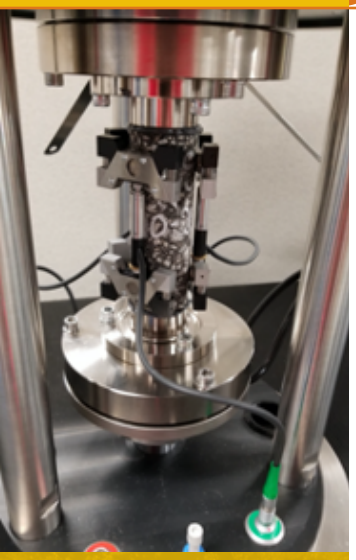
Researching Novel Approaches for Aging Resistant Binder Technologies

Exploratory Advanced Research . . . Next Generation Transportation Solutions



State Departments of Transportation (DOT) use chemical modifiers to improve the durability and longevity of asphalt roads and pavements and reduce costs. However, in some cases with new materials, it can be hard to gauge when, how, or why different modifiers work. With support from the Federal Highway Administration's (FHWA) Exploratory Advanced Research (EAR) Program, researchers at Auburn University, along with partnering groups, are examining fundamental aspects of asphalt modification to help the highway industry make better choices about pavement systems. By testing the effectiveness of additive products, the researchers hope to create asphalt mixtures that result in durable and longer-lasting roads and pavements. Researchers are also examining whether mitigating oxidation through use of certain additives is a viable approach in ensuring the durability of the chemical binders used in asphalt production. Ultimately, researchers hope to develop an underlying theory for why certain additives work so that future projects will have a tool to assess an additive's potential usefulness in different conditions.

Slowing Down the Rate that Asphalt Ages

State DOTs maintain thousands of miles of roads in the United States. Many use asphalt because of the material's flexibility. Harsh conditions—rain; snow; extreme hot or cold temperatures; the ultraviolet rays of the sun; and the weight of passing cars and trucks—impair asphalt's long-term performance. Aging also results in the oxidation of asphalt, which means that as asphalt and its components—including the chemical binders that keep asphalt together—get older, their chemical properties change and make them more susceptible to breaking. Over time, the asphalt becomes inflexible, causing cracking and allowing moisture to get into the pavement. This can result in pieces of the road unraveling or the formation of potholes.

Material engineers and pavement designers working for the State DOTs and local agencies have been looking for solutions that help slow down the deterioration of asphalt roads and pavements. One way to address the deterioration of asphalt roads is to add chemical additives to the asphalt mix.

The researchers at Auburn University are collaborating with researchers at Iowa State University and five industry partners—Blacklidge Emulsions, ChemCo Systems, the Kraton Innovation Center, Lehigh/Michelin, and MTE Services—to gain a new understanding of additive products that can help asphalt pavements last longer by slowing down the rate at which asphalt ages. In a three-year study, they will be looking at six additives to see how they perform as a basis to develop a standard process that can be used to evaluate future anti-aging asphalt additives. While previous research has focused on using additives to stiffen the asphalt binders so that asphalt can maintain its durability, this project takes a different angle with how to incorporate additives. This project looks at how to mitigate oxidation through use of chemical additives so that the binders can function over time while maintaining performance of the pavement.

The goal is to create an underlying theory for understanding why additives work so DOTs will not need to spend as much time testing each new additive. The results from this research might give DOTs an improved ability to assess which additives can improve the performance of asphalt under environmental contexts such as various weather conditions and traffic loading.

Putting Theory Into Practice

The research will involve testing different classes of asphalt additives made by the project's partners and collaborators. These additives show promise in being able to reduce the rate that asphalt binders age. By reducing the aging rate, these additives would ultimately contribute to extending the life of asphalt roads and pavements.

U.S. Department of Transportation
Federal Highway Administration

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Roads across the United States can benefit from the latest technology in additives for asphalt binders. © *National Center for Asphalt Technology, Auburn University.*

Photo credit, page 1: An example of laboratory equipment used to test aging resistant binder technologies. © *National Center for Asphalt Technology, Auburn University.*

The asphalt additive products include diluted epoxy asphalt; a hybrid ground tire rubber additive; a lignin additive or an additive that consists of macro-molecules found in the cellulose of plants; an additive that uses recycled materials; an additive that consists of biosynthetic oils, petroleum-based oils, and rheology modifiers; and an epoxidized benzyl soyate additive obtained from soybean oil.

The research will be done in two phases. The first phase will include laboratory tests to determine the dosage of each additive to minimize aging. These tests will include gauging the additives' abilities to perform under diverse climatic conditions and assessing both the changes in the physical and chemical properties of the additives and the performance of the mixtures containing these modified additives.

"There are decades of research that have gone into developing the test methods that we will be using to evaluate how the additives work in an asphalt paving mixture. Each of the industrial and academic partners also have invested years of research in developing their additives to this point," said Randy West, principal investigator and project lead at Auburn University. He is also the director of the National Center for Asphalt Technology, which will be responsible for seeing this project through to completion.

The second phase will involve testing the asphalt mixtures with and without the additives using advanced mechanical tests and pavement modeling to predict how the additives will impact the life of a typical asphalt pavement.

By the conclusion of the study, the researchers hope to produce a report that defines how the proposed modification technologies affect the asphalt performance and its aging process. The research report will detail what these interactions look like at the molecular level and also how they affect the mechanical and thermo-volumetric properties of asphalt mixtures, that is how the chemistry of the binders and their mechanical properties affect how pavements expand and contract under harsh conditions. The report will also consider the potential costs of the proposed aging resistant technologies. The report's findings could inform future research with a fundamental understanding of how and why certain additives work.

"These results will be useful to all highway agencies in the selection and management of their asphalt surface layers," said Jack Youtcheff of FHWA's Office of Infrastructure Research and Development. "This research could result in much longer service lives for asphalt pavements, as well as substantial reduced costs related to maintaining the Nation's pavement infrastructure."

EXPLORATORY ADVANCED **RESEARCH**

What Is the Exploratory Advanced Research Program?

The EAR Program addresses the need for longer term, higher risk research with the potential for transformative improvements to transportation systems. The EAR Program seeks to leverage advances in science and engineering that could lead to breakthroughs for critical, current, and emerging issues in highway transportation by experts from different disciplines who have the talent and interest in researching solutions and might not do so without EAR Program funding.

To learn more about the EAR Program, visit https://highways.dot.gov/research/exploratory-advanced-research. The website features information on research solicitations, updates on ongoing research, links to published materials, summaries of past EAR Program events, and details on upcoming events.

Learn More

For more information about this EAR Program project, contact Jack Youtcheff, FHWA Office of Infrastructure Research and Development, at 202-493-3090 (email: jack.youtcheff@dot.gov).

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