KSU-14-05

I. Research Project Title: Friction Management on KDOT Highways

II. Problem Statement: For safer highways, good pavement condition is an essential prerequisite. An appropriate amount of pavement friction is critical for safer driving condition especially for preventing roadway departure crashes that account for a majority of roadway fatalities. Many of these occur on wet pavements. Several nationwide studies have demonstrated that 15 to 18 percent of the traffic crashes occur on wet pavements. The Federal Highway Administration (FHWA) estimates that 70% of wet pavement crashes can be prevented or minimized by improving pavement friction. In 2009, 14,000 highway fatalities occurred due to poor pavement conditions. Additionally, more than 2.4 million people were injured in vehicle crashes. Figure 1 shows the relationship between wet crashed and pavement surface friction.

Thus "High Friction Surface" has a become priority area of FHWA's "Everyday Counts (EDC2" initiative. A new technical advisory issued by FHWA on June 17, 2010, Pavement Friction Management (T 5040.38), provides guidance to State and local highway agencies on managing pavement surface friction on roadways. The new technical advisory covers topics such as: test equipment; the identification and classification of roadway locations with elevated crash rates; how to prioritize projects for improving pavement friction; the appropriate frequency and extent of friction testing on a highway network; and how to determine a pavement friction management program's effectiveness. The "High Friction Surface" locations have been identified as the locations where drivers may brake excessively.

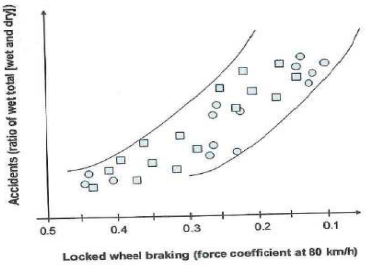

Figure 1 Relationship between wet crashes and pavement surface friction (Schulze et al., TRR 623, 1976)

When going around curves, down hills or steep grades, or when approaching an intersection; the road surface can become prematurely polished, reducing the pavement friction and allowing vehicles to skid when the drivers brake. Drivers may also be speeding or distracted, contributing to the high-crash rates in critical locations. Wet road surfaces can also reduce pavement friction and cause skidding or hydroplaning. High friction surface (HFS) treatment is an emerging technology that dramatically reduces crashes and the related injuries and fatalities. Several high friction surface treatment products are available now and other, more cost-effective products are being developed. However, the long-term efficacy of these products is not known. Yet better if the conventional thin surface treatments or surfacing layer hot-mix asphalt or concrete texture can be modified to meet the requirements. However, continuous skid testing is needed to monitor such surfaces. In KDOT, such testing is done with the ASTM skid trailer following ASTM E-274 protocol. The test is slow and the test process needs expensive traffic control. Thus a faster way of testing will be definitely helpful in implementing better friction management on Kansas highways.

III. Research Proposed: The objectives of this project are (i) to investigate friction number progression on various thin surface treatments as well other surfacing layer (including typical concrete textures) used by KDOT and (ii) to develop a state-of-art three dimensional (3-D), laser-based pavement texture measurement method for KDOT that can either complement or replace traditional testing using the ASTM skid trailer. Currently, most profilers measure texture using a single-point laser resulting in a two-dimensional (2-D) texture profile with distance along the pavement surface as one dimension and the texture elevation as the second. Pavement texture, especially that of concrete is anisotropic. That means the texture varies depending on the measurement direction, longitudinal or transverse. Thus a 2-D profile fails to completely describe characteristics of the pavement texture. Recent developments in 3-D laser scanning technology have offered the possibility to measure pavement texture more precisely (texture profile with distance along the pavement surface as one dimension, distance along the laser line as the second dimension, and texture elevation as the third dimension).

The following tasks need to be accomplished to fulfill objectives of this study (unless mentioned Kansas State University will be responsible for accomplishing all tasks).

Task 1: Select at least 3 to 5 types of pavements each in a wide variety of functional classes of highways in Kansas and study the progression of friction number on these highways as a function of thin surface treatment type, aggregate characteristics in hot mix or texture types on concrete pavements.

Task 2: Conduct 3-D laser scanning measurements on projects (10 miles total maximum) including all HFS projects in Kansas. KDOT will conduct concurrent ASTM skid trailer tests on these sections.

Task 3: Correlate measurements obtained in Task 2 and develop recommendations for 3-D laser-based texture measurements in Kansas.

Task 4: Develop specifications for a standard (KT) test for 3-D laser scanning measurements for texture.

Task 5: Write the final report.

IV. Estimate of Funding and Research Period:
Estimated project duration: 24 months (start: June 2012)
Estimated budget: $78,000 (includes $22,000 cost for 3-D laser survey and data processing on 10 miles of Kansas highways using Trimble MX8 Mobile Spatial Imaging System owned by Seiler Instruments, St. Louis, Missouri. http://www.seilerinst.com/)

V. Urgency and Payoff Potential: The research should have a high priority. KDOT is fully supportive of EDC2 initiative of FHWA. The project will enhance the safety on Kansas highways while easing the burden of traditional frication measurements.

VI. Implementation Strategy: Implementation of this study is expected to be carried out by the Bureau of Materials & Research. It is anticipated that pavement preservation as well as new surface policies related to friction for both asphalt and concrete surface will be developed.

VII. Project Personnel: This project will be carried out under the direction of **Mustaque Hossain**, Principal Investigator and **Ryan McGrath**, KSU staff in close cooperation with the Bureau of Materials & Research. One graduate student and one undergraduate student in civil engineering will also work on this project.

Mustaque Hossain, Ph.D., P.E. is the Munger 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).

Ryan McGrath, P.E. is a faculty instructor for Civil Engineering at Kansas State University and teaches courses in Elementary and Advanced Surveying. Ryan has been a certified Trimble Trainer for GPS and optical surveying since 2002, has a Masters degree in Water Resources Engineering and is a licensed professional engineer. For the past eight years, he has been an owner of a company focused on surveying and geospatial positioning systems.

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