



Project Number

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Long-Term Aging of Recycled Binders

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Current Situation

At 80 million tons a year – representing more than 80% of all milled asphalt pavement – asphalt paving is America’s most recycled material. Asphalt can be recycled in place, which is very cost effective; however, aging of recycled binder can have a serious impact on pavement durability. Chemical rejuvenators added to recycled binder can improve its workability, but the long-term behavior of binder treated with rejuvenators is not well known.

Research Objectives

Florida International University researchers compared the effects of long-term aging on recycled asphalt binders and on virgin binders.

Project Activities

The researchers obtained samples of ten rejuvenators from different vendors. The samples were subjected to a battery of tests to determine their suitability for long-term studies. These preliminary tests included softening properties, rotational viscosity test, rolling thin film oven mass loss, open cup Cleveland flash point, and others. Based on the results of these tests, five products were selected for further testing.



Asphalt removed by milling can be recycled and reused to pave again.

Samples of virgin asphalt binder were aged in the pressure aging vessel (PAV), which uses specific heat and pressure programs to simulate up to several years of aging. Samples were then blended with rejuvenators until their initial rheological properties were restored. These samples were then returned to the PAV for another round of aging. Superpave performance grading was used to characterize the extent of aging achieved in the PAV.

Additional testing was performed to study the relationship between aging and cracking resistance in recycled binders, prepared by taking recycled binder from an ongoing road project and mixing it with rejuvenators. The cracking resistance of these mixes was evaluated using the Texas Overlay Test which simulates reflection cracking from thermal movements. The change in the mix’s crack resistance over time was evaluated using the Accelerated Pavement Weathering System, which simulates the effects of rain, sun, and temperature changes. These methods specifically simulate aging effects in the field not included in Superpave performance grading.

Results of rejuvenators varied considerably. Some delayed the effects of aging, while some accelerated it. Correct rejuvenation procedures were critical. In some cases, rejuvenators improved the performance of asphalt binder over a simulated 7-10 year period. These studies demonstrated the need for further long-term testing of rejuvenation products and procedures.

Project Benefits

The cost benefits of recycling asphalt and the additional benefits of recycling in-place can be ensured by a thorough understanding of the long-term behavior and use of binder rejuvenators.

For more information, please see dot.state.fl.us/research-center