I. Research Project Title: Durable Superpave (SM and SR) Mixes in Kansas

II. Problem Statement: The Kansas Department of Transportation (KDOT) is increasingly using Superpave hot-mix asphalt (HMA) mixtures some of which are somewhat susceptible to moisture damage. The moisture susceptibility is currently evaluated by the Kansas standard test method KT-56. KT-56 is similar to AASHTO T 283 procedure adopted during the Superpave research. It has minor modifications in the conditioning procedure. This test is time consuming at best – takes four days to run. According to current KDOT specifications for Superpave mixes, it takes two failing tests to shut down the production. This potentially can result in eight days of Superpave mixture production that could be susceptible to stripping. This is to be noted that all of these mixtures satisfied the KT-56 test criteria at the design asphalt content. Another criticism of the current test procedure is the use of anti-stripping agent to rectify the low Tensile Strength Ratio (TSR) or to make the mixture "meet" the minimum TSR requirements. Usually, instead of increasing the conditioned strength, the current test procedure lowers the tensile strength of the anti-stripping treated unconditioned specimen. A recent K-TRAN study (KSU-09-7) 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 nonconforming moisture-susceptible mixes and sometimes, 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. Kansas State University, as part of K-TRAN study KSU-09-07, has incorporated voids in mineral aggregates (VMA) in an equation for expected life so that higher effective asphalt content can be assessed:

$$EL = e^{-5.450+0.287PWL_{VA}^{0.5}+0.219PWL_{DEN}^{0.5}+0.178PWL_{AC}^{0.5}+0.138PWL_{VMA}^{0.5}}$$

Where, VA= air voids, DEN= in-place density, AC= asphalt content, and VMA= voids in mineral aggregate. However, verification is needed whether this would result in mixtures with higher expected life (better moisture susceptibility and cracking resistance).

III. Research Proposed: The primary objective of this project is to investigate moisture resistance and cracking resistance of Superpave SM and SR mixtures with varying effective asphalt content. 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: Evaluate the recommendations of the KSU-09-07 study and compact mixture samples with varying air voids (as allowable by current KDOT specifications) and varying VMA (or effective asphalt content) for four mixture types (SR-19A, SR-12.5A, SM-9.5A, and SM-9.5T) (*part of this task is being accomplished now in KSU-09-07*).

Task 2: Conduct Hamburg Wheel and KT-56 tests for evaluating moisture susceptibility of mixtures designed in Task 1.

Task 3: Conduct crack propagation tests on the selected HMA specimens prepared with the mixture designs developed in Task 1.

Task 4: Compute the film thicknesses of the mixtures designed in Task 1.

Task 5: Correlate the film thickness and/or VMA to the results obtained in Tasks 2 and 3. Identify the absolute minimum value of the optimum asphalt content.

Task 6: Develop recommendations for implementation of the new specifications based on VMA and/or film thickness.

Task 7: Write the final report.

IV. Estimate of Funding and Research Period:

Estimated project duration: 18 months (start: June 2011)
Estimated budget: $38,000

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 achieving its sustainability goals.

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:
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