# Field Aging and Oil Modification Study

## Research Objectives

- Develop standard long-term and short-term oven-aging test protocols
- Determine the effect of binder formulation on the cracking performance of mixtures
- Verify the effect of low-temperature additives on the aging of mixtures

## Research Benefits

- Recommended standards for improving oven-aging test accuracy and consistency
- Identified effects of softening oils and polymers on pavement-performance characteristics

**Principal Investigator**

**Hussain Bahia**
University of Wisconsin - Madison
bahia@engr.wisc.edu

**Project Manager**

**Stacy Glidden**
Payne & Dolan, Inc.
sglidden@crmanagement.com

## Background

Asphalt pavements suffer physical and mechanical deterioration over time as asphalt binders age. The rate at which a binder ages depends on its composition and interactions with other mix design components, such as aggregate gradation, surface area and voids content. The ability to accurately estimate binder aging and the rate at which it causes pavement deterioration is critical to developing cost-effective construction and maintenance strategies.

The objectives of this research were to develop oven-aging protocols for simulating short-term and long-term aging in a laboratory and to determine the effects of binder formulation on the cracking performance of mixtures.

## Methodology

Eight field test strips were compared to laboratory-replicated plant-produced mixtures. Samples were submitted to short-term oven aging (STOA) and long-term oven aging (LTOA). STOA was performed for four hours, LTOA was performed for six and 14 hours, at 135°C in containers with a standard size.

Temperature monitoring of covered and uncovered samples

In addition to the field study, researchers investigated the effects of asphalt binder softening oil and polymer modification on short- and long-term aging. Eight combinations of softening oils and polymers were used to prepare a PG58-34 binder. These mixtures were tested for volumetric properties and resistance to fatigue damage using Semi-Circular Bending-Illinois Flexibility Index Test (SCB-IFIT) at different aging levels.

The research team also evaluated the effects of sample size, boxing, oven type and variations in preheating and aging temperatures on test results.

*"Simulating the effects of aging on flexible pavement can help Wisconsin industry professionals predict performance. This study verified a laboratory aging protocol that will be used on future WisDOT paving projects."*
*– Erik Lyngdal, WisDOT*

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## Results

Results of the eight mixtures collected from the field showed that the STOA procedure accurately simulates the aging of mixtures during production in the field. Unboxing samples had significant effects on reheating time, not accounting for exposure to air moving within the oven. The LTOA protocol increased theoretical maximum specific gravity (Gmm) values, which confirms the effect of more absorption during the long-term aging of the mixtures.

Mixtures produced with blends of softening oils and polymers resulted in varying recovery percentages and non-recoverable creep compliance values, characteristics which could affect pavement performance. Flexibility Index (FI) values measured for these mixtures were highly sensitive to mixture aging, and the results show that mixtures with Recycled Engine Oil Bottoms (REOB) have the lowest FI values at all aging levels, but also have aging rates lower than mixtures with no oils or with bio-oils. The use of bio-oil significantly improved FI values at different aging levels, but also increased the aging rate of FI. The mixtures with no oils showed similar FI results and aging rates to mixtures with bio-oils.

Multiple Stress Creep Recovery and Linear Amplitude Sweep test results of binders extracted and recovered from plant-produced mixtures differ significantly from results collected for the binders received from the field. This may be caused by solvents used in extraction as well as aggregate interactions.

## Recommendations for implementation

The collective results of field sampling and oil modification tests confirm that LTOA of 14 hours is too severe for asphalt mixtures and not suitable for distinguishing between mixtures. The research team recommends the standard duration for LTOA of asphalt mixtures be set at six hours. Current STOA procedures are acceptable and do not require modification.

The influence of temperature variations during oven aging procedure should be minimized by standardizing mixture sampling, handling and aging procedures. Solvent used in extraction and recovery should be standardized to avoid disputes between suppliers and transportation agencies.

This brief summarizes Project 0092-17-04,
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