I. Research Project Title: Durable Recycled Superpave Mixes in Kansas

II. Problem Statement: The Kansas Department of Transportation (KDOT) has been using Superpave hot-mix asphalt (HMA) mixtures since 1997. The principal focus of Superpave mix design had been rutting resistance. This is accomplished though selection of angular materials with rough texture and an optimum asphalt content that is somewhat lower than that used to be obtained in the Marshall mix design method. Superpave has largely addressed the issue of rutting on KDOT highway network. However, a recent K-TRAN study (KSU-09-07) has shown that the asphalt producers are producing mixtures with lower asphalt contents than those were in the job-mix formula. This "drier" mix has been found responsible for some early cracking. This trend has been found to be more prevalent among the mixtures with recycled asphalt pavement (RAP). In the recent past, KDOT has taken some steps to bring more binder into the asphalt mixtures that are being produced. These include designing mixtures at 3.5% air voids @ N_{design}, lowering design number of gyrations, etc. The contractors have introduced dust instead of extra binder to achieve lower air voids and some mixtures designed with lower N_{design} have also failed the Hamburg wheel and KT-56 tests. Thus nothing has seemed to resolve this issue of "dry" mixes and associated cracking issue. Kansas State University has been researching the Semi-circular Bending (SCB) test as a tool to identify the crack propensity of the Superpave mixtures. However, some other tools need to be investigated to identify crack-susceptible mixtures in Kansas. Two tools that had been identified are: (1) Texas Overlay Tester, and (2) Viscoelastic Continuum Damage (VECD) Fatigue Test.

The Texas overlay tester was developed at the Texas Transportation Institute (TTI) to verify reflection cracking potential of hot-mix asphalt (HMA) overlays. Figure 1 shows a schematic of the test. The test is done at 77°F with a special-shaped sample sawn out of a 6-inch diameter Superpave Gyratory Compactor-compacted plug that had been compacted at 7% air voids. The test simulates thermal cracking of HMA mixtures over cracks and joints. The sample is subjected to a crack/joint opening displacement of 0.025 inches in a cyclical manner up to a maximum of three hours. The test output is the number of cycles to failure. TxDOT has successfully implemented this test for the virgin Superpave mixtures and TTI is currently researching it for Superpave mixtures with high volume RAP.

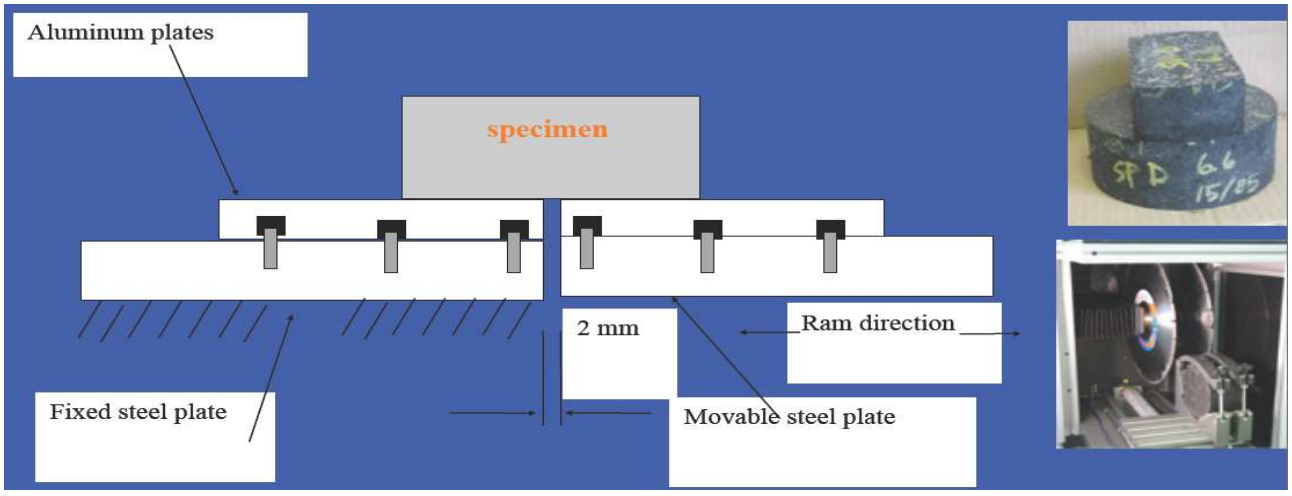

Figure 1 Schematic of the Texas Overlay Tester Test.

Viscoelastic continuum damage (VECD) fatigue testing in the direct tension mode is a promising alternative to flexural fatigue testing. The test can be executed within the framework of the Asphalt Mixture Performance Tester (AMPT) that can characterize fatigue performance quickly using cyclic test data. A simplified viscoelastic continuum damage model developed at NCSU is used to analyze the data. This simplified VECD model can predict fatigue tests fairly accurately under various temperature conditions and strain levels.

III. Research Proposed: The primary objective of this project is to investigate cracking resistance of Superpave Recycled (SR) mixtures using two newly acquired tools at KSU. The following tasks need to be accomplished to fulfill objectives of this study (Kansas State University will be responsible for accomplishing all tasks).

Task 1: Compact mixture samples for three mixture types (SR-19A, SR-12.5A & SR-9.5A).

Task 2: Conduct Texas Overlay and NCSU Direct Tension Fatigue tests for long-term cracking performance prediction of the SR mixes in Task 1.

Task 3: Conduct moisture susceptibility tests on the mixtures in Task 1.

Task 4: Investigate whether in SR mixtures, aged binders in RAP has co-mingled with the virgin binder using Transmission Electron Microscopy (TEM) and correlate this with the results obtained in Tasks 2 and 3.

Task 5: Develop recommendations for implementation of new specifications for crack-resistant SR mixtures.

Task 6: Write the final report.

IV. Estimate of Funding and Research Period:

Estimated project duration: 18 months (start: June 2012)
Estimated budget: $68,000

V. Urgency and Payoff Potential: The research should have a high priority. With higher binder prices in a lean economic environment, extending lives of HMA overlays and pavement should save KDOT millions of dollars. The research results will also help KDOT to do less maintenance and rehabilitation thereby saving a substantial amount of money.

VI. Implementation Strategy: Implementation of this study is expected to be carried out by the Bureau of Materials & Research.

VII. Project Personnel: This project will be carried out under the direction of **Mustaque Hossain**, Principal Investigator in close cooperation with the Bureau of Materials & Research. **Mr. Lon Ingram** will work as a consultant to this project. One graduate students and one undergraduate student in civil engineering will also work on this project.

Mustaque Hossain is a professor of Civil Engineering at Kansas State University. His areas of expertise are pavement materials, pavement design, performance, management and non-destructive evaluation using Falling Weight Deflectometer (FWD). **Lon Ingram** retired as the Acting Director of the Division of Operation of KDOT. He has many years of experience with Superpave HMA and specifications in Kansas.

VIII. Submission Information:

November 29, 2012
Mustaque Hossain, Ph.D., P.E.
Munger Professor
Department of Civil Engineering
2118 Fiedler Hall
Kansas State University
Manhattan, KS 66506.
Tel: (785) 532-1576. Fax: (785) 532-7717.
E-mail: mustak@ksu.edu