Transportation Consortium of South Central States

Key Points

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Lead Institution:
Louisiana State University

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

Total Project Cost:
$91,710

Enhancing the Durability and the Service Life of Asphalt Pavements through Innovative Light-Induced Self-Healing Materials

Brief Project Description

This study aims to evaluate the efficiency of a new generation of light-induced polymers in enhancing elasticity and improving the self-healing properties of asphalt mixtures. Light-induced self-healing polymer is an evolving technology that would delay crack propagation in the early stages of crack appearance, resist cracking damage, and therefore, extend the service life of pavements.

Problem Statement

Utilization of recycled asphalt materials such as RAS and RAP in asphalt pavement is a cost-effective approach to reducing the use of virgin material consumptions and negative environmental impacts associated with paving construction. Yet, the challenge that the industry is facing is the oxidation and brittleness of the recycled binder. Age hardening of the recycled binder can also reduce pavement durability and eventually lead to premature failure. Self-healing agents were recently proposed to enhance the self-healing capabilities of asphalt binder, delay crack propagation at early stages, and therefore extend the service life of the pavement.

An innovative smart self-healing agent, which will be evaluated in the present study, is Ultra-Violet (UV) activated self-healing polymer. This new class of polymer can enhance elastic recovery of the binder and to increase the self-repairing ability of the polymer. The appearance of micro-cracks because of aging and excessive loading would cause the chemical breakage of polymer bonds and consequently produce free radicals. The produced free radicals would recombine through UV light exposure and close the micro-cracks. Based on this mechanism, it is expected that the new self-healing polymer can be useful in reducing the cost of maintenance and repair of asphalt pavements.

Objective

To address the aforementioned problem statement, the following objectives will be achieved:

- Develop an optimized synthesis procedure for the production of UV light-induced self-healing polymers;
- Examine the thermal stability of the produced polymer during asphalt pavement mixing processes;
- Evaluate the effect of self-healing polymer on the rheological properties of the binder;
- Evaluate the effect of self-healing polymer on the mix mechanical properties;
- Evaluate the effect of UV light-induced polymer on self-healing capabilities of asphalt mixtures.

Intended Implementation of Research

Technology Transfer

The results of this study will develop a new self-healing polymer that can be activated by UV light exposure, which would be used to enhance the durability of asphalt pavements and delay crack propagation at early stages of crack appearance. Detailed steps on how to produce and utilize the proposed technology will be provided to the state agencies to enhance implementation. Moreover, analyzed data from the proposed study including raw data, figures, and tables will be published through journal publications, presentations at related conferences that presents the latest findings of the study.

Education, Workforce Development, and Outreach

Educational material will be provided on the basic chemistry of self-healing production process and incorporation in asphalt pavement industry. This material will be added to transportation and materials courses at LSU and will be shared with other universities in Region 6. Summarized YouTube videos and PowerPoint presentation will be provided for DOTs and Transportation industries. In addition, the research team will also present their results at middle and high schools as well as develop seminars and webinars explaining the fabrication process and the functioning of light-induced polymers will be offered to DOTs, universities, and consultants. Results of this work will also be disseminated at national conferences such as TRB and ASCE.

Anticipated Impacts/Benefits of Implementation

The proposed project will focus on developing a polymer-modified asphalt binder that has self-healing capabilities and superior performance characteristics than unmodified asphalt binders. Currently, polymer-modified asphalt binders have the capability to enhance durability and cracking resistance of unmodified asphalt binders; yet, they do not have self-healing capabilities, which could further improve the longevity of asphalt pavements. The proposed study will advance the understanding of the effect of light-induced polymers on asphalt binders on their contributions to the mechanical properties of asphalt and the efficiency of autonomous crack repair mechanisms.

Weblinks:

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

https://rip.trb.org/view/1466860