VIRGINIA TECH

Effective Friction for Safe and Sustainable Pavements

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Presentation Outline

- ✓ Pavement Friction in the US
- ✓ Microtexture and Macrotexture
- ✓ Pavement Desing Policies
- ✓ Illinois Friction and Macrotexture
- ✓ Case studies (examples)
- ✓ Myths of Pavement Friction
- ✓ How can we increase Macrotexture?

Pavement Friction in the US

- ✓ ASTM E-17 Committee on Vehicle–Pavement Systems, 50-year History by E.A. Whitehurst, 1995, updated by J.J. Henry, 2005/2010.
- ✓ First Int. Skid Prevention Conference, Charlottesville, VA Sept 8-12, 1958, ASTM Committee on Skid Resistance, chair Tilton E. Shelburne (VTRC).

Pavement Friction in the US

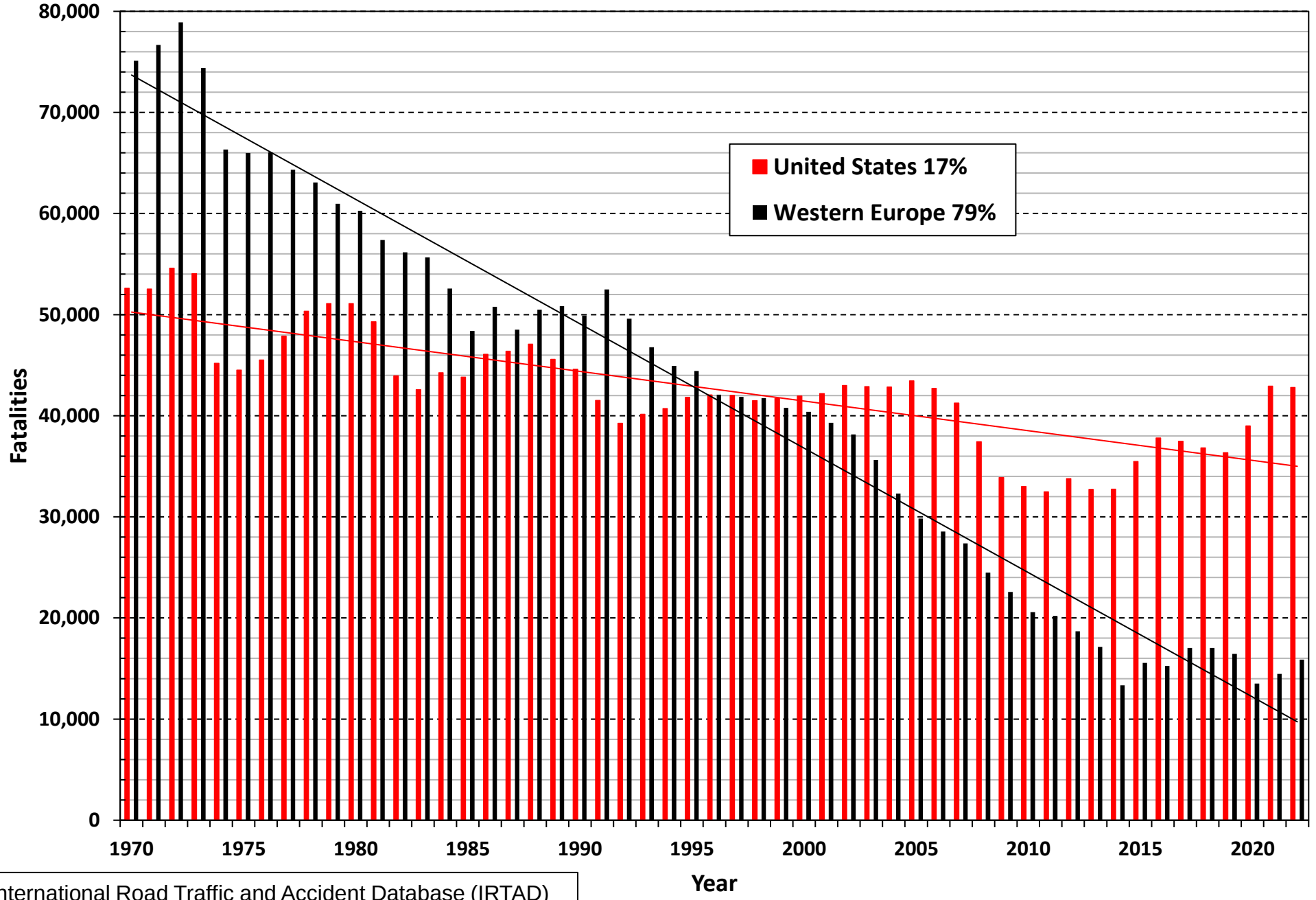
Hartwig W. Kummer and Wolfgang E. Meyer, the first test runs of the Brake Test Trailer with the Boeing Antilock System Installed The Mechanical Engineering Laboratory, Pennsylvania State University 1959.

Pavement Friction in the US

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.

H.W. Kummer and W.E. Meyer, Tentative skid-resistance requirements for main rural highways, NCHRP Report 37, 1967.

Highway Fatalities in the United States & Western Europe 1970-2022



Source: International Road Traffic and Accident Database (IRTAD)

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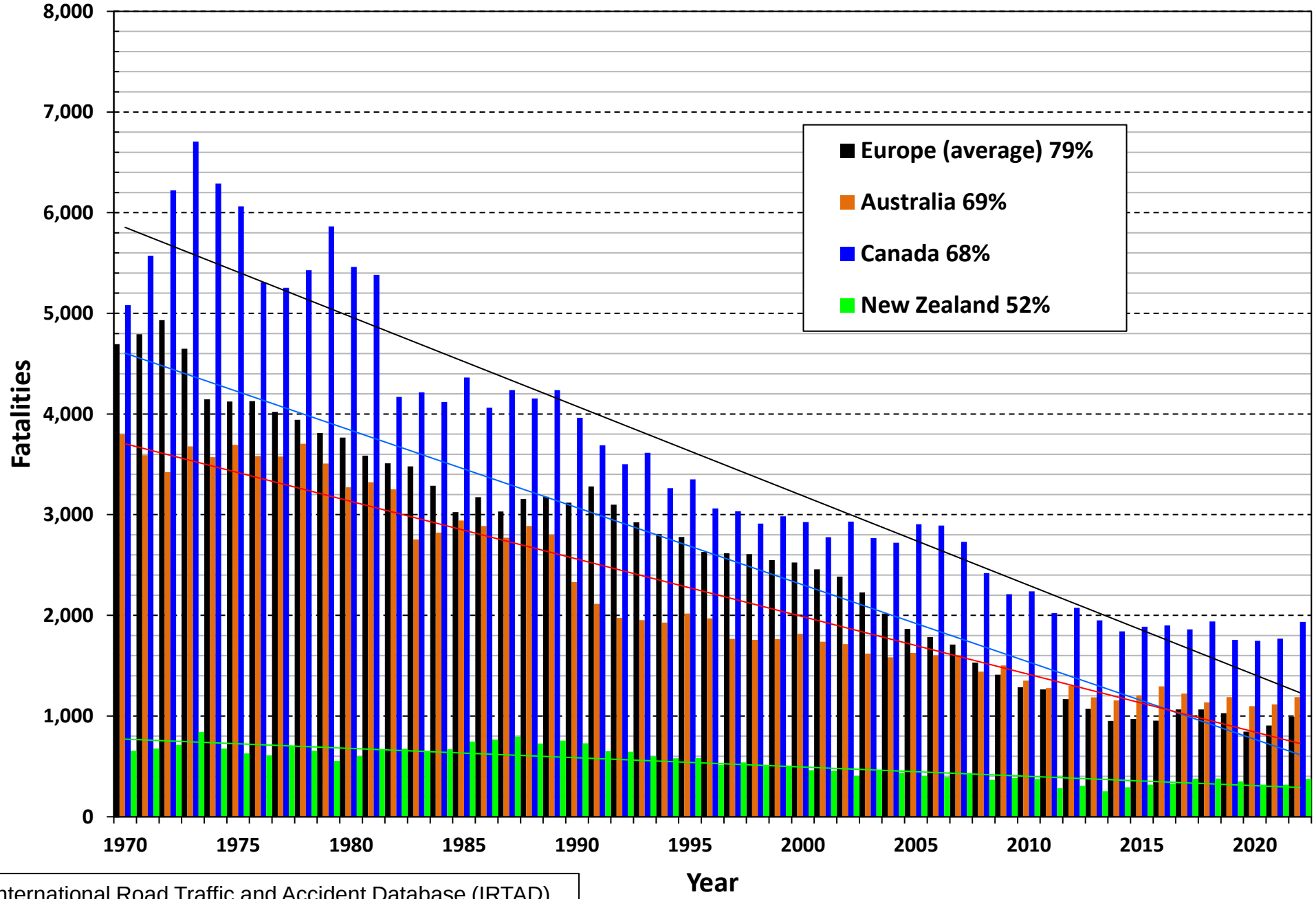
Highway Fatalities (other countries) 1970-2022



Source: International Road Traffic and Accident Database (IRTAD)

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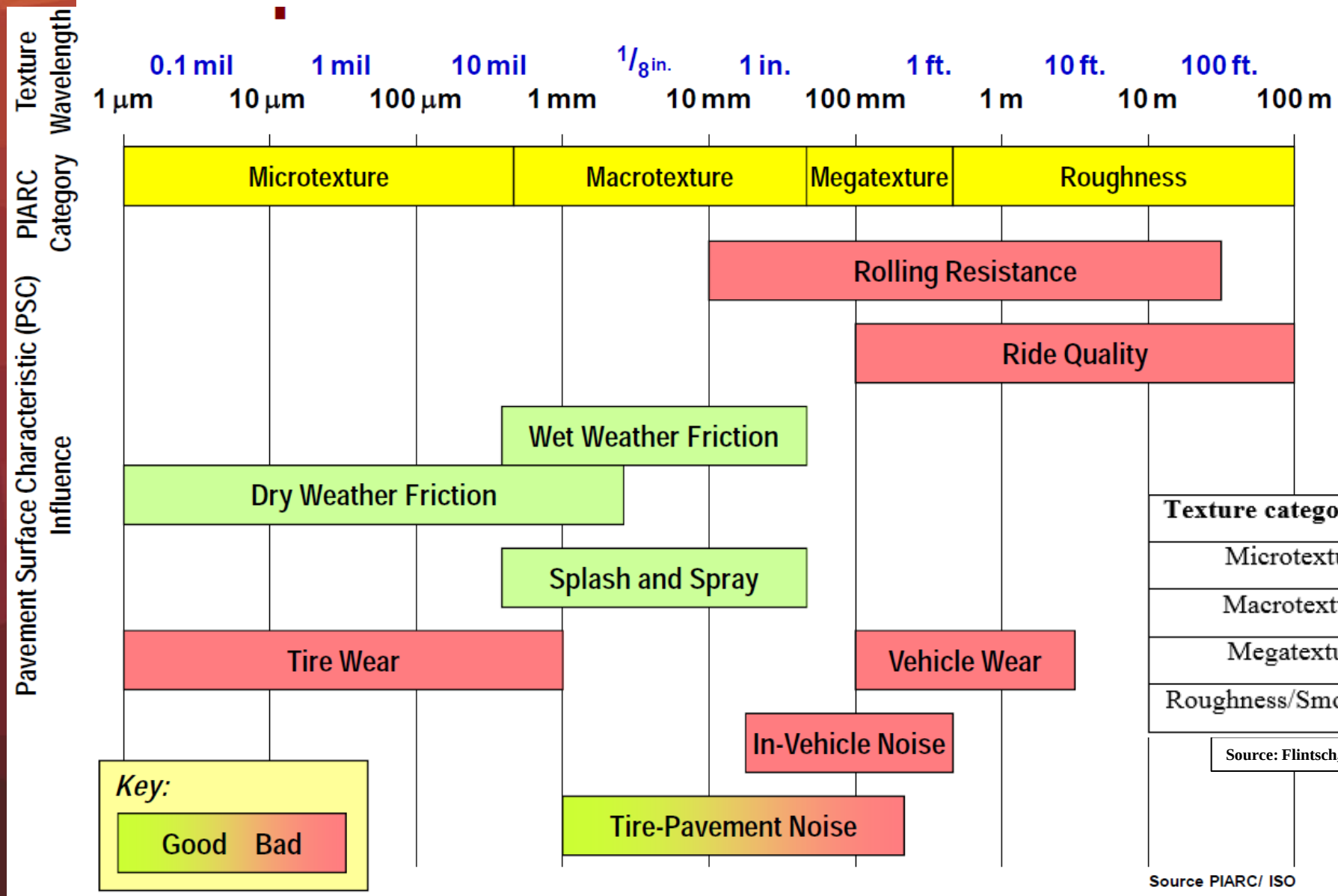
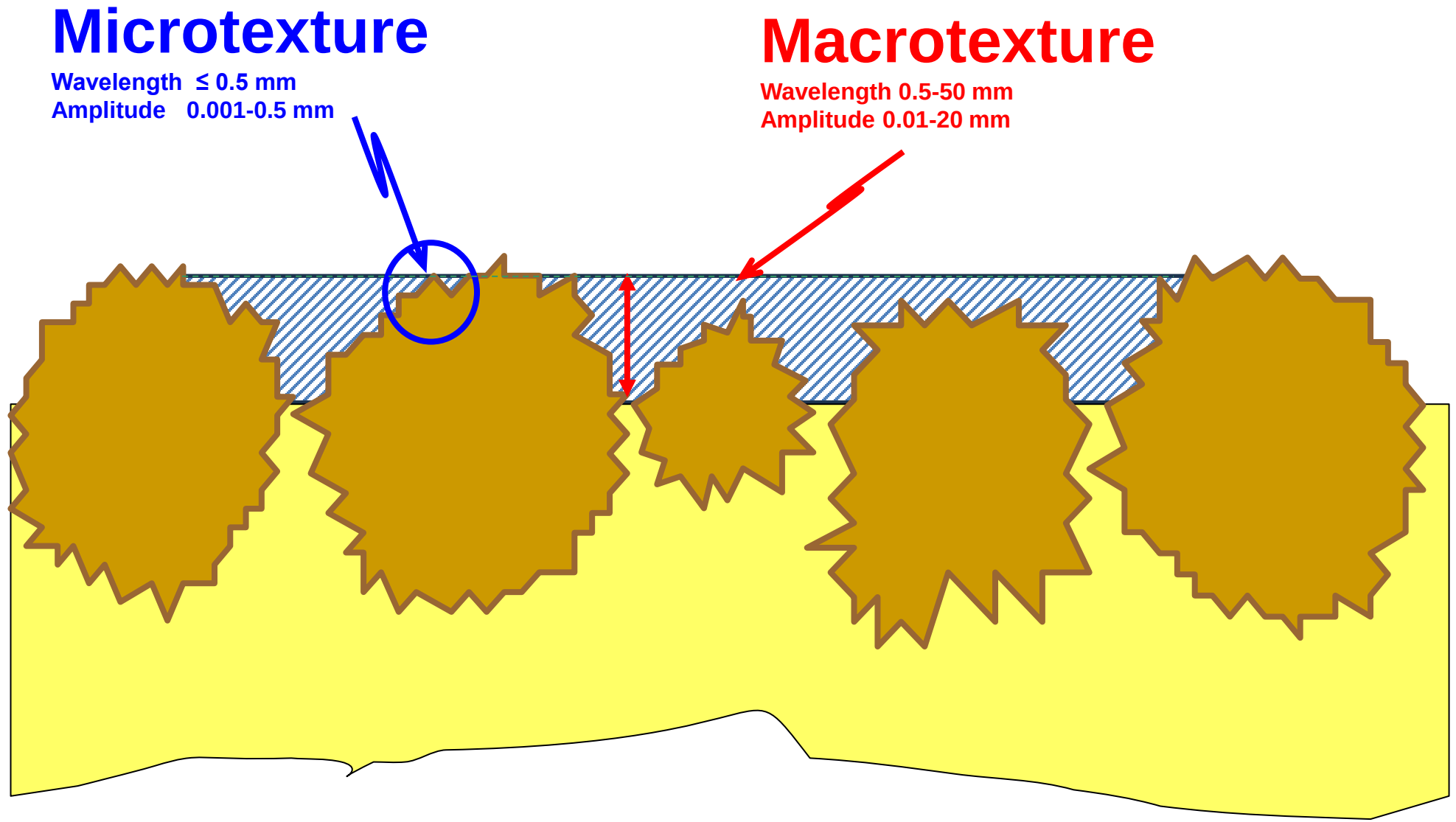
Microtexture and Macrotexture



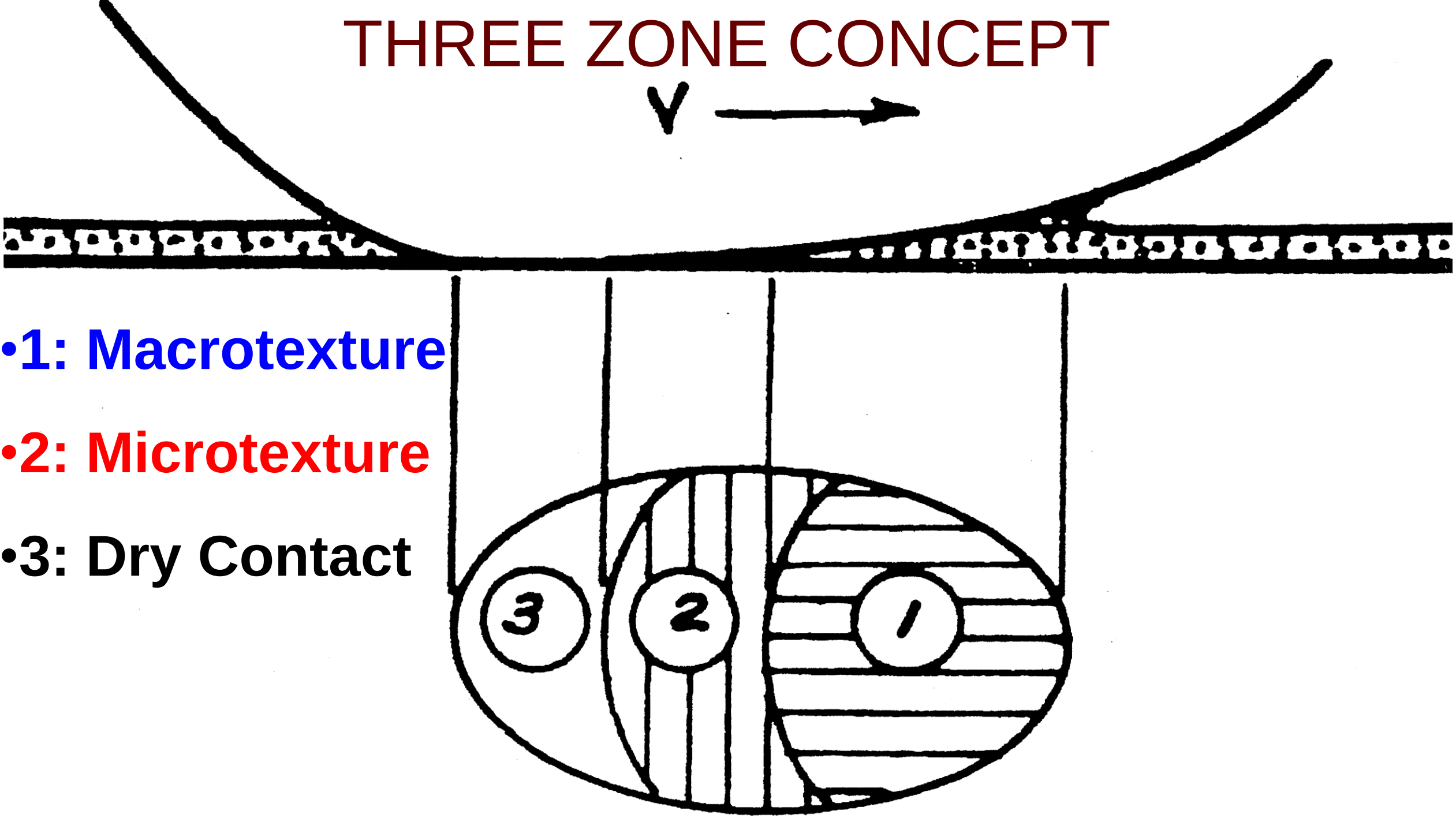
Texture categorization	Texture Wavelength (λ)
Microtexture	$\lambda < 0.5$ mm
Macrotexture	$0.5 \text{ mm} < \lambda < 50$ mm
Megatexture	$50 \text{ mm} < \lambda < 500$ mm
Roughness/Smoothness	$0.5 \text{ m} < \lambda < 50$ m

Source: Flintsch, et.al. *Little Book of Pavement Friction*, 2012.

Microtexture and Macrotexture



THREE ZONE CONCEPT



- **1: Macrotexture**
- **2: Microtexture**
- **3: Dry Contact**

Source: Ohio DOT

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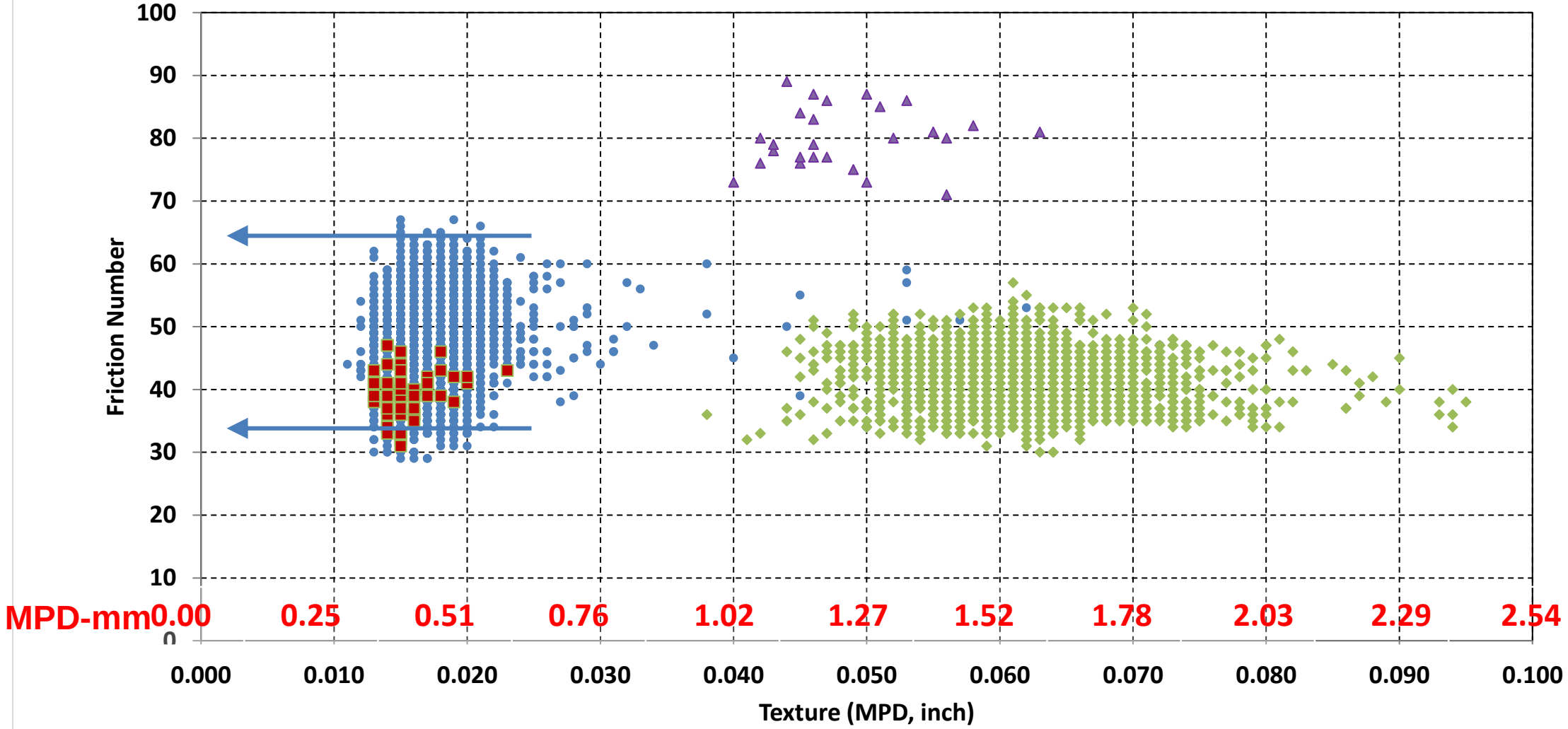
Pavement Design Policies

Florida Flexible Pavement Design Manual

Friction Course: top layer pavement surface with good frictional characteristics. Two types: Dense graded (FC-9.5 and FC-12.5) and Open graded (FC-5).

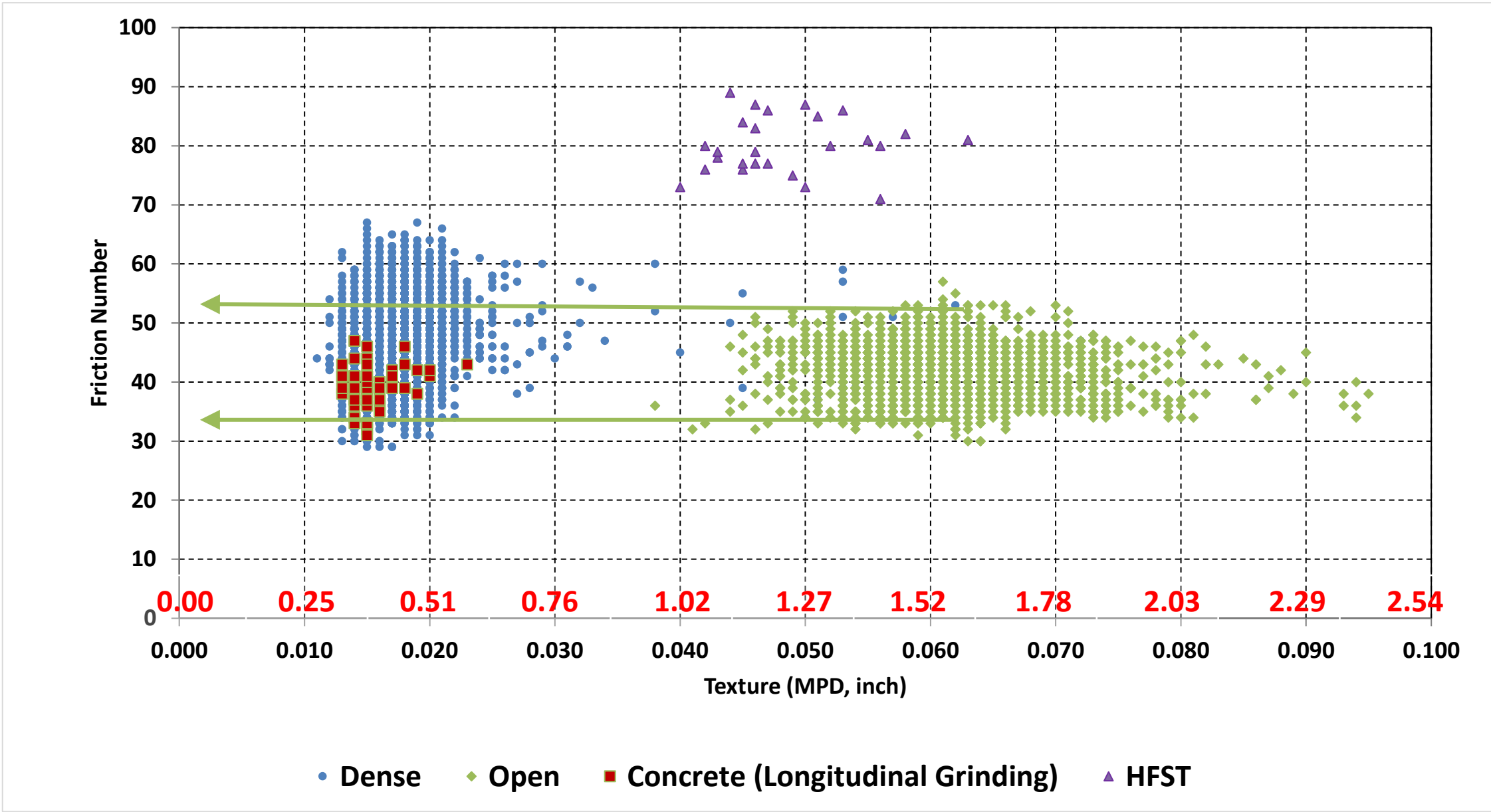
Design Speed	Two-Lane	Multi Lane
35 – 45 mph	Dense	Dense
50+ mph	Dense	Open Graded

Pavement Design Policies



Source: FDOT, 2013.

Pavement Design Policies



Roadway Facility Type	Site Type	Suggested
Freeways	Tangents	40
	Curves	45
	Ramp Access	45
Urban and Suburban Arterials	Divided Tangents	50
	Undivided Tangents	50
	Curves	50
	Intersections	55
Rural Multilane Roadways	Divided Tangents	50
	Undivided Tangents	50
	Curves	55
	Intersections	55
Rural 2-lane, 2-way Roadways	Tangents	50
	Curves	55
	Intersections	60

Higher for roads with lower geometric standards

Flintsch, G., de León Izeppi, E., McCarthy, R., Katicha, S., Persaud, B., Medina, A., and Tobias, P. (2023). *Characterizing Road Safety Performance using Pavement Friction*, Report FHWA-SA-23-006. Washington, DC.

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Higher for segments with higher friction demand.

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Macrotexture in UK (MPD)

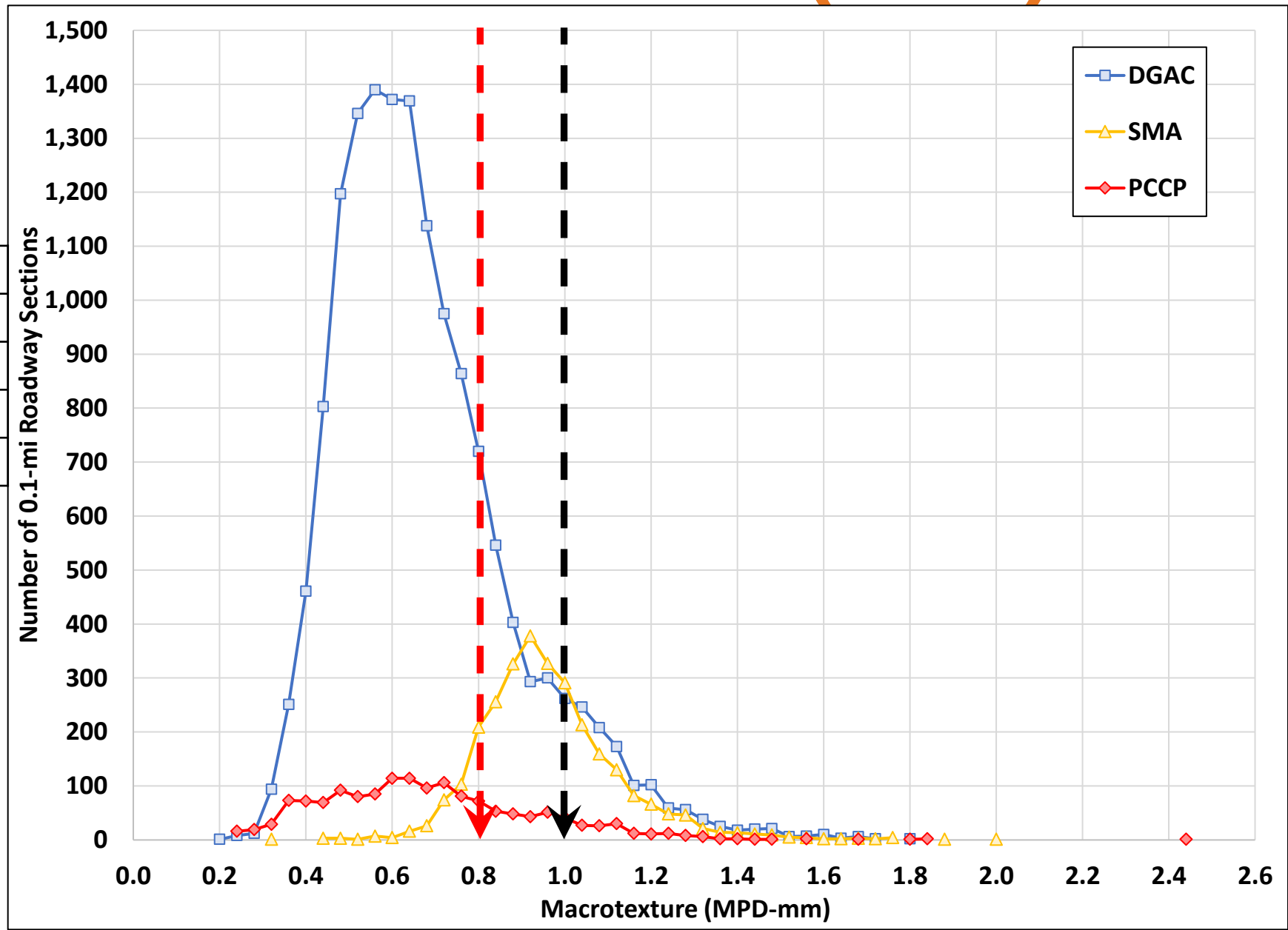
Table 1. Requirements for initial texture depth for trunk roads including motorways. (British Standards EN 13036-1).

Road type	Surfacing type	Average / 1,000 m	Average / 10 measures
High Speed roads >50 mph	Thin surface overlay Aggregate size<14mm	MPD 1.4mm	MPD 1.0mm
	Surface treatments	MPD 1.6mm	MPD 1.25mm
Lower Speed roads <40 mph	Thin surface overlay Aggregate size<14mm	MPD 1.4mm	MPD 0.9mm
	Surface treatments	MPD 1.25mm	MPD 1.0mm
Roundabout, high speed >50 mph	All surfaces	MPD 1.25mm	MPD 1.0mm
Roundabout, low speed <40 mph	All surfaces	MPD 1.0mm	MPD 0.9mm

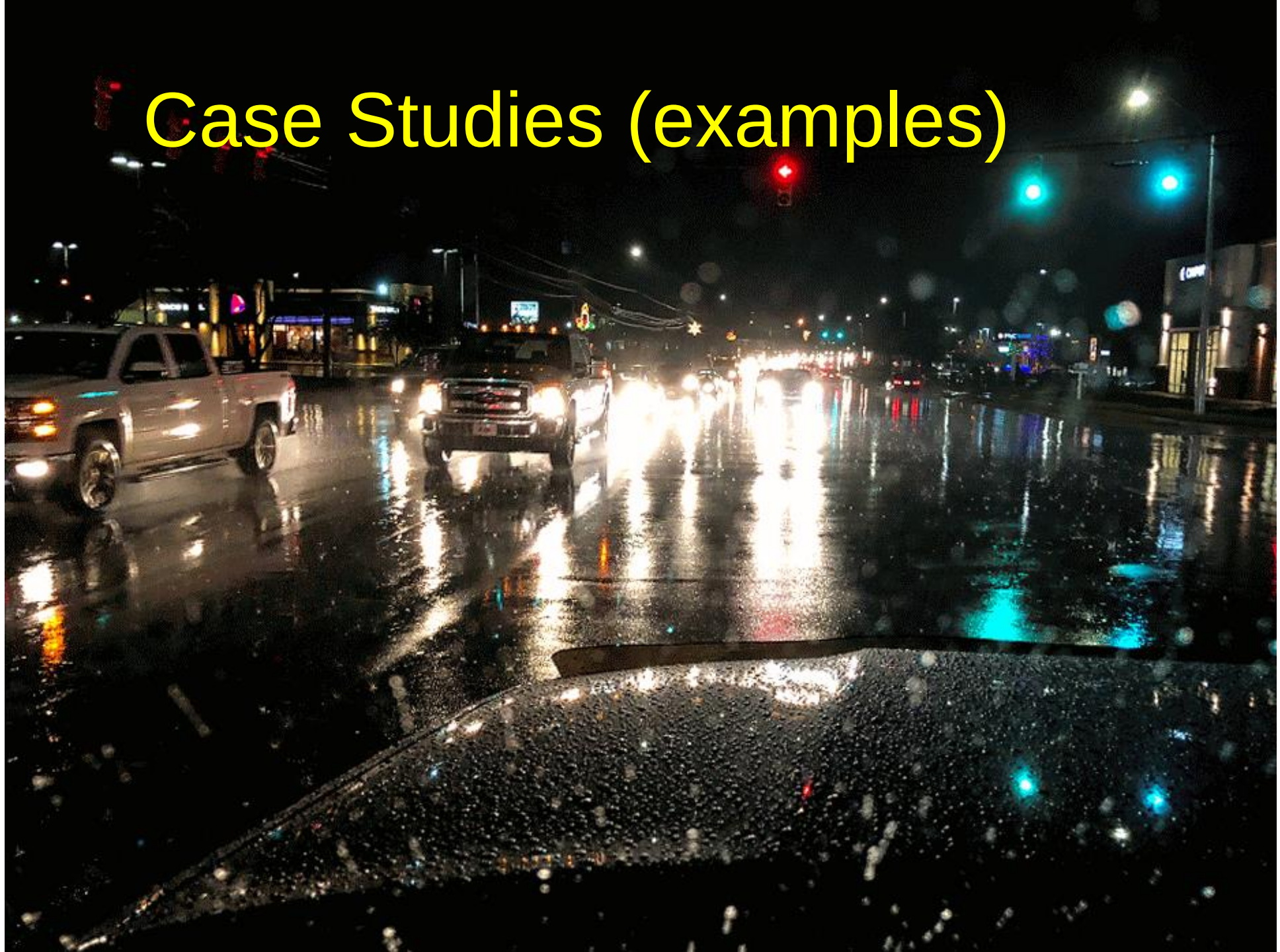
Note: The values in the following table have been converted to the mean profile depth (MPD) using the equation in ASTM E1845 where MPD = (ETD -0.2)/0.80. ETD is the estimated texture depth equivalent to the measurement obtained from the sand patch method.

Macrotexture in Illinois (MPD)

	DGAC	SMA	PCCP	TOTAL
Mean	0.65	0.94	0.66	0.70
SD	0.21	0.16	0.25	0.23
Min	0.20	0.31	0.21	0.20
Max	1.80	1.97	2.42	2.42



Case Studies (examples)



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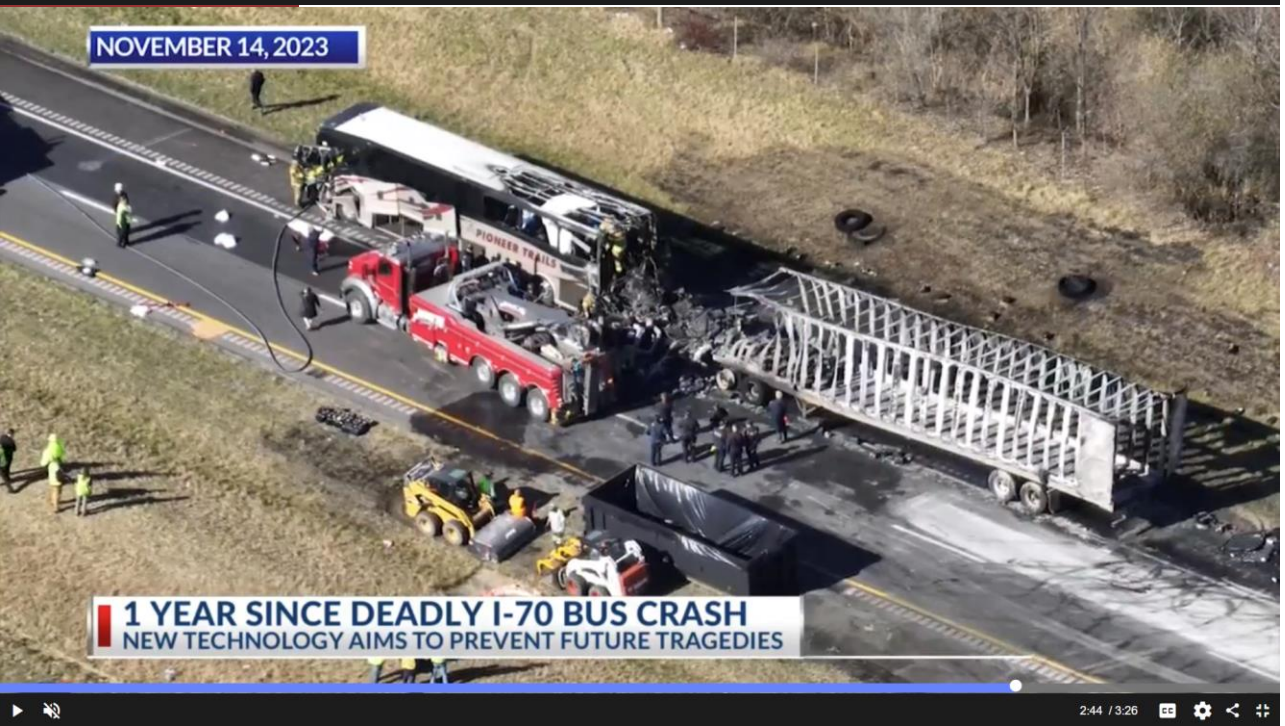
Why Are Officials Repaving Roads That Don't Have Potholes?

That new project is happening along I-85 where it spits as you head out of Greensboro. NCDOT is putting down a new layer of asphalt to make the roads safer when it rains.

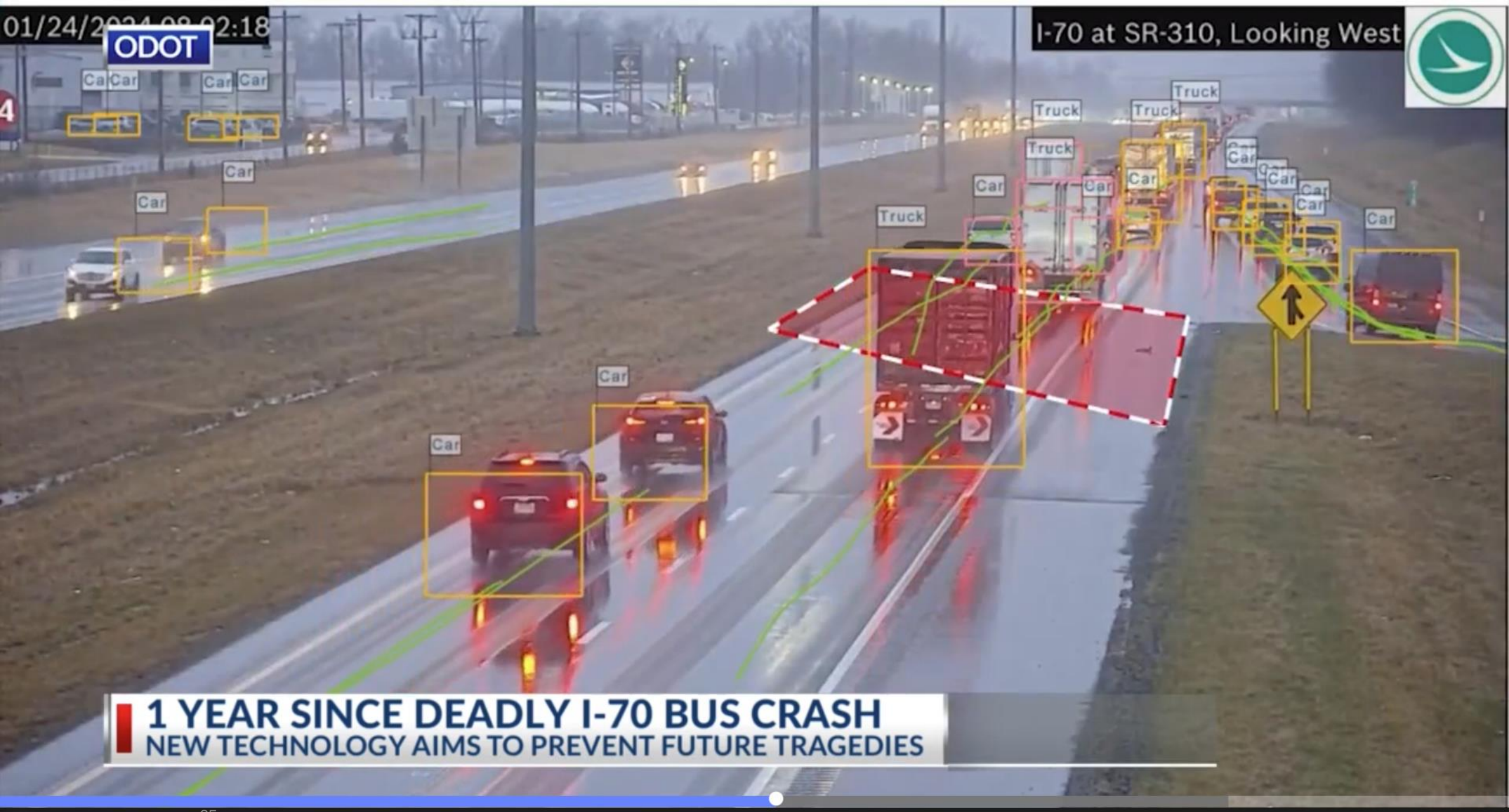
This road was recently paved with dense graded mix (no potholes) and then decision to pave open graded friction course due to safety.

https://www.wfmynews2.com/video/travel/why-are-officials-repaving-roads-that-dont-have-potholes/83-4a48b5c8-4cf5-4bef-8a52-b5d4ccb5c12b



Using new technology to prevent future crashes.

https://www.nbc4i.com/news/local-news/licking-county/how-ohio-is-preventing-accidents-one-year-after-fatal-i-70-bus-crash/


01/24/2024 08:02:18
ODOT
I-70 at SR-310, Looking West
1 YEAR SINCE DEADLY I-70 BUS CRASH
NEW TECHNOLOGY AIMS TO PREVENT FUTURE TRAGEDIES

25

1:46 / 3:26

Myths in Pavement Friction

1. Friction only affects wet crashes
2. Friction related crash sites only need investigation when wet/dry ratios > X%
3. Changing the friction of a pavement will only reduce the wet crashes

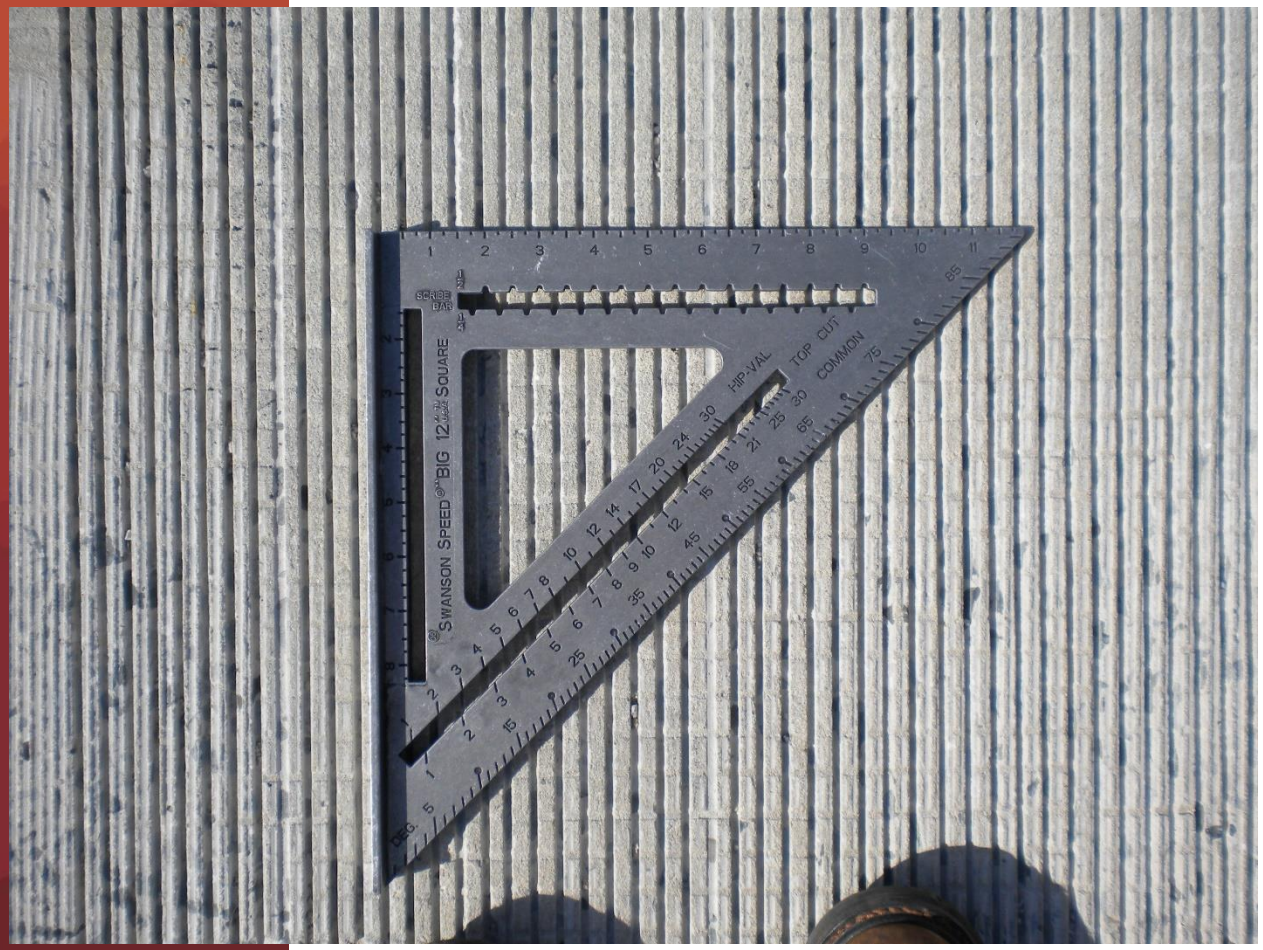
Myths in Pavement Friction

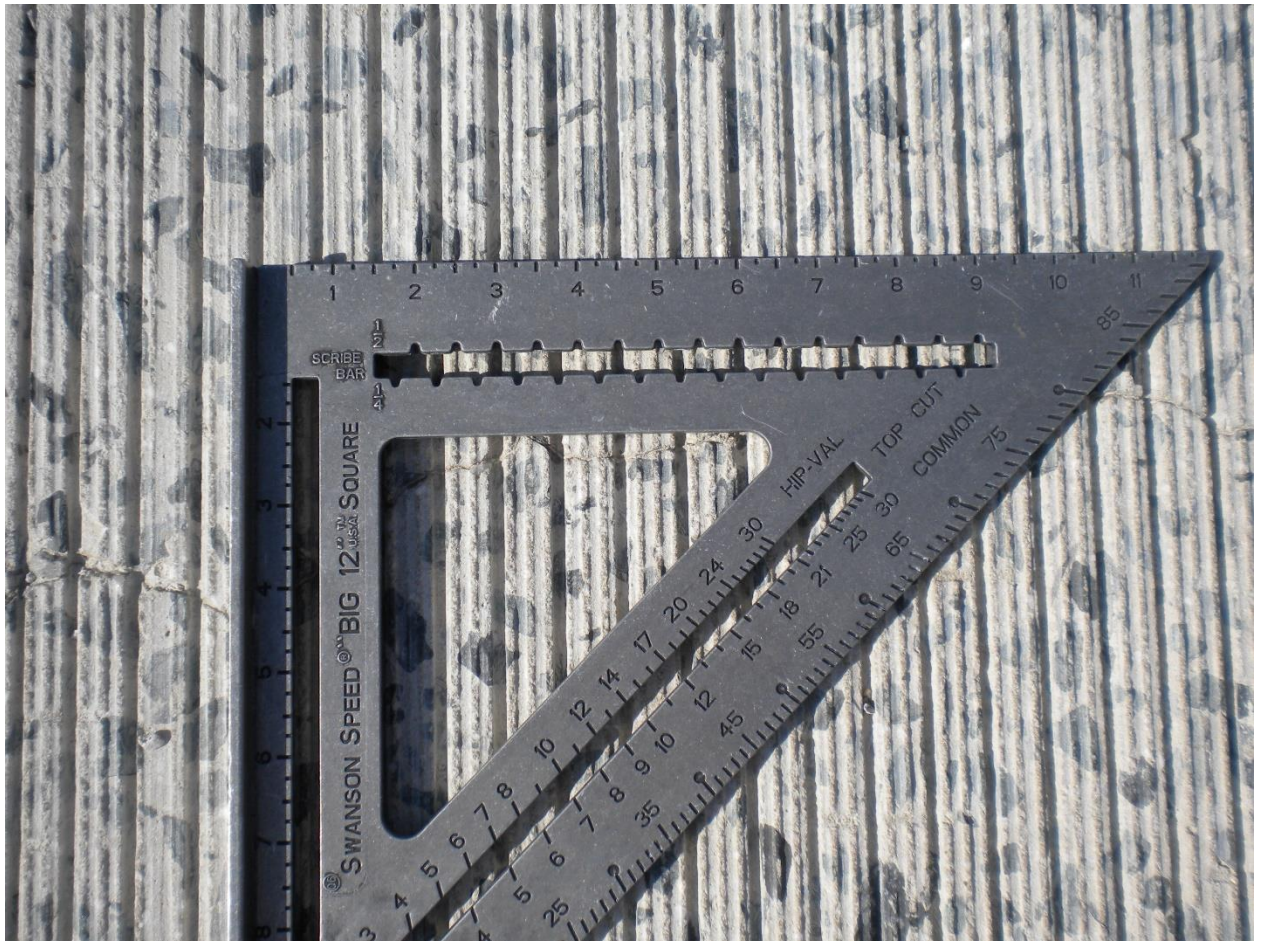
Annual	ALL	RAMPS	CURVES
Wet Avg.	91%	85%	86%
Dry Avg.	**53%**	**66%**	**47%**
Total Avg.	87%	78%	73%

After the installation of HFST, the number of dry weather reduction in crashes was also very significant (June 2015).

Source: https://safety.fhwa.dot.gov/roadway_dept/pavement_friction/case_studies_noteworthy_prac/kytc/ky_hfst_15_038.pdf

Increasing macrotexture





Increasing macrotexture

Source: McGraths Limestone (Cong) Ltd.

Increasing macrotexture

- ✓ **Florida DOT requires the use of OGFC, for speeds > 50mph (MPD > 1.25 mm).**
- ✓ **However, these mixes tend to present certain challenges in areas of cold weather. Maybe Grinding & Grooving? Rolled Asphalt?**
- ✓ **Recent study recommended an investigatory level MPD > 0.80 mm for 60 mph.**

(https://connect.ncdot.gov/projects/research/Pages/ProjDetails.aspx?ProjectID=2022-05)


Questions?
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