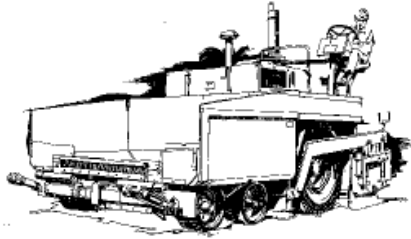


**OHIO
ASPHALT
PAVING
CONFERENCE**

41st Annual Conference



Wednesday, February 3, 2016

Fawcett Center
Campus of The Ohio State University
2400 Olentangy River Road
Columbus, Ohio 43210

Sponsored by:

American Council of Engineering Companies of Ohio

Asphalt Institute

City of Columbus

County Engineers Association of Ohio

Federal Highway Administration

Flexible Pavements of Ohio

Ohio Department of Transportation

Ohio State University

Ohio University

Correcting Low Asphalt Pavement Friction

Brian L. Schleppi

OH DOT Office of Technical Services



Overview

- ▶ AC Pavement Surface Features which give us Friction
- ▶ Ideas about Friction Demand
(How much friction do I need where?)
- ▶ How we figure out what's wrong when we have insufficient friction
- ▶ Information needed to pick a good corrective action
(questions we need to answer)
- ▶ Corrective action options
- ▶ Questions

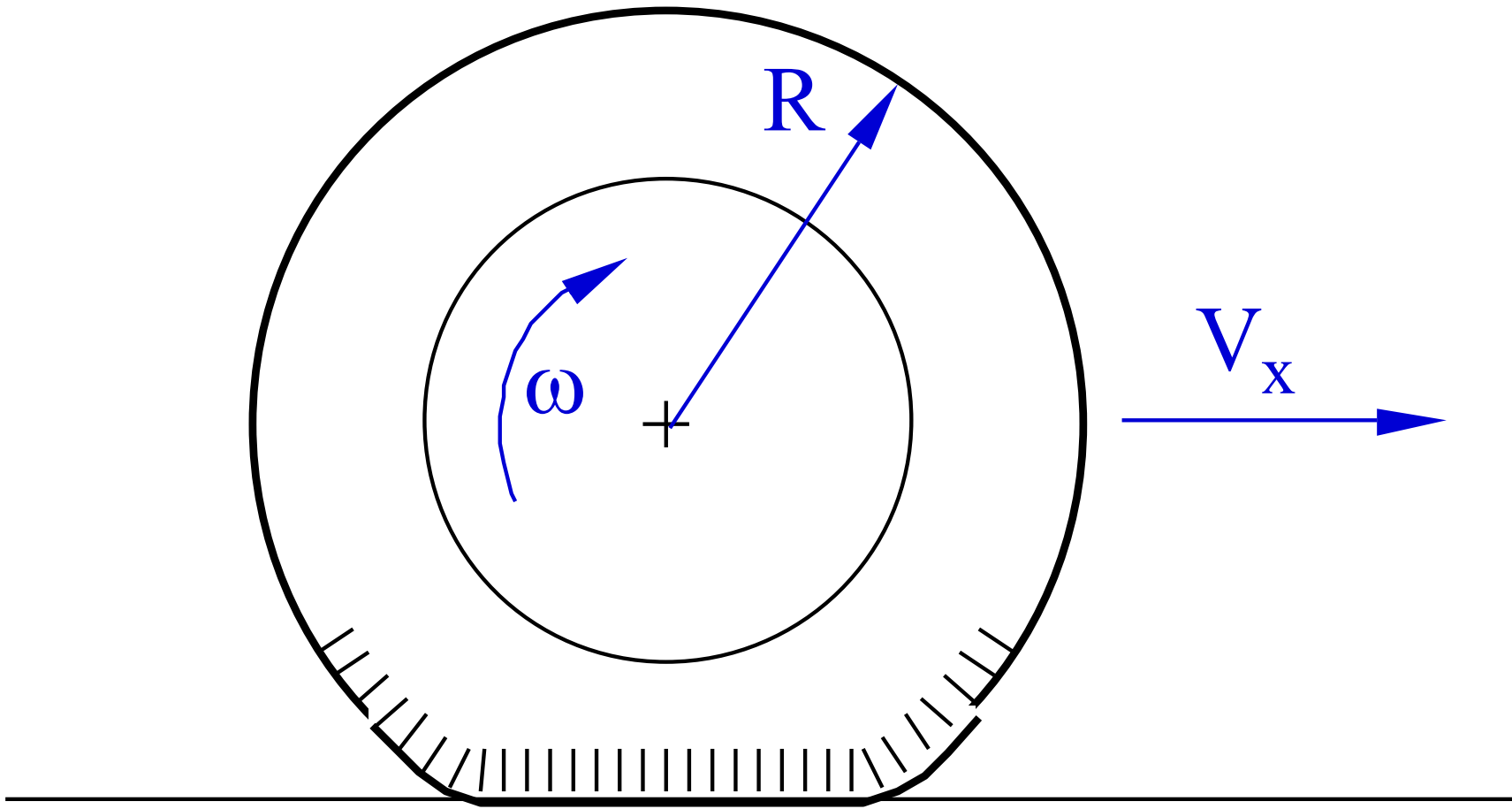
Features of Asphalt Concrete which contribute to Tire/Pavement Friction

Assuming no impediments to drainage and surface water run-off & only looking at the pavement surface contribution:

Tire/Pavement Friction and Grip (both wet & dry) is exclusively a function of the **micro and macro texture** of the pavement surface

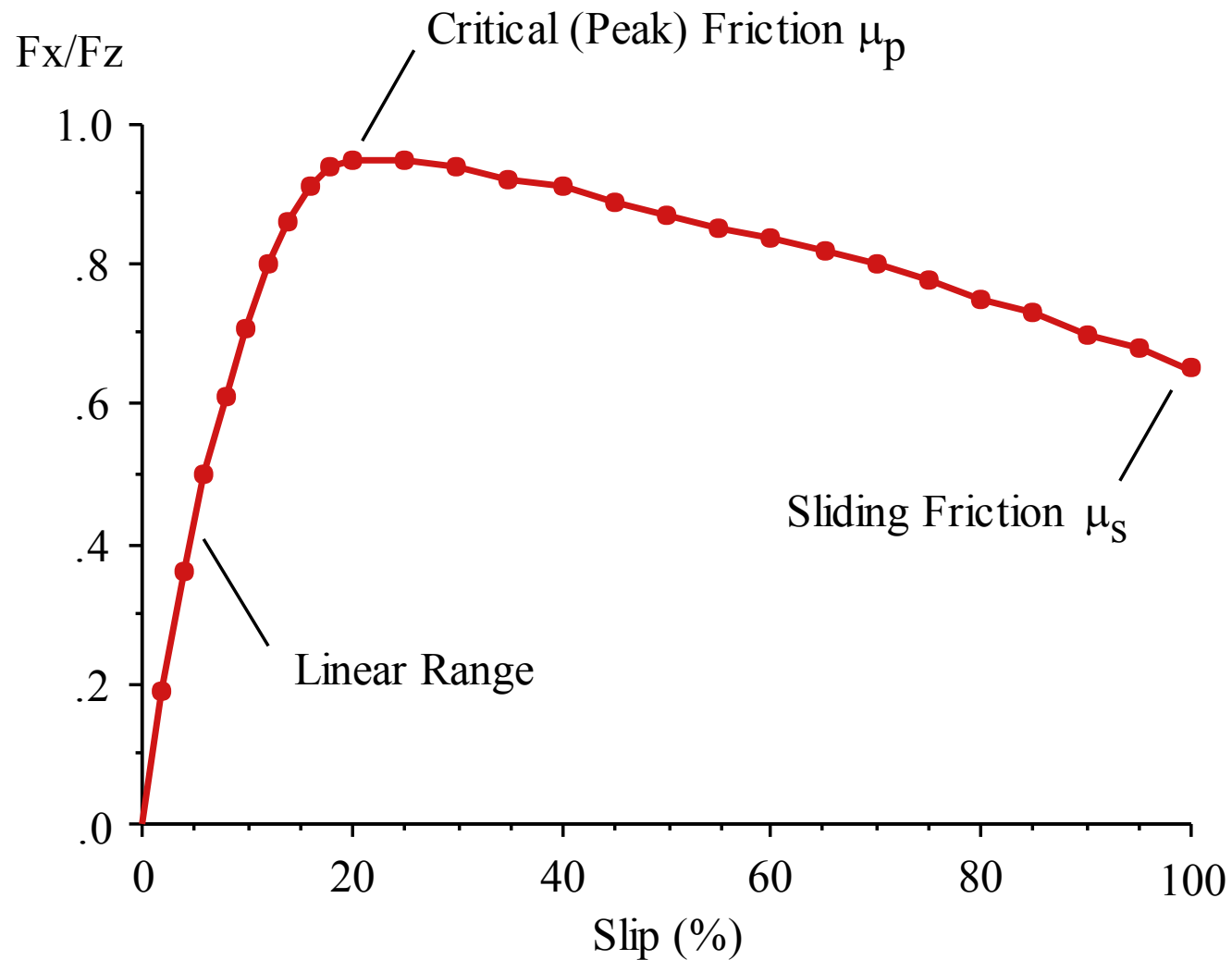
- ▶ **Microtexture** - friction by “adhesion” or adhering to the tire
 - ▶ More easily felt than seen
 - ▶ Comes from the microtexture of the aggregate particles in the surface
- ▶ **Macrotexture** - friction by “hysteresis” or deforming the rubber in the tire; also works with tire tread pattern to evacuate water and deter hydroplaning
 - ▶ Visible voids in the surface of the asphalt concrete mat
 - ▶ Degree of how tight vs. open the mix is

Tire in Contact with Pavement



Source: Steve Karamihas UMTRI

Tire/Pavement Friction



Source: Steve Karamihas UMTRI

Friction Demand is Site Specific

It's not one size fits all!

Highway Concerns

- ▶ Traffic Speeds
- ▶ Traffic Volumes
- ▶ Truck Volumes
- ▶ Congestion
- ▶ Geometry Curves vs. Flat/Straight
- ▶ Vertical Curves
- ▶ Sight Distances
- ▶ Propensity to Change Lanes
- ▶ Mainline vs. Ramps
- ▶ Intersections
- ▶ Ingress & Egress Opportunities

Operator/Vehicle Concerns

- ▶ Operator Alertness & Awareness
- ▶ Operator Reaction Time
- ▶ Vehicle Weight
- ▶ Design and Condition of Brakes
- ▶ Vehicle Suspension System
- ▶ Tire Age
- ▶ Tire Wear
- ▶ Tire Tread Pattern
- ▶ Tire Inflation Pressure
- ▶ Tire Design
- ▶ Tire Tread Rubber Compounds

Friction Demand

- ▶ Can Friction Demand change through time?
- ▶ If so, how or why?

I have insufficient available wet friction on a particular AC Pavement

How might we have determined that?

- ▶ Frequently Replaced/Repaired Barrier or perhaps Chevron Signs
- ▶ Maintenance Supervisor/Engineer or Highway Worker has told us
- ▶ J. Q . Public has told us
- ▶ Law Enforcement Officers have told us
- ▶ ITS cameras gave visual footage
- ▶ Crash Analysis: Crash Rate; Wet vs. Total Crash Rate; Fixed Object Crashes
- ▶ Suspicion: bleeding, flushing, lots of crack sealer, spill/contaminant, etc.
- ▶ Friction Evaluation Performed

Friction & Texture Evaluation



- ▶ Proven
- ▶ Standardized
- ▶ Formal
- ▶ Repeatable
- ▶ Expensive
- ▶ Objective
- ▶ Scientific
- ▶ At speed (no MOT)
- ▶ Very few service providers
- ▶ Scheduling hurdles
- ▶ Subjective
- ▶ Informal
- ▶ Imprecise
- ▶ Very Inexpensive
- ▶ Requires some skill/experience
 - ▶ Quickly and Easily Learned
- ▶ Requires MOT (dodging traffic)
 - ▶ Spend some time at a given location
- ▶ Easily scheduled and performed

Friction/Texture Evaluation Higher End

Example: ASTM E-274 Locked Wheel Friction Tester



ASTM E 274 Locked Wheel Friction Testing Units

$$SN = (F_h / F_v) * 100$$

SN - skid number or friction number

F_h - horizontal force to drag locked wheel

F_v - vertical or load force on locked wheel

r subscript for ribbed test tire

s subscript for smooth test tire

standard test speed = **40 mph**

ASTM E-501 (Ribbed) Test Tire



Photos courtesy of Daniel McNeil OH DOT Tech Services

ASTM E-524 (Smooth) Test Tire



Photo courtesy of Daniel McNeil OH DOT Tech Services

Friction/Texture Evaluation Higher End

Example: ASTM E-274 Locked Wheel Friction Tester

E-501 Ribbed Tire

- ▶ More Sensitive to **Microtexture** as Ribs evacuate Water

E-524 Smooth Tire

- ▶ Sensitive to both **Micro and Macrottexture** - Relies on Pavement to evacuate Water

Response from both test tires yields an indication that the friction problem is **insufficient microtexture**, or **insufficient macrottexture** or **both**

Strip Chart

File View Scale Help



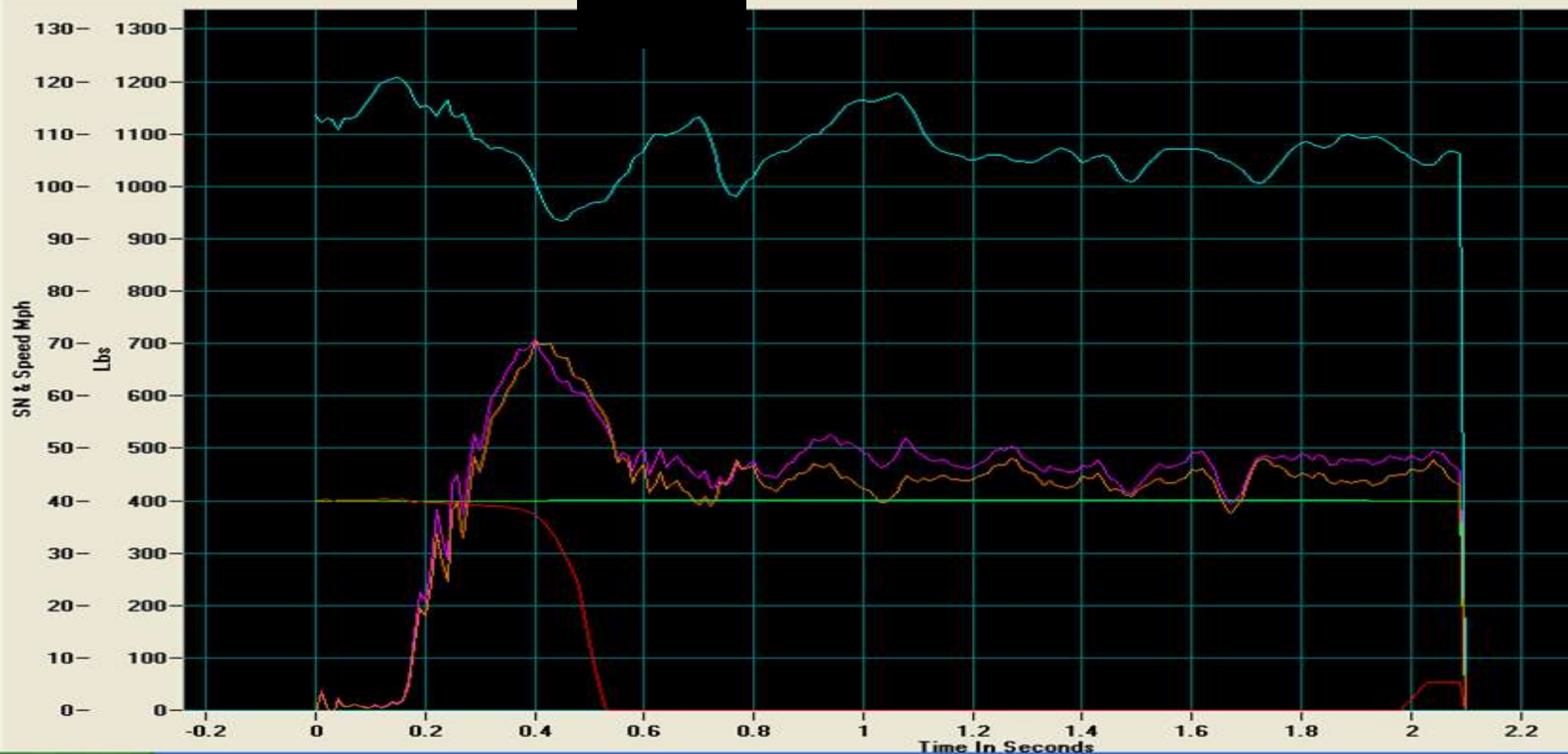
Test Data

Avg Spd = 39.9 MPH SN = 43.4 % Slip @ Peak = 8.3
 Peak Time = 0.41 Peak = 70.034 Lock Up Time = 0.49

Trac Load SN Speed Lw Spd

File Name: FRA1

est Run Time & Date 12:36:4 10/28/201 Current Date 1/30/2012



Friction/Texture Evaluation Lower End

Example: Yukon Cornelius Method

Based on Optical and Contact Sensors

- ▶ Eyeballs
- ▶ Fingertips
- ▶ Foot and Shoe Sole

Examine and compare the **Wheel Tracks**, **Outside the Wheel Tracks**, and the **Shoulder**

- Close careful visual inspection & comparison
 - Shiny vs. dull; variation in “tightness” or “openness”
- How do the three areas feel to the fingertips?
- How do the three areas feel to the sole of the shoe (preferably when wet) **note: some shoe soles are rubber**



OK, I have a problem, How do I determine what to do about it?

- ▶ From evaluation, what's the problem: micro, macrotexture, or both?
- ▶ What aggregates do I have in the mix?
- ▶ How is my binder? Bleeding, flushing, tighter in the wheeltracks?
- ▶ Is the surface contaminated? Crack sealer, tar, or perhaps a spill?
- ▶ What is my traffic like? Speeds, vehicle mix, congestion?
- ▶ How much life do I want or need to get out of the fix? When is it programmed for a surface treatment? Can I bump it ahead in the queue?
- ▶ How old is the surface?
- ▶ Will weather prevent or delay an immediate fix?
- ▶ How much \$ do I have to correct the problem?
- ▶ How severe is my problem? Do I need to do a cheap/short term fix now to get by until \$ and/or weather allows for a long term fix?

What are my treatment options?

Like Friction Demand, It's not one size fits all!

Mechanically Change the Surface (scuff it up)

- ▶ Carbide Milling
 - ▶ Micro Milling
 - ▶ Fine Milling
 - ▶ Conventional Coarse Milling
- ▶ Diamond Grinding
- ▶ Diamond Grooving
- ▶ Shot Blasting

Cover Up the Surface

- ▶ Micro Surfacing
- ▶ HMA Overlay
 - ▶ Traditional Mill & Fill or Straight Overlay
 - ▶ Fine Graded Polymer Overlay (424B aka "smoothseal")
 - ▶ Open Graded Friction Course
- ▶ Chip Seal
- ▶ High Friction Surface Treatment (Epoxy Binder with Calcined Bauxite Chips)

Photo courtesy of
Aidan McDonnell
BOCA Construction Inc.



Conventional mill drum
16mm cutterbit spacing

Micro mill drum
5mm cutterbit spacing

Diamond Grinding Head stacked & spaced saw blades

Photo courtesy
of John Roberts
of the IGGA



Conventional / Coarse Carbide Milling



Carbide Micro Milling

Photo courtesy of
Aidan McDonnell
BOCA Construction Inc.



Diamond Ground AC



Photo courtesy of
Aidan McDonnell
BOCA Construction Inc.



Photo courtesy of
Scott LeBlanc OH DOT
District 7



Diamond Grooved AC



High Friction Surface

What are my treatment options?

Like Friction Demand, It's not one size fits all!

Mechanically Change the Surface (scuff it up)

- ▶ Carbide Milling
 - ▶ Micro Milling
 - ▶ Fine Milling
 - ▶ Conventional Coarse Milling
- ▶ Diamond Grinding
- ▶ Diamond Grooving
- ▶ Shot Blasting

Cover Up the Surface

- ▶ Micro Surfacing
- ▶ HMA Overlay
 - ▶ Traditional Mill & Fill or Straight Overlay
 - ▶ Fine Graded Polymer Overlay (424B aka "smoothseal")
 - ▶ Open Graded Friction Course
- ▶ Chip Seal
- ▶ High Friction Surface Treatment (Epoxy Binder with Calcined Bauxite Chips)

What are my treatment options?

Like Friction Demand, It's not one size fits all!

Mechanically Change the Surface (scuff it up)

- ▶ If mix is too rich then this is not a good option.
- ▶ If the coarse aggregate is soft or prone to polish, then the improvement could be short lived.
- ▶ Can be a long term fix if you have a stable mix with polish resistant aggregates.

Cover Up the Surface

- ▶ Weather/time of year can limit or prevent your choices.
- ▶ Don't use the same surface mix or you will get the same result.
 - ▶ Look at mix design, aggregates and binder.
 - ▶ What do I change to get more micro and/or macrotexture?
- ▶ Emulsion, HMA, or HFST?

Review

- ▶ For the Pavement side of Friction, it's all about the **micro** and **macro texture** of the surface (if surface water runs off)
- ▶ Friction Demand (what's needed) varies and is site specific
- ▶ Some kind of evaluation is necessary to tell us if the problem is with **micro**, **macro** texture or **both**
- ▶ You need to gather lots of different information in order to pick a good solution; **fix is not one size fits all**
- ▶ Corrective action options: **scuff it up** or **cover it up**

Questions

Brian L. Schleppi (614) 752-5745
OH DOT Office of Technical Services
Mailstop 3210
1980 West Broad Street
Columbus, OHIO 43223
brian.schleppi@dot.ohio.gov