VERMONT
AGENCY OF TRANSPORTATION
RESEARCH PROGRAM

Recycled Asphalt Shingles as an Full Depth Reclamation Mechanical Stabilizer

STUDY TIMELINE
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More information about the Agency of Transportation Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Introduction (or Problem Statement)

The use of recycled asphalt shingles (RAS) in transportation infrastructure has been extensively researched across the United States and other regions. An estimate of annual quantity of waste shingle in Untied States is 10 million tons and approximately 25,000 tons in Vermont (Vermont Department of Environmental Conservation). Recycled asphalt shingles contain valuable materials such as asphalt binder, aggregate, and fibers, making them suitable for reuse in pavement applications. By integrating RAS into asphalt mixes, road agencies and contractors can reduce reliance on virgin materials, conserve natural resources, and decrease the carbon footprint associated with road construction and maintenance activities. The use of RAS in road pavement should be assessed in context of the implications to the performance characteristics of asphalt mixtures. The asphalt binder contributing to the asphalt mixtures from the recycled shingles usually have higher stiffness and viscosity, and this can improve the rutting resistance. At the same time, due to the stiff nature, use of RAS can also potentially lower the cracking resistance of asphalt mixtures. Consequently, many agencies have imposed restrictions on the use of RAS in hot- and warm-mixed asphalts. The Vermont state law (10 V.S.A. § 6605m) requires that asphalt shingles be recycled. To address concerns about their use in asphalt concrete layers of pavement structures, it is necessary to explore their application in the lower pavement layers.

Many transportation agencies, including VTrans, prefer using full-depth reclamation (FDR) for rehabilitating flexible pavements due to its cost and environmental benefits. The "in-place" nature of the FDR process reduces the need to transport large quantities of materials off-site, thus lowering costs, fuel usage, and associated emissions. Stabilizing agents such as Portland and other hydraulic cements, emulsified asphalt, foamed asphalt, and their combinations are often used in FDR to enhance its structural contribution to the pavement and improve roadway longevity. However, these stabilizing agents tend to be expensive and have high carbon footprints. If RAS can achieve similar stabilizing effects as non-recycled products, the cost-effectiveness and environmental benefits of FDR could be further enhanced, while also incorporating RAS into pavement infrastructure without compromising performance. To achieve this goal, this research will address two critical questions: (1) Can RAS be utilized in its "as-is" condition from when it is generated as architectural waste, or does it require processing to resize it? (2) Does RAS provide mechanical stabilization effects to FDR?

Project Methodology

This research study is undertaking a laboratory experimental campaign and corresponding analysis to determine whether RAS can be utilized in “as-is” or resized condition to serve as stabilizing agent within FDR. This question is critical to answer since additional processing steps would have cost and logistics implications with respect to usage of RAS. A hypothesis is that the FDR process can provide some crushing effort towards breakdown of waste shingle sheets. To evaluate this hypothesis and to determine feasibility of using RAS in FDR an assessment is necessary to determine constructability of FDR stabilized using RAS, specifically in terms of compactability. This study will develop recommendations for determining suitable dosage of RAS that can be accommodated within FDR to realize appreciable mechanical stabilization effects. Further, it will also explore the use of recycling agents to provide additional stabilizing effect of RAS. Lastly, to quantify the stabilizing effects of RAS, the outcomes of laboratory characterization will be used in a pavement design and analysis system to determine life cycle cost benefits.

Conclusions/Next Steps

The project is currently in its second stage, a comprehensive review of literature was conducted to establish the state of the art and the state of practice regarding the use of RAS in FDR and an experimental plan was developed. FDR materials were sampled from two different VTrans projects (Marshfield-Danville NH PS19(1) and Cambridge-Johnson STP 2925(1)). RAS from two different sources will be considered and sampled to assess whether their variability affects the performance of the final products. In addition to unprocessed ("as is") RAS, two sizes of processed RAS will be considered, traditional RAS processed for use in hot mix asphalt (3/8 inch minus) and partially resized RAS.

From left: "As is" architectural waste shingles; resized processed waste shingles; first pass reclamation from VTrans Marshfield-Danville project (reclaimer and water tanker)

Preliminary material analysis is now underway (the particle size distribution of RAS and FDR materials, the actual contribution of the binder within the RAS by cohesion test, and the optimum moisture content and density of the FDR materials). Preliminary analysis will allow determination of the "optimal" RAS content. Laboratory experimentation will then continue with mechanical characterization of RAS-stabilized FDRs and non-stabilized control materials through measurement of indirect tensile strength, resilient modulus, and shear strength. RAS and FDR with RAS will be evaluated for environmental contaminants, particularly PCBs, PFASs and PAHs, including the use of Synthetic Precipitate Leaching testing (SPLP).

Impacts and Benefits

Results of this study will be in the form of recommendations for VTrans to revise FDR construction and material specifications to include RAS. The research results will also provide VTrans with quantitative measures associated with mechanical stabilization potential of RAS in FDR. Further, as a first step to implementation of using RAS in FDR, VTrans will have information on optimal dosages as well as lab procedures that should be used to validate the dosage amounts. As an added outcome, this project will provide recommendations on suitable roadway rehabilitation candidate projects where RAS stabilized FDR would provide positive life cycle cost and pavement performance benefits. Ultimately, the results of this project will enhance the understanding of the risks or benefits associated with utilizing recycled products in FDR layers and their potential to impact pavement performance. This will ensure VTrans has the information needed to make prudent decisions regarding their asphalt pavements, as they strive to develop treatments that require less frequent maintenance and/or rehabilitation while lowering life cycle costs. The research project will conduct preliminary life cycle cost analyses comparing pavements rehabilitated using unstabilized FDR with those using RAS stabilized FDR. This research will also provide VTrans with a better tool to evaluate new materials and additives (e.g. recycling agents) resulting in improved materials. Use of RAS in FDR will allow VTrans to support Vermont's initiatives towards recycling additional construction waste materials and open up a new market for RAS in areas where inclusion in HMA is limited.