CPFM

CONTINUOUS PAVEMENT FRICTION MEASUREMENT

U.S. Department of Transportation
Federal Highway Administration

Enhancing Safety through Continuous Pavement Friction Measurement

Pavement friction can save lives in your state.

The friction provided by a roadway surface affects how vehicles interact with the roadway. Measuring, monitoring, and maintaining pavement friction – especially at locations where vehicles are frequently turning, slowing, and stopping – can prevent many roadway departure and intersection related crashes, resulting in fewer serious injuries and fatalities. Best practices and proven technology in use for several decades in other countries present an exciting opportunity for the U.S. road safety community.

Roadway departure and intersection crashes account for 75 percent of traffic fatalities across the United States.
Source: Fatality Analysis Reporting System

Experience with High Friction Surface Treatment (HFST) in the U.S. has revealed that friction is an important safety performance parameter.
Source: FHWA HFST Website

Why Continuous Pavement Friction Measurement is Better

To characterize the safety performance of a specific horizontal curve or intersection, it would not make sense to report it as an average of the crashes observed (or expected) at locations several thousand feet or more away. And yet, this is usually how friction is reported for most locations. Furthermore, pavement friction is not currently a parameter used in crash-based safety modeling in the same way as other roadway characteristics, such as number and width of travel lanes; presence, width, and type of shoulder; degree of curvature, etc. For these reasons, Continuous Pavement Friction Measurement (CPFM) offers a two-fold opportunity for enhancing road safety.

Today, it is standard procedure for network level friction in the United States to be measured using a sample-based, discrete (i.e., not continuous) measurement called the Locked-Wheel Skid Trailer (LWST) test, in which a measurement is taken over a 60-foot distance by locking a wheel on a tow-behind trailer. This method is highly reliable and does provide useful point information. However, reported values reflect averages across long distances through changing road conditions, and do not effectively differentiate the changes in friction along the route corridor. Furthermore, LWST equipment is difficult to utilize in critical high friction demand locations, such as horizontal curves or intersections, which tend to experience greater tire scrubbing and polishing that lead to loss of pavement friction. For this reason, surrogate safety metrics, such as the number or ratio of wet weather crashes, are used to screen for locations that may respond to friction improvement. Unfortunately, opportunities to improve friction and enhance safety at locations below the wet weather crash threshold may be overlooked.

Fortunately, CPFM is an established and proven approach that has been used for several decades in other countries that could revolutionize the role of pavement friction in framing our understanding and management of the safety performance of our Nation's roads. CPFM equipment is able to measure pavement friction continuously, through tangents, curves and intersections, at speeds as high as 50MPH. This data can then be post-processed at user-defined increments as small as 1-foot. This approach is commonly used by road authorities in many European countries, Australia, and New Zealand, and even by airport authorities in the U.S. to measure friction on runways. Figure 1 presents CPFM data acquired at one U.S. location that was part of a recent FHWA pilot project, where it was found that pavement friction varied throughout the curve; it was considerably less through the curve and intersection area than on the tangent approaches. It would have been very difficult, if not impossible, to measure pavement friction at this resolution in these locations using LWST equipment.

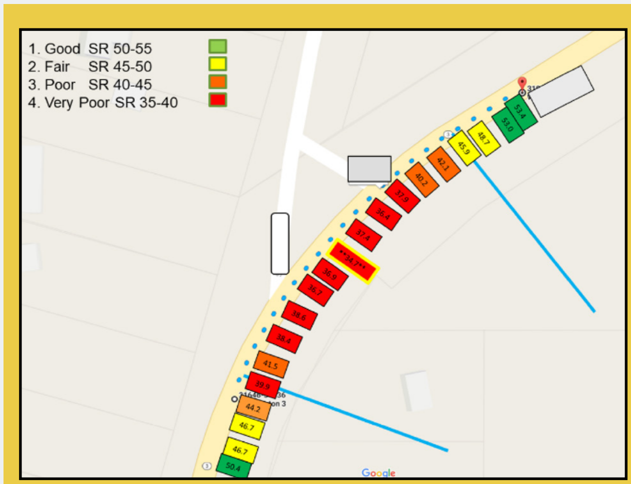

Figure 1: Visualization of CFM data through a curve with an intersection (presented in 30-foot averaged intervals).

Managing Friction for Safety

More than 50 years ago, **National Cooperative Highway Research Program (NCHRP) Report 37** stated that "the lowest friction levels are found on high-speed roads, curves and approaches to intersections; in short, in locations at which high friction values are needed most." Essentially, this research recognized that a clear friction "supply and demand" relationship exists, and is a factor in determining the safety performance of a road. While aggregate testing and specifications, pavement mix designs, and rubber tire manufacturing have evolved in the years since that report was published, the basic friction supply and demand relationship is still relevant. Research conducted in other countries has consistently found a relationship between pavement friction levels and safety, and programs that subsequently established maintenance values for friction that are grounded in safety performance rely upon CPFM for monitoring. Furthermore, pavement friction treatments, including HFST, can be better targeted for installations that are more efficient and effective when using CPFM data.

In 2015, the Federal Highway Administration (FHWA) began collaborating with four State departments of transportation on a pilot study to demonstrate CPFM equipment technologies and compare results to each State's LWST equipment. The study confirmed that CPFM data, combined with crash data, provides significant insight regarding whether friction improvements reduce crashes. Based on the pilot results, FHWA encourages the use of CPFM to provide comprehensive pavement friction data, combined with existing safety data and analysis, to create an overall pavement friction management program anchored in safety.

CPFM: An International Best Practice

United Kingdom

*Since the 1980s, pavement friction of the English Strategic Road Network has been managed through a requirement to provide specific levels of skid resistance and texture depth, using CPFM as the basis for monitoring. A **1991 paper** by Rogers and Gargett referenced a National Skidding Resistance Survey report that estimated this approach would result in 6 percent fewer casualties per year on trunk roads, and a benefit-cost ratio of 5.5-to-1. In 2016, the Transport Research Laboratory published **PPR 806**, which further reviewed the relationship between crash risk and skid resistance. The study found that for curves and steep grades, roadways with higher skid resistance have a lower risk of collisions, even in wet conditions, and recommended that enhanced skid resistance treatments be prioritized for those sites.*

New Zealand

*Throughout the 1990s, the New Zealand Transport Agency (NZTA) sponsored road surface friction research and development and established their first skid resistance policy and specification in 1997, which required CPFM equipment be used for network skid resistance measurement. Consistent with UK experience, the 1998 Transfund New Zealand **Research Report 141** documented a statistically significant relationship between crashes and skid resistance at junctions, curves and steep grades, and indicated that wet road crashes could be reduced 45-61% at these locations with targeted enhanced skid resistance. Finally, a **2011 paper** by Whitehead, et al, reviewed 11 years of experience with the NZTA policy and found the benefit-cost ratio ranged between 13:1 and 35:1.*

Including pavement friction as a parameter in road safety performance modeling, establishing friction performance thresholds based on context, and proactively and systemically managing friction can help your agency achieve its road safety goals to save lives and prevent serious injuries.

For more information:

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