Effectiveness of Softening Agents for Enhancing Properties of Asphalt Mixes with High RAP Contents

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$60,500.00

Developing a thorough, efficient method for assessing flexible pavements' resilience

Reclaimed asphalt pavement (RAP) use in hot mix asphalt (HMA) has increased in recent years due to the rising costs and demand for crude oils and aggregates. However, using high RAP in new mixes may have performance issues such as low resistance due to fatigue cracking. This is due to the excessive oxidative aging RAP used in the mix, and it becomes an issue when high RAP is used. To fix this problem, mixes with RAP usually require the use of a softer binder (e.g., PG 58-22) or a softening agent. However, the use of a softer binder puts the contractor in a non-compliance situation as it is not often an approved Performance Grade (PG) binder (e.g., PG 58-28). The Arkansas Department of Transportation (ArDOT) allows only PG 64-22, PG 70-22, and PG 76-22 on highways. Furthermore, a PG 58-28 binder is more costly than the base binder (PG 64-22). The second solution of using a softening agent appears to enhance the performance of high RAP mixes as it allows contractors to use ArDOT approved binders without increasing the cost of materials significantly. The aim of the proposed study is to determine the effectiveness of different rejuvenators on blended binders' rheological and mechanistic properties by means of traditional test methods (e.g., Superpave) and non-traditional techniques such as the atomic force microscopy (AFM). The test results will reveal mechanistic performance data of the blended binders. Binders from two RAP samples will be recovered, and they will be blended with two base binders. As the softening agents, a commercial rejuvenator and two waste products, namely waste cooking oil (WCO) and engine bottom oil (EBO) will be investigated in this study

Problem Statement

The RAP has become an essential ingredient in HMA pavements recently. According to a Federal Highway Administration (FHWA) study, over 90% of roads and highways in the U.S. are constructed with HMA. Therefore, a massive amount of RAP is generated yearly from repairing existing asphalt pavements and reconstruction of new pavements. The FHWA has noted using recycled materials in the highway construction industry due to their engineering, economic, and eco benefits. Thus, using RAP in asphalt pavement production can become a crucial way to save energy and cost. It has been reported that the use of RAP in highway construction is becoming more popular to pavement professionals particularly to reduce the amount of virgin binder as RAP contains old asphalt binder and, therefore, has the additional benefit of reducing the amount of new binder to be added.

Objectives

The objective of this research project is to assess the effectiveness of softening agents in highly aged binders. Specific objectives of this study are:

- Determine the Penetration and PG grades of the RAP-blended binders
- Evaluate the effects of RAPs on the base binders' properties.
- Quantify the amount of RAP or level of aging of RAP when a softening agent is required
- Determine the best amounts of different softening agents;
- Evaluate the effectiveness of softening agents on binders' rheological properties
- Observe the changes in morphological phases and interactions of virgin and aged binders at the molecular level.
- Evaluate plant mixes with high RAPs and monitor the field performance.

Intended Implementation of Research

Workforce Development: This will be achieved directly by training graduate, undergraduate, and high school students interested in pursuing a

career in STEM or Transportation Engineering career.

Education and Outreach: Research findings will be shared with students enrolled in Advanced Civil Engineering Materials, taught by the PI. Also, a Ph.D. student will pursue his/her Dissertation related on this topic. Furthermore, local K12 students will be exposed to this project via internship and hands-on activities. Presentations based on the findings of this study will be made at local chapter meetings of professional organizations such as ASCE. Such initiative supports the outreach activity of the Center.

Figure 1: A Reclaimed Asphalt Pavement mix being developed at a plant.

Anticipated Impacts/Benefits of Implementation

The main deliverables from this study are:

1) A technical report containing the feasibility of the use of high RAP along with suitable softening agents in preparing durable asphalt mixes. The report will also contain recommendation(s) the mixing and compaction temperatures asphalt mixes containing high RAP.

2) The findings of the study will be showcased at symposia such as the ArDOT Annual Technical Research Committee (TRC) Conference and at the Tran-SET Annual Conference.

3) Technical articles (scientific journal and conference proceedings) will be published.

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 Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.