# DEVELOPMENT AND EVALUATION OF TEST METHODS TO EVALUATE WATER DAMAGE AND EFFECTIVENESS OF ANTI-STRIPPING AGENTS

## PROBLEM STATEMENT

Fine aggregate for asphalt mixtures often contain crystalline quartz particles that will not retain asphalt coatings and that will strip readily in the presence of water. This condition can reduce the durability of asphalt pavements resulting in raveling and/or cracking. Liquid anti-strip agents are often added to asphalt cements to promote adhesion and prevent stripping of the asphalt film from the aggregate. Lime treatment of aggregate prior to production of hot-mix asphalt is considered as an alternative to liquid anti-stripping agents in the prevention of stripping. Although the term "stripping" is generally used to define any form of water damage, the mechanisms that promote distress in asphalt pavements are various. None of the mechanisms proposed in the literature have been proven by connecting theoretical considerations to observed field behavior. Rather, these mechanisms are hypothesized based on field observation and limited basic laboratory characterization.

There are currently no performance-based methods available for evaluating moisture damage in mixtures that have been widely accepted by state agencies. The methods used to evaluate moisture susceptibility of mixtures tend to be either qualitative techniques, e.g., the boil test, or crude quantitative techniques that may neither include the appropriate mechanism of moisture damage nor the appropriate framework for analyzing the effects of moisture damage on mixtures.

There is a clear need to identify the most likely mechanism(s) of moisture damage in pavements. The identification of the key mechanism(s) of moisture damage will allow for the development of an appropriate laboratory-based conditioning system, along with the development of a robust performance-based framework for the evaluation of mixture moisture damage susceptibility. These new conditioning and evaluation methods should be capable of quantifying the effectiveness of liquid anti-stripping agents, lime, and/or other additives considered to enhance the adhesion of asphalt binders to aggregate surfaces.

## OBJECTIVES

The primary objective of the proposed research is to define the effect that interacting mixture and mineralogical properties have on moisture damage in mixtures. Specific objectives include the following:

- Identification of key mechanism(s) of moisture damage in pavements.
- Development of test equipment and procedures for evaluating moisture damage in mixtures.
- Determination of permeability limits to minimize moisture damage, as well as aggregate mineralogical properties that affect moisture damage.
- Development of a new conditioning, which is based on the most likely mechanism(s) of water damage.

- Development of a new laboratory-based protocol for the evaluation of moisture damage in mixtures. This new evaluation protocol should be based on a theoretical framework that defines the interactive damage effects of variables.

## FINDINGS AND CONCLUSIONS

Researchers developed test methods and criteria needed to relate mixture characteristics with the potential severity of moisture damage. A fundamental theoretical framework for the evaluation of moisture damage in mixtures was developed, along with associated specification parameters. A new moisture conditioning procedure using cyclic pore pressures was developed based on fundamental considerations of key moisture damage mechanisms present in pavements. The new condition and evaluation methods were tested on mixtures of varying aggregate types and gradations and were shown to result in consistent evaluation of the moisture damage potential of mixtures. These test methods were also shown to be capable of evaluating the effectiveness of anti-stripping agents, considered to enhance the adhesion of asphalt binders to aggregate surfaces.

The following key conclusions may be derived from the findings in this research project:

- The Hot Mix Asphalt Fracture Mechanics model developed at the University of Florida provides a theoretical framework for the evaluation of water damage in asphalt mixtures. All necessary input parameters can be obtained from routine Superpave indirect tensile strength IDT testing.
- Moisture conditioning of mixtures can be effectively performed with cyclic pore pressures in the range of 5 – 15 psi at a conditioning temperature of 40 °C.
- In lieu of the Superpave IDT test and the Florida cracking model, the new cyclic pore pressure conditioning system should be used for conditioning mixtures irrespective of the performance test used. The results presented show clearly that pore pressures may play an important role in the physics of moisture damage in mixtures.

## BENEFITS

There are two major types of damage mechanisms daily at work on pavements. The first is load induced damage to pavements, including fatigue cracking and rutting. The second is damage due to environmental factors, e.g., moisture. The damage of asphalt pavements due to moisture can significantly increase the maintenance costs of a pavement and, ultimately, reduce the life of the pavement. This project provides a new moisture conditioning and testing system for evaluating the susceptibility of Florida asphalt mixtures to moisture damage. The evaluation of moisture damage using the new conditioning and testing system is based on a theoretical framework, which allows for the analysis of the effects anti-stripping agents in mixtures, as well as the identification of the influence of mixture characteristics on the severity of moisture damage.

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