EVALUATION OF LAB TESTING SYSTEMS FOR ASPHALT MIXTURE DESIGN AND EVALUATION

PROBLEM STATEMENT

Instability rutting is a major distress mode in hot mix asphalt (HMA) pavements that occurs when the structural properties of the compacted mix cannot resist near surface critical stress conditions caused by traffic loads. This mode of failure reduces serviceability and creates the hazard of hydroplaning because of accumulated water in the wheel-path ruts. Rehabilitation of this type of rutting usually involves asphalt concrete (AC) overlay or mill and replace. Currently, there is no reliable approach for instability-rutting assessment of HMA.

OBJECTIVES

The main objective of this study is to identify the loading, environmental, and construction (density) factors that are critical/essential in defining the mechanism of rutting. The identification of these conditions will logically lead to the development of a reliable physical model. The current version of the Asphalt Pavement Analyzer (APA) was selected for the experimental program; necessary modifications will be made to incorporate new testing procedures, which more realistically simulate traffic and environmental conditions existing on pavements.

FINDINGS AND CONCLUSIONS

Researchers found that critical stress states associated with instability rutting involve shear in the presence of minimal confinement or tension, which is a stress state that cannot be induced by existing laboratory tests in their present form. A modified version of the asphalt pavement analyzer (APA) was developed with a loading device that induces stress states similar to those found under radial truck tires. Also, a modified measurement and interpretation method far more sensitive to the presence of instability rutting was developed for the APA. For purposes of quality control, a test method involving measurements obtained during instability induced using the gyratory compactor was developed.

The primary accomplishments of this work include the following:

- Identification of potential stress states that might be conducive to impending instability based on measured surface contact stresses under radial truck tires. Current mixture design and evaluation procedures do not properly account for these critical stress states—high near-surface shear stress with reduced confinement or tension.
- Determination that existing equipment, testing, and interpretation procedures may not capture these stress states and their effects.
- Identification of test methods that would provide measurements of instability rutting resistance based on stress states identified above.
- Identification of three approaches to evaluate mixtures under conditions of impending instability:
    1. Evaluation during the compaction process using the Servopac gyratory compactor, suitable for mix design and QC/QA

2. Mixture evaluation using a laboratory physical model with modified APA
3. Hollow Cylinder as a research tool for evaluation of the impending instability concept

- Specific procedures were developed and evaluated on a range of mixtures of known relative performance and verified the ability of the devices to distinguish between mixtures with varying performance. Specific parameters and criteria suitable for mixture design and specification purposes were determined.

The following conclusions were drawn from this study:

- Existing systems, even the dynamic modulus approach proposed as part of the new AASHTO pavement design guide, are unable to screen mixtures susceptible to instability rutting.
- Keys to developing a relevant test are (1) to capture the critical stress states associated with instability (APA), and (2) to measure the mixture's strength at impending instability (Servopac).
- Evaluation using the existing APA device could immediately improved by obtaining a detailed profile of the rutted surface, but greater 'reliability' can be achieved by introducing a modified loading system that more closely represents tire stresses.
- The implementation of the system on a large scale would require the ability to easily apply two angles of gyration and to measure the gyratory shear strength during the compaction process (Servopac or with modification to existing gyratory compactors widely available at this time).
- The new data-measurement method should be implemented immediately with the existing APA equipment.
- Whenever possible, specimens should be tested at both 7%AV and 4%AV when evaluating the mixture's ability to resist instability with the APA.
- At this point, there is not enough evidence to support a move to higher temperature testing for a single-condition test (specimen tested at one temperature).

BENEFITS

There exists a need to assess a mixture's sensitivity to rutting with a simple test. This research resulted in the development of two simple test procedures for determining that sensitivity. The first employs the modified asphalt pavement analyzer, and the second uses properties measured with the ServoPac gyratory compactor. FDOT has (1) begun using the modified asphalt pavement analyzer in all research work and (2) ordered a ServoPac gyratory compactor. These two devices will improve FDOT's ability to determine a mixture's sensitivity to rutting, and advances in combating can potentially provide both safety and economic benefits.

This research project was conducted by Reynaldo Roque, Ph.D., P.E., and Bjorn Birgisson, Ph.D., P.E., of the University of Florida. For more information, contact Bruce Dietrich, Project Manager, at (850) 414-4371, bruce.dietrich@dot.state.fl.us