Center for Transportation Research and Education

Impact of Pavement Friction on Traffic Safety, Phase I: Pavement Friction Evaluation

tech transfer summary

The use of continuous friction measurement equipment to assess pavement friction has the potential to improve network-level pavement friction measurement, analysis, and treatment.

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RESEARCH PROJECT TITLE
Impact of Pavement Friction on Traffic Safety, Phase I: Pavement Friction Evaluation

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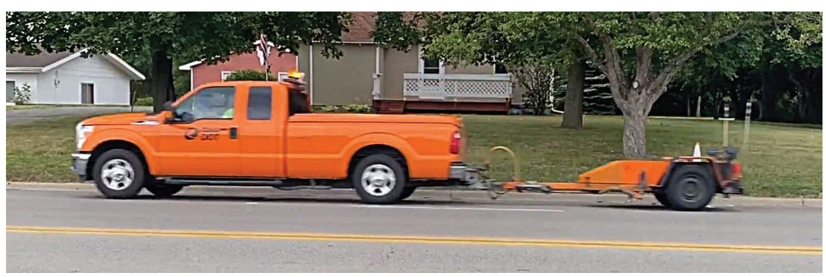
Objectives

- Perform an initial evaluation of continuous friction measurement equipment (CFME) technologies relative to the locked-wheel skid tester (LWST) currently available at the Iowa Department of Transportation (DOT).
- Provide guidance and recommendations regarding friction evaluation on different components of the network, including curves and low-speed segments.

Background

Pavement friction significantly contributes to roadway safety by providing the grip required for safe travel. The Iowa DOT has long recognized the importance of evaluating pavement skid resistance and its impact on traffic safety.

Several devices have been developed to measure pavement friction. The Iowa DOT currently uses the LWST, which is well accepted globally. Because of the LWST's known limitations, however, various CFME devices have been proposed, including the widely accepted sideway-force coefficient routine investigation machine (SCRIM).



Locked-wheel friction tester

SCRIM

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Problem Statement

Despite the widespread use of the LWST, measurements are only valid at speeds between 40 and 60 mph, and the method is limited when applied to curves and short, low-speed roadway segments such as ramps and intersections.

A broader issue in friction measurement is the repeatability and reliability of measurements under different operational conditions, with temperature, pavement wetting, and test speed affecting the correlation between different devices. This is especially a concern at the network level, where different levels of tolerance might be used to determine acceptable measures.

Additionally, there is a lack of consistent procedures for using pavement friction data to assess safety performance, which hinders the establishment of a mature friction management program.

Research Description

The SCRIM was selected as a candidate CFME technology, and the device's suitability for pavement friction evaluation was assessed relative to the LWST currently available at the Iowa DOT.

The SCRIM and LWST were used to measure pavement friction on three asphalt and three concrete pavement test segments at different speeds and using smooth and ribbed tires. Tests were repeated on different days to determine performance in different operational conditions. The SCRIM yielded friction measurements in terms of SCRIM reading (SR) values, and the LWST yielded skid number (SN) values.

Additionally, a British pendulum tester (BPT) was also used at the sites to capture low-speed friction characteristics, reported as British pendulum number (BPN) values.

A dynamic friction tester (DFT) and stationary laser texture scanner (LTS) were used to verify the correlation between the CFME and LWST and to investigate the impact of pavement texture on dry and wet skid resistance. The DFT yielded coefficient of friction (COF) values, and pavement texture was measured in terms of mean profile depth (MPD) values by the LTS and by a macrotexture profiler on the SCRIM.

Dynamic friction tester

Stationary laser texture scanner

British pendulum tester

Key Findings

- The SCRIM acquired friction measurements at a high rate and under varying conditions and road geometries, which can be advantageous for network-level data collection.
- The texture measurements (MPD values) produced by the SCRIM varied when acquired at different speeds on the same surface.
- The LWST measurements were highly repeatable across tangent segments.
- The BPN values showed a statistically significant correlation with the LTS MPD values and a significant but sparser correlation with the SCRIM MPD values acquired at 40 mph.
- The COF values acquired at 30 and 40 mph showed a statistically significant correlation with the LTS MPD values and a significant but sparser correlation with the SCRIM MPD values at 40 mph.
- The peak SN values showed a greater spread than the average SN values when correlated to both the LTS MPD values and the SCRIM MPD values at 40 mph. This may indicate that the peak SN can be more sensitive to the MPD values acquired in this study.
- A significant and strong correlation was found between the SCRIM and BPN values, indicating that the SCRIM can capture low-speed friction.
- A significant and strong correlation was found between the SCRIM and LWST measurements acquired at 30 and 40 mph using the smooth and ribbed tires. This indicates that the SCRIM measurements can capture fully locked friction values.
- The SCRIM measurements had three sources of variability: measurement uncertainty, short-range spatial variability, and long-range spatial variability. These should be investigated further to quantify their magnitudes.
- Understanding the sources of variability will be critical for using SCRIM data in safety evaluations because the current safety analysis method assumes deterministic and consistent explanatory variables across a given analysis segment. This variability can be understood with more detailed and robust statistical modeling.

Implementation Readiness and Benefits

The results of this study can contribute to improved safety on Iowa's roadway network in terms of the acquisition, analysis, and interpretation of friction measurements using CFME and LWST. In addition, the results can contribute to the development of a mature pavement friction management (PFM) program for the state of Iowa.

The SCRIM presents a promising tool for acquiring friction measurements at the network level. However, further investigation is needed to better understand the measuring mechanism and develop a robust procedure to use the data in safety analyses, especially given the spatial nature of the data.

The conclusions of this study are based on a limited number of test surfaces and should not be extrapolated to describe other surfaces and testing conditions. The developed correlations are empirical in nature and do not suggest a fundamental model describing the behavior of the tested devices on pavement surfaces.

Reference

Hall, J., K. L. Smith, L. Titus-Glover, J. C. Wambold, T. J. Yager, and Z. Rado. 2009. *NCHRP Web-Only Document 108: Guide for Pavement Friction*. National Cooperative Highway Research Program, Washington, DC.