Continuous Pavement Friction Measurement

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Today’s Presenter

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Outline

- What are Pavement Friction Characteristics?
- Continuous Pavement Friction Measurement
  - Case study – Florida DOT HFST at Intersection
  - Arkansas Demonstration
- Wrap-Up

What are Pavement Friction Characteristics?
Friction Characteristics

- Friction: function of pavement surface macrotexture and microtexture.

- Pavement Friction Design Objective:
  - Design for end-of-life friction meeting road friction demand.
  - Different roads have different friction demand.

- Friction Demand: Friction needed to safely perform braking, steering, and acceleration maneuvers.

NCHRP Report 37 (1967)

- “...Because the intensity of the polishing process increases markedly with tread element slip, all other factors being equal, 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.”
What is Texture?

Microtexture
Macrotexture
Aggregate

Pavement Cross Section

Source: Center for Sustainable Transportation Infrastructure (CSTI)/ Virginia Tech Transportation Institute (VTTI).

23 CFR Part 626
Pavement Design Policy

§626.3 Policy.

Pavement shall be designed to accommodate current and predicted traffic needs in a safe, durable, and cost-effective manner.

67166 Federal Register / Vol. 61, No. 245 / Thursday, December 19, 1996 / Rules and Regulations
Friction Measurement

**Standard Friction Measurement**
- Locked-Wheel Skid Trailer (LWST) – 40 mph 60’ test sample.
- Sample Based Friction Testing.

**Continuous Friction Measurement**
- Rubber Tire test continuously measuring every foot of pavement (more sensitive to microtexture).
- Laser based texture measurement system measuring every foot of pavement (macrotexture).

Source: Center for Sustainable Transportation Infrastructure (CSTI)/ Virginia Tech Transportation Institute (VTTI).

Continuous Pavement Friction Measurement (CPFM)
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.

Best practices and proven technology in use for several decades in other countries.

Provides a comprehensive picture of how friction varies across pavement segments and can measure friction continuously at operating speeds.

Provides both network and project level data, and can analyze friction, crash, and roadway data better than traditional methods.

Data Collection:
• Lock Wheel skid trailer (LWST) — measuring about 60 feet every mile.
• Sideway-force Coefficient Routine Investigation Machine (SCRIM) — measures as small as 0.1 meter or 4 inches.

Enable more strategic installation of pavement related safety countermeasures such as HFST and others.
Continuous Pavement Friction Measurement
SCRIM Data Collection System

State Route A (MM 59.8)

Comparison CPFM and Texture Data Collection

Data source: FHWA
Friction Demand Categories
- Investigatory Friction Thresholds

- In support of NCHRP 37 statement on low available friction at high friction demand locations (curves/intersections).
  - Friction below a given threshold should result in an investigation to determine if a treatment is needed.
  - Friction threshold should not be the same for all road segments.
- Low friction data is not a reason to automatically invest in a treatment – it is one piece of information.
- Analysis segment length – 0.1 mile.

Improving Pavement Friction for Safety at a Florida Intersection

Florida DOT (FDOT) Case Study: SR580 (Hillsborough Ave.) at Central Ave.
2019 Road Safety Audit (RSA) identified pavement friction (lower than adjacent pavement sections) as potential contributor to higher-than-average crashes.

2015-2021: ~13.5 crashes/year

- ~86 percent dry crashes
- ~68 percent rear-end crashes

Hillsborough Ave. at Central Ave.

- Continuous pavement friction measurement (CPFM) identified lower pavement friction at intersection approach.

Image source: Map Data © 2022 Google. Annotations by FHWA.
Hillsborough Ave. at Central Ave.

- HFST installed in July 2020:
  - Application in accordance with FDOT Section 333 (HFST specification).
  - Mill and repave existing asphalt in poor condition.
  - HFST applied to left-turn lane and 2-3 thru lanes.
  - ~350 ft of intersection approach, through intersection, and ~150-ft beyond intersection.

  HFST installation using fully-automated method. (Source: FDOT)
  Finished HFST surface. (Source: FDOT)

Functional Performance

- **Pavement Friction:**
  - Pre-HFST: FN40R = 36.9 (based on SR30 = 44.1).
  - Post-HFST: FN40R = 78.5 (average of 2 lanes).

- **HFST Condition (8 months after installation):**
  - No major distresses or defects.
  - Very minor delamination in one area.
  - Small area of premature HFST loss where material was applied manually.

  Premature HFST loss within an irregular area where manual installation was necessary. (Source: FDOT)
Safety Performance

Analysis of Video Footage for Change in Drivers’ Behavior

Overall, 31-percent reduction in crosswalk incursions at 9 months after HFST application.

Results from analysis of stopping behavior before and after HFST application. (Source: CUTR)

** significant at a 95% confidence level
* significant at a 90% confidence level

(Source: FDOT)

Arkansas Demonstration
Arkansas CPFM Demo

- US 65 Southbound
- SR 107 Northbound
- US 64 Southbound
- US 67 Southbound

Image source: Map Data © 2022 Google. Annotations by Virginia Tech Transportation Institute (VTTI) and FHWA.

Data Source: Virginia Tech Transportation Institute (VTTI).
US 65 SB PART 2, MP 4.7 - 6.2

Crashes
Friction
Texture

Image source: Map Data © 2022 Google. Annotations by VTTI.

Data Source: VTTI
Arkansas CPFM Demo Summary

- CPFM provides a level of resolution of data that is not feasible with other data collection methods.
- CPFM provides another data source for asset management, policy changes, and safety site diagnosis.
  - Includes videos, cross-slope, profile grades.
  - Low values of friction can trigger investigation.
- Macrotexture, in general, appear to be within reasonable ranges.
- Measured friction at Arkansas HFST locations demonstrates high level of friction performance.
CPFM & The Safe System Approach

The Six Safe System Principles

- Death/serious injury is unacceptable
- Humans make mistakes
- Humans are vulnerable
- Responsibility is shared
- Safety is proactive
- Redundancy is crucial
The Five Safe System Elements

- Safe road users
- Safe vehicles
- Safe speeds
- Safe roads
- Post-crash care

Conclusion

- Collecting continuous friction and macrotexture data through the adoption of CPFM can have a significant impact on crash reductions.
- CPFM, when complemented by road geometry data, provides a more effective method for identifying the most critical sections and allows focusing the safety improvement efforts on the higher risk locations, such as intersections and curves.
Continuous Pavement Friction Measurement is a valuable tool for thoroughly evaluating pavement friction to more clearly identify conditions that may contribute to crashes.

Thank You!
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CPFM Resources

- FHWA Pavement Friction site
  https://safety.fhwa.dot.gov/roadway_dept/pavement_friction/
- FHWA CPFM Video
  https://www.youtube.com/watch?v=frVLkrU3NPU
- Pavement Friction Management Program Demo (virginiadot.org)

FHWA Safety Resources

- Zero Deaths & Safe System
  https://safety.fhwa.dot.gov/zerodeaths/zero_deaths_vision.cfm
- Systemic Approach to Safety
  https://safety.fhwa.dot.gov/systemic/
- Proven Safety Countermeasures
  https://safety.fhwa.dot.gov/provencountermeasures/