Tran-SET
Transportation Consortium of South-Central States

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Key Points

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Principal Investigator(s):
Dr. Marwa Hassan
Louisiana State University
Email: marwa@lsu.edu

Lead Institution:
Louisiana State University

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Tran-SET
Louisiana State University
Louisiana Transportation Research Center (LTRC)

Total Project Cost:
$91,710

Development of Self-Healing and Rejuvenating Mechanisms for Asphalt Mixtures Containing Recycled Asphalt Shingles

Brief Project Description

The purpose of this project is to test the hypothesis that hollow-fibers containing a rejuvenator product can improve both self-healing, rejuvenation and mechanical properties of asphalt mixtures. Sodium-alginate fibers with a rejuvenator product will be developed to address the aging of the binder through its service life and to improve the performance of the mixture against cracking and rutting.

Problem Statement

Recycled materials such as recycled asphalt pavements (RAP) and recycled asphalt shingles (RAS) have been incorporated into hot mixed asphalt (HMA) to reduce virgin materials consumption and to alleviate the environmental effects of paving operations. However, the aged binder in these recycled materials may affect the cracking performance of HMA prepared with RAS or RAP. Asphalt rejuvenators have emerged as a promising solution to address the issues related to the aged binder. Asphalt rejuvenators have been shown to partially restore the rheological properties of asphaltic materials. Yet, studies have shown that the effectiveness of asphalt rejuvenators depend on how much they can penetrate into the pavement.

An innovative approach, which will be evaluated in the present study, is to encapsulate the rejuvenator in microcapsules such as sodium-alginate hollow fibers. Sodium-alginate is a low-cost and low-environmental impact polymer. These hollow fibers may be used to encapsulate the rejuvenator product, which may enhance the cracking resistance of the mixture. It would also support a more reliable and resilient design of asphalt mixtures that are intended to provide a service life of 20 years or more without delays to the users. The enhancement of self-healing mechanisms with asphalt rejuvenator products would also increase the use of recycled materials such as RAS by restoring the properties of the aged binder.

Objective

The objectives of this study are to:

- Develop a synthesis procedure for production of sodium-alginate hollow-fibers containing an asphalt rejuvenator;
- Evaluate the thermal stability and the resistance to mixing processes of the fibers;
- Evaluate the performance against fatigue cracking, low temperature cracking, and rutting susceptibility of HMA with fibers will be assessed through laboratory tests; and
- Evaluate the self-healing efficiency of hollow-fibers, through crack healing and stiffness recovery of damaged mixture specimens under two different healing conditions.

Intended Implementation of Research

Technology Transfer

Detailed steps on how to produce and utilize the proposed technology will be provided to the state agencies to enhance implementation. Results of this work will be disseminated at national conferences such as the Transportation Research Board (TRB) and the American Society of Civil Engineers (ASCE). In addition, seminars and webinars explaining the fabrication process and the functioning of the fibers will be offered to asphalt research institutes and companies interested in sustainable pavement technologies in collaboration with the highway agencies in Region 6.

Education, Workforce Development, and Outreach

This research project will provide funding to one Ph.D. student at Louisiana State University. This will help recruit and train future leaders in Transportation. The research team will also prepare educational materials for the production and use of sodium-alginate fibers containing a rejuvenator product to be incorporated in transportation courses at LSU, and share it with other universities in Region 6. The educational materials will also be summarized in the form of YouTube videos for dissemination to DOT and the Transportation industry.

This project will offer two summer internships; one for a Native American student from Navajo Technical University and another for a student from BRCC to introduce them to research in Transportation. The developed educational materials prepared in this project will be shared with our partner community colleges to be used to recruit students to Transportation. The project will also offer 2 internships one for a high school student and one for an undergraduate student to work with the research team and learn about emerging technologies in Transportation.

This research project will create awareness of the benefits of rejuvenating fibers in asphalt mixes in the region and produce knowledge on the subject, which may be implemented in courses in asphalt materials at LSU and other universities in Tran-SET university consortium. In addition, a new mechanism to enhance asphalt mixture performance and to recover the binder rheological properties will be developed with the fibers encapsulating a rejuvenator product. Many more studies can be performed based on the results of this study such as determining the optimum amount of fibers in HMA mixtures, the effect of adding fibers in 100% recycled HMA mixtures, etc.

Anticipated Impacts/Benefits of Implementation

The addition of fibers containing an asphalt rejuvenator will retard the deterioration process by restoring the rheological properties of the binder affected by the oxidation process. The life-cycle cost of pavements with this new technology will be positively affected as the service life will increase whereas the initial construction costs will decrease by increasing the percentage of recycled materials such as RAS. Also, incorporating more recycled materials in HMA will enhance sustainability as it will reduce the virgin materials consumption and the environmental effects of virgin materials extraction. This will result in major cost savings for State DOTs.

Weblinks:

http://transet.lsu.edu/research/research-in-progress/

https://rip.trb.org/view/2017/P/1467123