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THE FUTURE OF FRICTION MEASUREMENT & MANAGEMENT

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OWNER

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THE FUTURE OF FRICTION MEASUREMENT & MANAGEMENT

BRIAN L. SCHLEPPI, VIHSC

RPUG ANNUAL MEETING
SHERATON PITTSBURGH HOTEL
AT STATION SQUARE
APRIL 29, 2026

VEHICLE
INTERACTION
HIGHWAY
SURFACE
CHARACTERISTICS

Overview

- Definitions of Friction Management
- Tire/Pavement Friction Mechanisms
- Monitoring Friction & Developing Technologies
- Friction Through the Lifecycle of highway surfaces
- Various Roles at an Agency
- What a Mature Friction Management Program may be
  - How do we get there?
- Questions & Dialogue

Goals of Friction Management

Friction Supply exceeds Friction Demand Throughout the Service Life of a Highway Surface – Pavement/Materials view

We never have Crashes Due to Insufficient Friction – Safety view

Quickly Identify where Supply falls below Demand or Insufficient Friction exists, and correct in a timely manner

Tire / Pavement Friction Mechanisms

"If there are no impediments to surface drainage then the highway's contribution to friction is exclusively a function of its microtexture and macrotexture." – Schleppi 2009

Microtexture and Macrotexture are what drive Friction Response with a Pneumatic Tire

TIRE / PAVEMENT FRICTION MECHANISMS

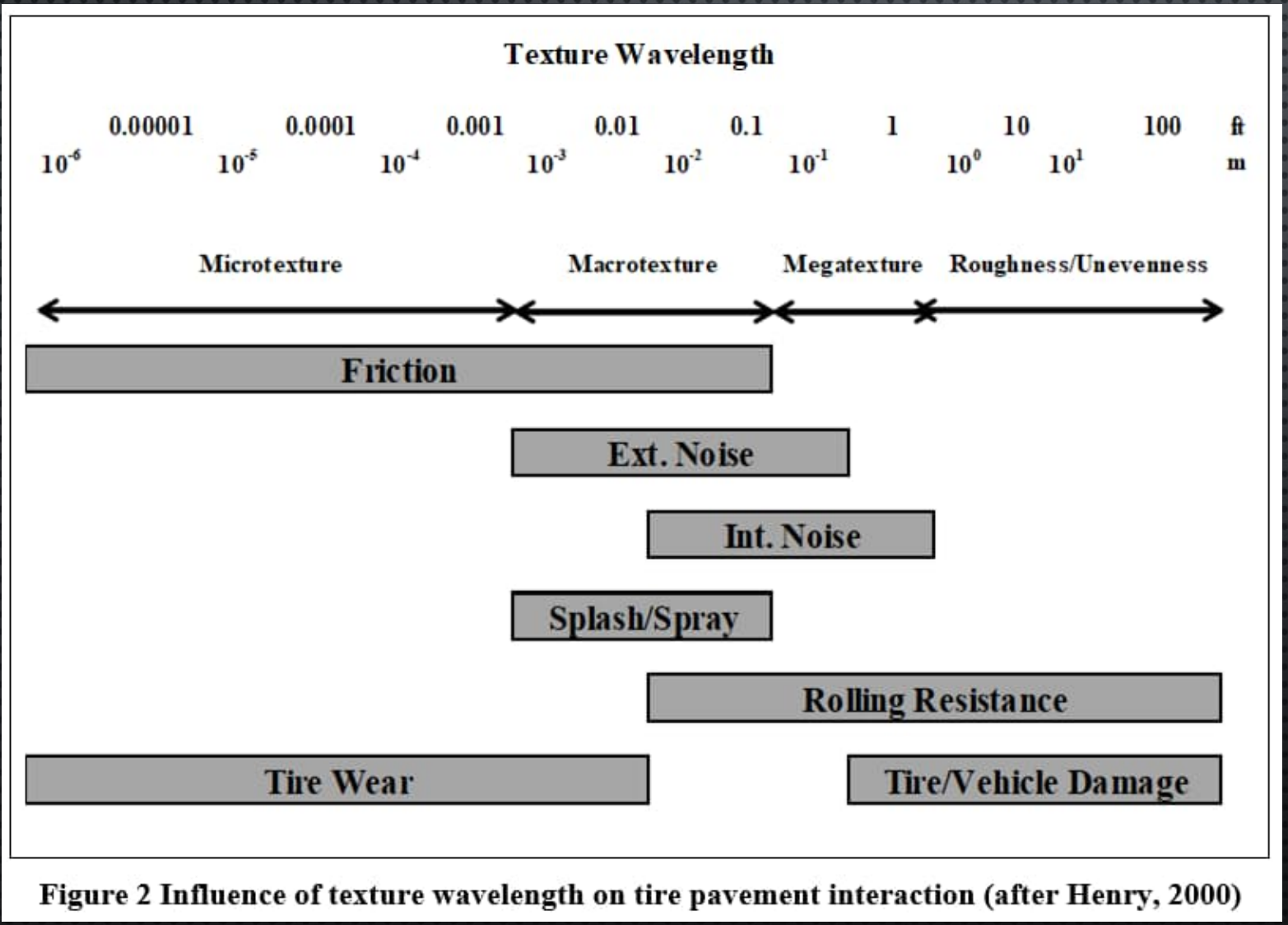
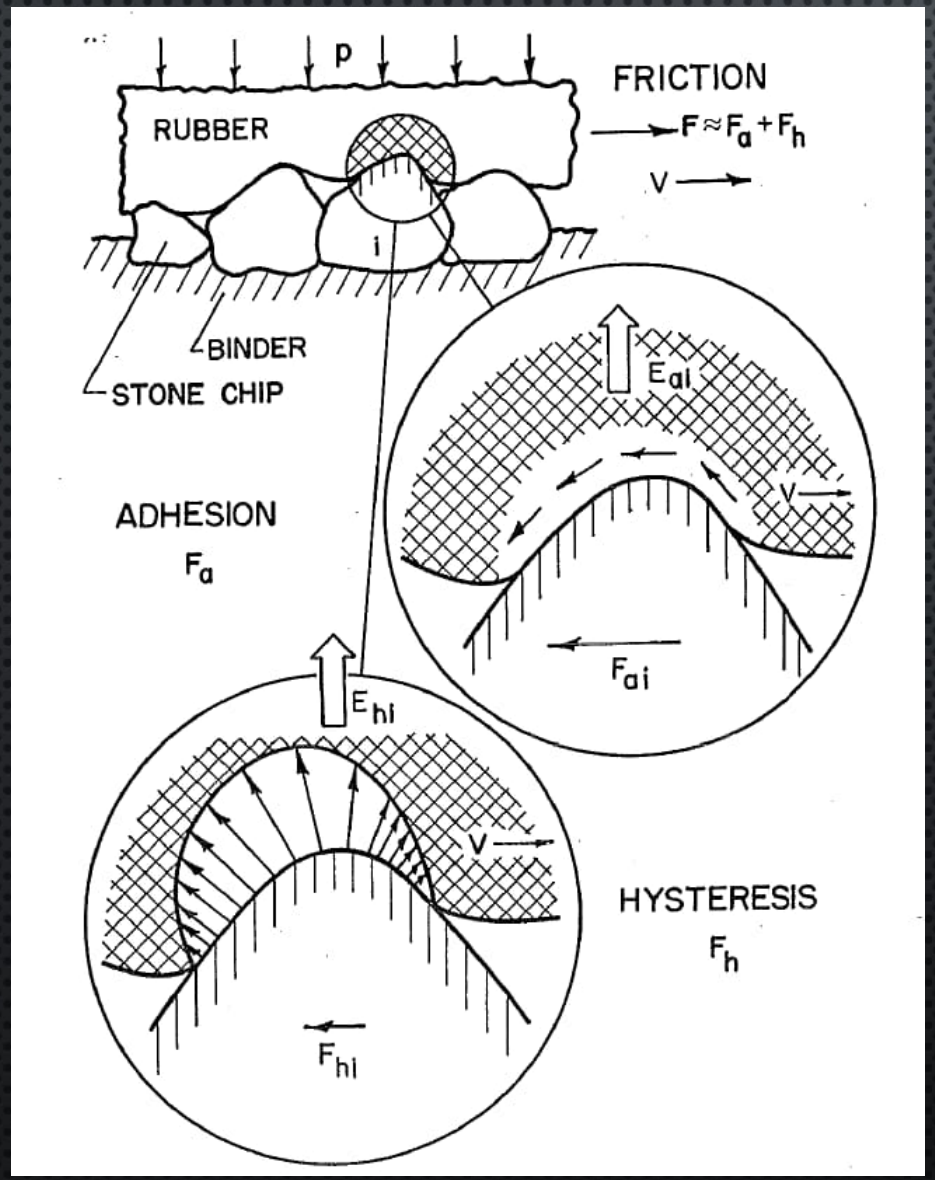
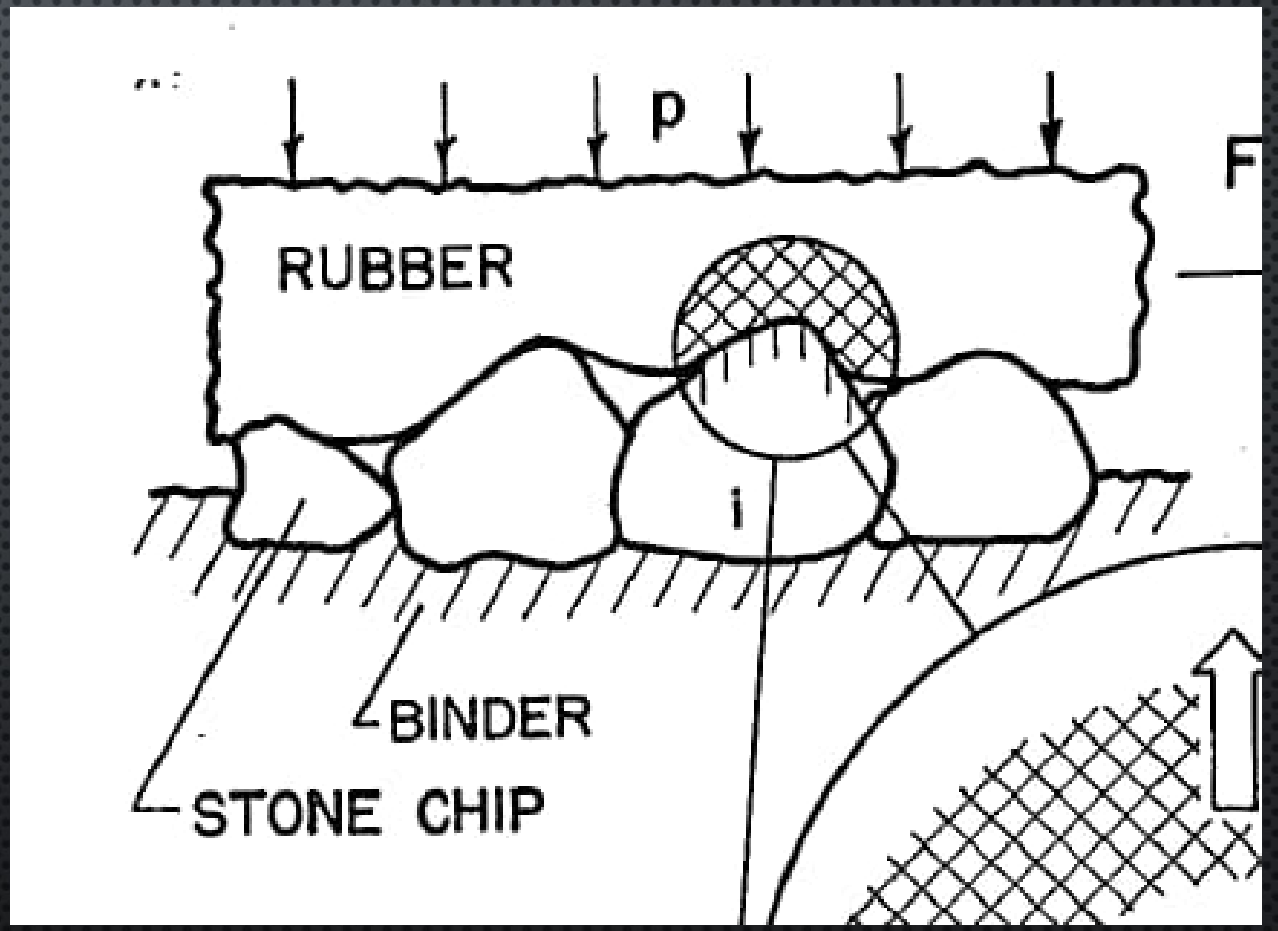


Figure 2 Influence of texture wavelength on tire pavement interaction (after Henry, 2000)

Flintsch, Mcghee, Izeppi, Najafi 2012 The Little Book of Tire Pavement Friction

TIRE / PAVEMENT FRICTION MECHANISMS





Source: Hartwig Kummer, 1966 ERB 94 PSU
Unified Theory of Rubber And Tire Friction

TIRE / PAVEMENT FRICTION MECHANISMS

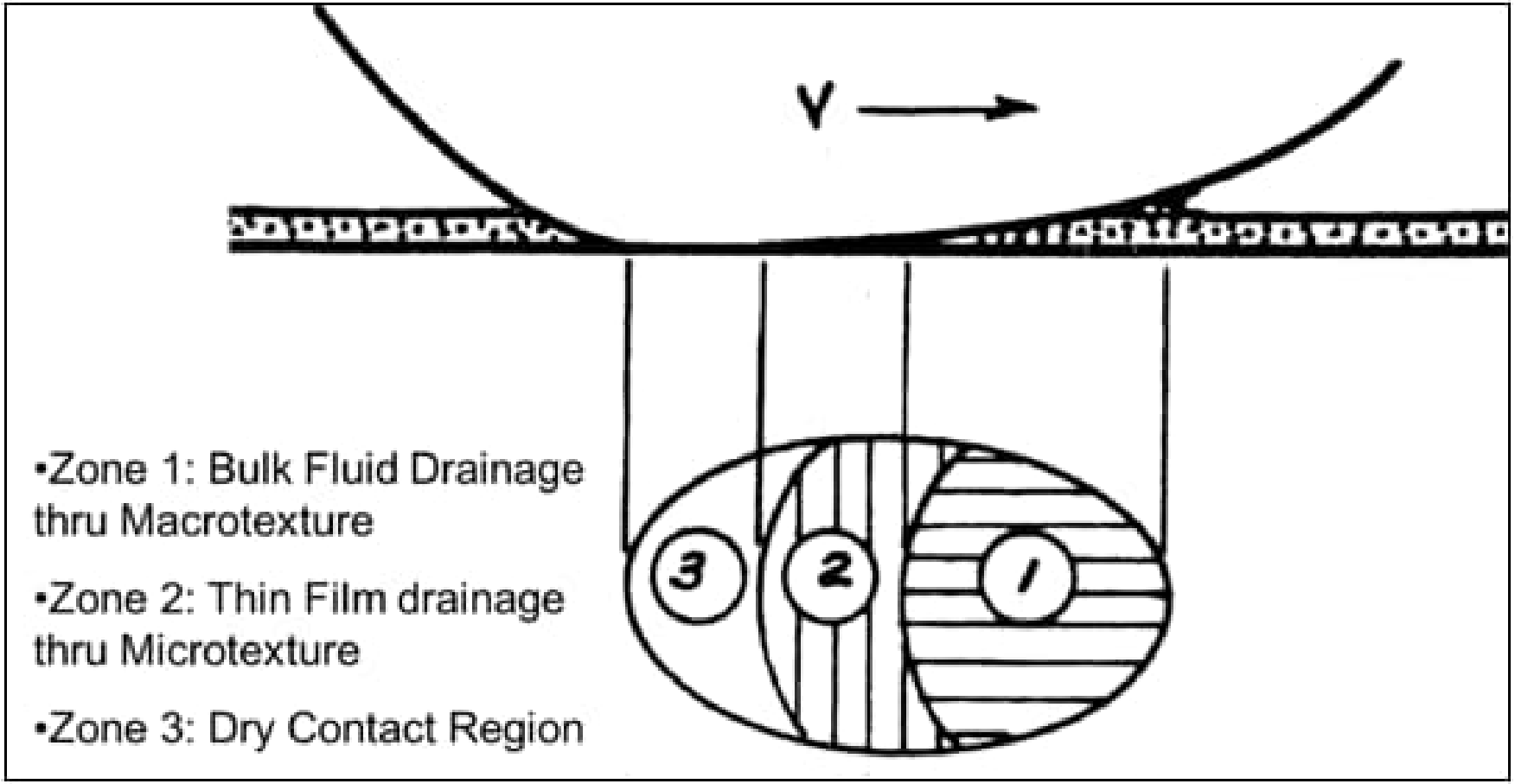


Figure 3 Texture Three Zone Concept of a wet surface (after Moore, 1966)

Flintsch, Mcghee, Izeppi, Najafi 2012 The Little Book of Tire Pavement Friction

Tire / Pavement Friction Mechanisms

1. Adhesion/Micro Hysteresis – Microtexture
2. Hysteresis of Tread Blocks and Tire Patch – Macrotexture
3. Bulk water evacuation – macrotexture works with the tread pattern to form evacuation channels in wet conditions
4. Mechanical Interlock – Anisotropic Macrotextured Surfaces (e.g. Grooved, Ground, Tined surfaces)

"Mechanical Interlock": Hartwig Kummer, 1966 ERB 94 PSU Unified Theory of Rubber And Tire Friction

Friction Response Measurement

Dragging wet rubber across the highway surface in a controlled fashion and measuring the response

1. Necessary and not going away anytime soon
2. Very expensive and resource intensive to run particularly at the network level
3. Safety Risks of running such devices on the highway
4. Consider very strategic use of such devices

Non-Contact Texture Measurement

Using a Point (2D) or Line (2D or 3D) Laser or Photogrammetry to capture the texture

- Can the full microtexture can be measured in the lab?
- Currently Microtexture cannot be directly measured in the field at any travel speed
- Full spectrum of Macrotexture can be measured both in the lab and in the field at high speed both 2D and 3D

Estimating/Simulating Friction Response from Texture Measurements

Problems:

1. We're missing a piece of the puzzle: Microtexture
2. How do we adequately characterize the Macrotexture?
   - MPD is important but not sufficient on its own
   - 90+ currently known parameters (Source: Christian A Sabillon-Orellana)
   - Do we need parameters that don't currently exist?
   - What relative mix of parameters are important in what conditions?

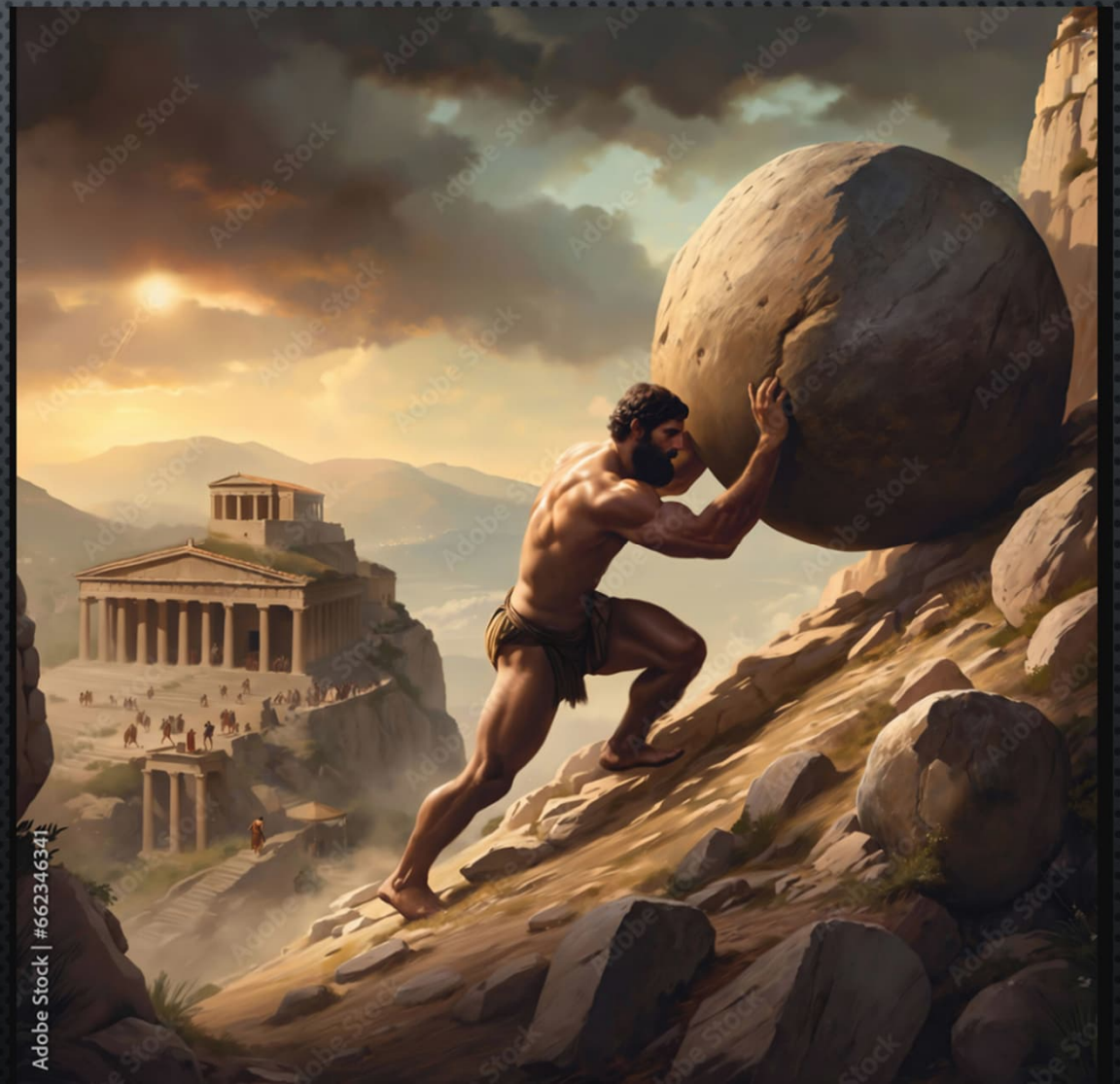
ESTIMATING/SIMULATING FRICTION RESPONSE FROM TEXTURE MEASUREMENTS

IS THIS A SISYPHEAN TASK?

NO!

2026 TRBAM PROGRAM

- 19 PAPERS DIRECTLY CONTRIBUTE
- 25 PAPERS INDIRECTLY CONTRIBUTE



Developing Technologies

1. Estimating or Predicting Friction from non-contact measures
2. Modern Vehicles
   - Estimating Mu
   - Measuring/monitoring Wheel Slip
   - Monitoring Breaking Forces or Distance

Friction Management Hurdles

Buy-in and real Participation from all that need to be involved

Fear

- Of what folks don't understand
- Of Litigation
- Of spending $ on a fix and it now working or working well
- Of additional demand put on the surface of our pavements

“...Yet DOT engineers are often concerned about testing pavement surfaces for friction in fear of litigation and liability risk. However, departments of transportation benefit from robust federal protections that encourage comprehensive friction data collection and internal safety analysis. Under Federal Law 23 USC 407, data and reports compiled solely for the purpose of developing, implementing or evaluating federal highway safety enhancement programs are expressly protected from being used as evidence in federal or state court proceedings arising from civil actions for damages. This statute is designed to foster a candid and thorough safety review process, shielding agencies from legal exposure when they identify areas for improvement....”

IGGA Technical Bulleting March 25, 2026

“...Further strengthening these protections, Federal Law 23 USC 409 prevents the discovery or admission into evidence of highway safety data, reports or surveys used for hazard identification or prioritization programs. The intent is to ensure that DOTs and similar agencies can openly assess roadway risks and implement corrective actions without fearing that their proactive measures will become a source of litigation or liability in court. This statutory framework enables transparent internal audits and supports a culture of continuous safety improvement across transportation networks....”

IGGA Technical Bulleting March 25, 2026

Signs of Mature Friction Management Programs

- Friction is thought about through the entire lifecycle of each surface – Design to Resurfacing or Reconstruction
- Every area at an Agency that should be involved, is!
- Problem locations identified with Certainty & Celerity
- Appropriate Treatment Actions are Identified & Executed Swiftly
- Various data sources are Identified, Linked & Leveraged
- The Highway Network is monitored in Multiple ways

Signs of Mature Friction Management Programs

- The Reactive side of the Program Informs the Proactive

QUESTIONS?

THANK YOU!

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VEHICLE
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QUESTIONS?

Thank you!

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