition, the field performance and cost-effectiveness of these mixtures will be predicted. The results of this study will provide solutions for fatigue and rutting failures in asphalt pavements in Region 6 enhancing the durability and service life of the road infrastructure. Furthermore, it will enhance the sustainability of the road infrastructure through using crumb rubber from scrap tires.

Problem Statement

Asphalt concrete mixtures are primarily designed using the Superpave mix design procedure where the proportioning of asphalt mix components is primarily based on volumetric properties. Early Superpave implementation mainly focused on rutting resistance. Mixture designs for moderate and high traffic pavements were designed for improved rutting resistance by specifying a higher grade of asphalt binder and higher quality aggregate. Most highway agencies now report that rutting problems have been virtually eliminated. However, there have been growing concerns that the primary mode of distress for asphalt pavements is cracking of some form or another. One of the emerging solutions to enhance the durability of asphalt pavements is the use of a French asphalt mix known as "High-Modulus Asphalt Concrete (HMAC)". This mix was developed in France in the 1980s using hard asphalt binders (typically PG 88 or higher for critical high temperature properties), relatively high binder content (about 6%), and relatively low air voids (close structure) as compared to conventional Superpave asphalt mixtures. In general, two classes of HMAC mixes exist, Class 1 and Class 2. Class 2 has an excellent fatigue and rutting resistance, while Class 1 is a "low-cost" mixture with lower binder content, thus having similar stiffness and rutting resistance to Class 2 but with a relatively lower fatigue resistance. Unlike the Superpave mix design procedure, the French mix design approach is not driven by volumetric properties as much as it is driven by trying to meet performance-based specifications. When compared to Superpave mixtures, HMAC mixes have high modulus/stiffness, high durability, superior rutting performance and reasonable fatigue resistance. For these reasons, HMAC mixes are considered as an excellent option to be used in the binder course in the pavement structure, which is subjected to the highest levels of tensile and compressive stresses. HMAC mixes have been successfully adopted by many other countries such as United Kingdom, Poland, Switzerland, South Africa, and Australia.

Objectives

This study aims to optimize the performance, cost-effectiveness, and sustainability of HMAC mixtures using crumb rubber and local materials in Louisiana. To achieve this objective, high-modulus asphalt mixtures mimicking the European approach will be prepared using the Superpave specifications. These mixtures will include different percentages of crumb rubber, two PG grades, and different binder contents. The dynamic modulus as well as the performance of these mixtures against rutting and cracking will be evaluated in the laboratory. In addition, the field performance and cost-effectiveness of these mixtures will be predicted.

Figure 1. Loaded Wheel Tracker (LWT)

Intended Implementation of Research

Workforce Development, Education, and Outreach: This research project will provide funding to one master student at Louisiana State University. This will help recruit and train future leaders in the Transportation Sector. The research team will also prepare educational materials on the guidelines for HMAC mix design to be incorporated in courses at LSU and share it with other universities. The educational material will also be summarized and disseminated to government entities and the industry. Results of this work will be also disseminated at national conferences such as TRB and ASCE. It will also offer one summer internship to high school students within the High School Student Research (HSSR) Intern Program organized by Dr. Adam Melvin at LSU.

Anticipated Impacts/Benefits of Implementation

In this project, local virgin and recycled materials in Louisiana would be used to produce HMAC mixtures based on the European mix design procedure to be used in asphalt pavements. The success of this project is to show better performance and higher cost effectiveness of HMAC mixtures when compared to conventional mixtures in Louisiana. The results of this study will provide solutions for fatigue and rutting failures in asphalt pavements in Region 6 enhancing the durability and service life of the road infrastructure.

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.