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CHARACTERIZATION OF SURFACE TEXTURE: TECHNOLOGY UPDATE

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Presentation Overview

- **Pavement Surface Texture**
- **Specifications**
- **Measurement Methods**
- **Surface Texture & Friction**
- **Next Steps**

Why Surface Texture?

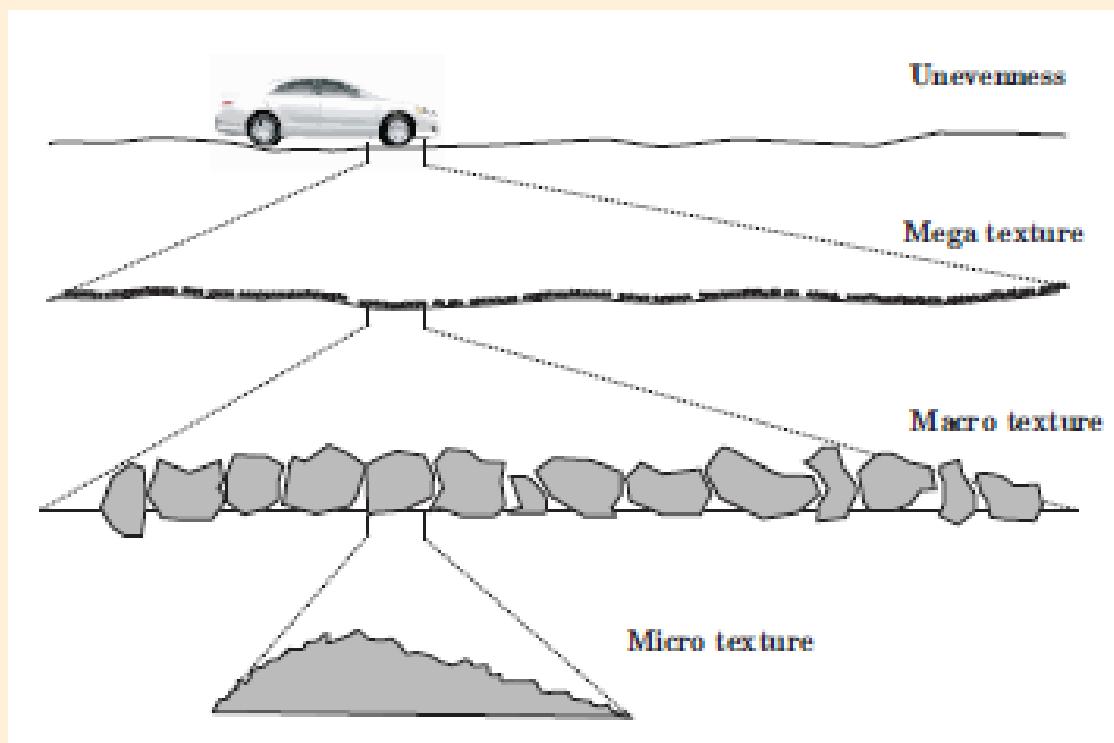
- **Surface texture affects the user!**
 - **Safety**
 - **Vehicle fuel economy**
 - **Noise**
- **Surface conditions influence decision-making processes and asset management strategies of state highway agencies.**

Big Questions

- **How is texture related to friction?**
- **What are desired test specifications and methods?**
- **What analysis techniques are available?**
- **What data is most critical for state agencies?**

Pavement Surface Texture

- Defined by four primary ranges.

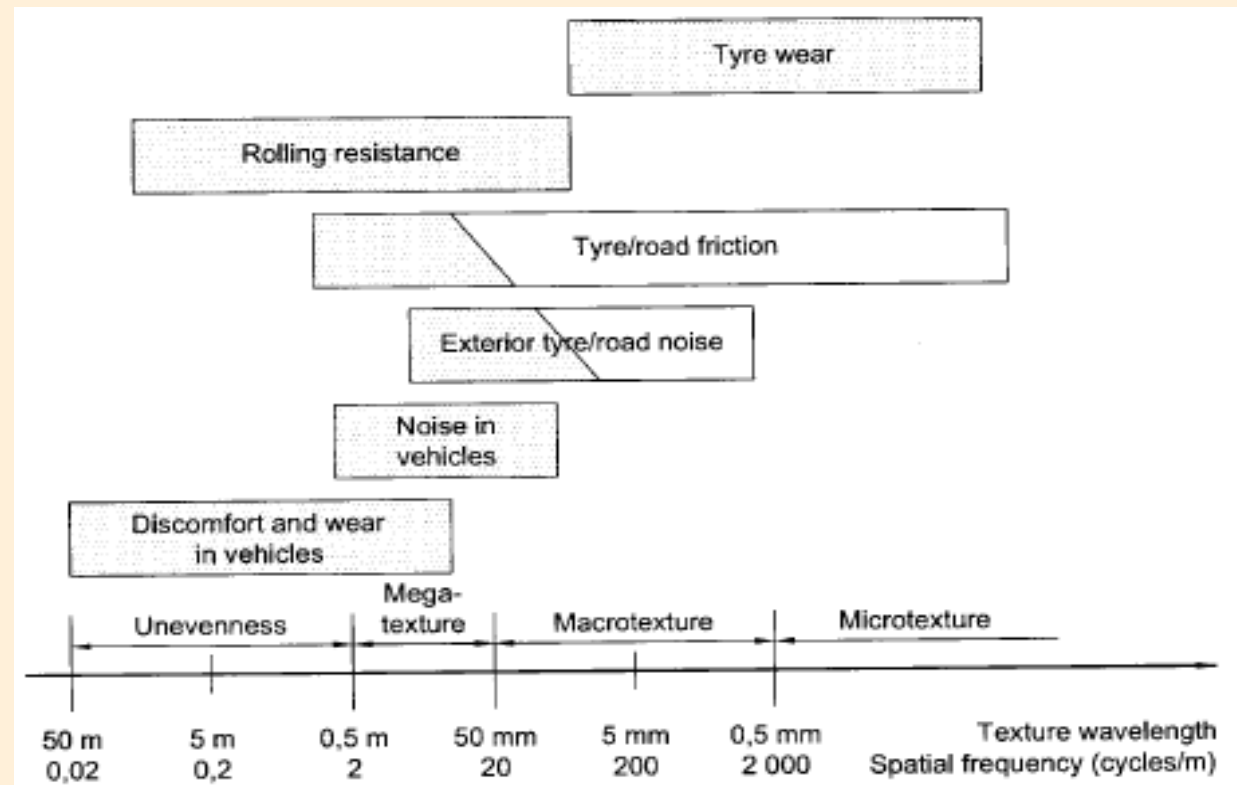


Result of mixture design, material characteristics, construction practices, and variability.

Name	Wavelengths	
Micro texture	<0.5	[mm]
Macro texture	0.5 - 50	[mm]
Mega texture	0.05 - 0.5	[m]
Unevenness	0.5 - 50	[m]

Effects of Surface Texture

- Rolling resistance
- Friction
- Tire wear
- Noise
- Vibration



Specifications

- **AASHTO, ASTM, ISO standards for friction and texture measurement methods and devices.**
- **Several indices have been developed, though a unified standard has not appeared.**

Ratings and Indices

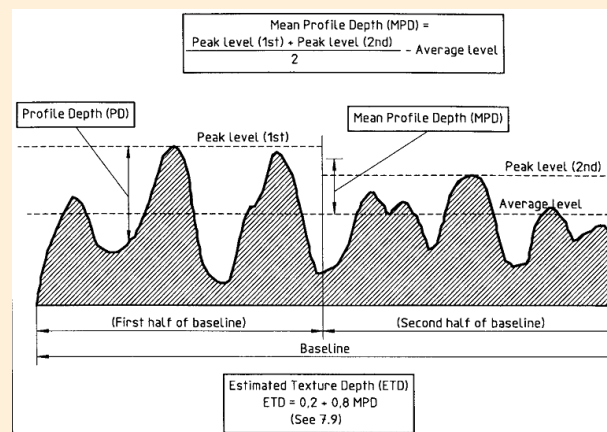
- **Roughness and Unevenness**
 - International Roughness Index (IRI)
- **Friction Indices**
 - International Friction Index (IFI)
 - Friction Number (FN)
- **Texture**
 - Mean Profile Depth (MPD)
 - Mean Texture Depth (MTD)
- **Other rating systems**

Key Processing Method

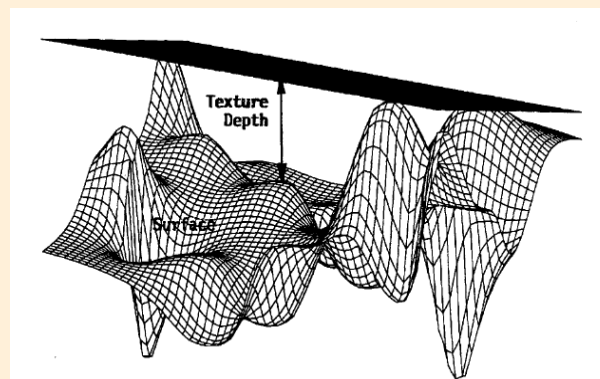
- **Use laser profiling techniques and theories to analyze surface texture.**
- **Treat surface profiles as signals, analyze with Discrete Fourier Transform methods to determine frequency spectral content.**
- **Investigate asperity distribution, relate spectral attributes to user impacts and pavement distresses.**

Current Texture Metrics

- Mean profile depth (MPD)

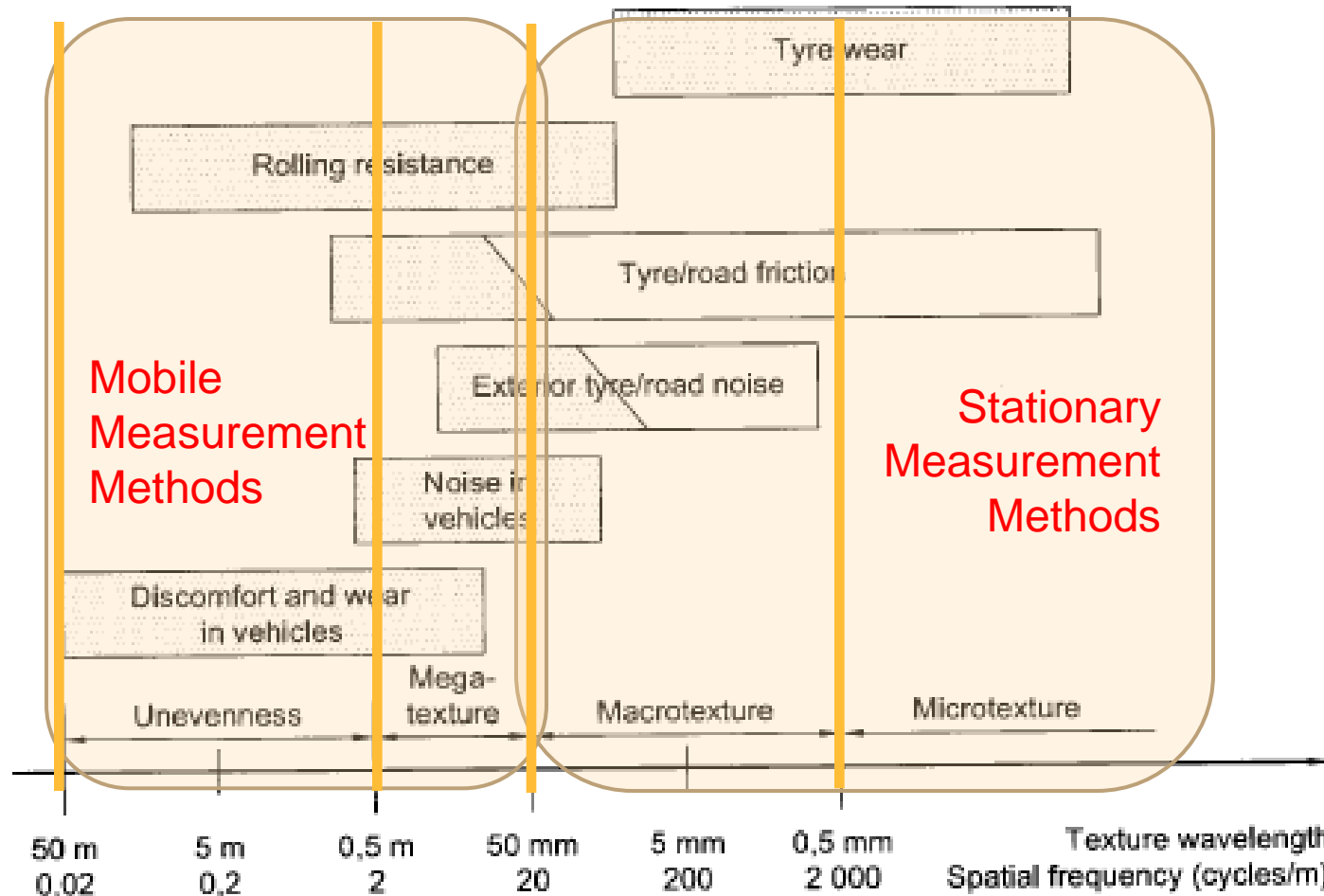


- Mean texture depth (MTD)



Source: ISO 13473-2, 2002

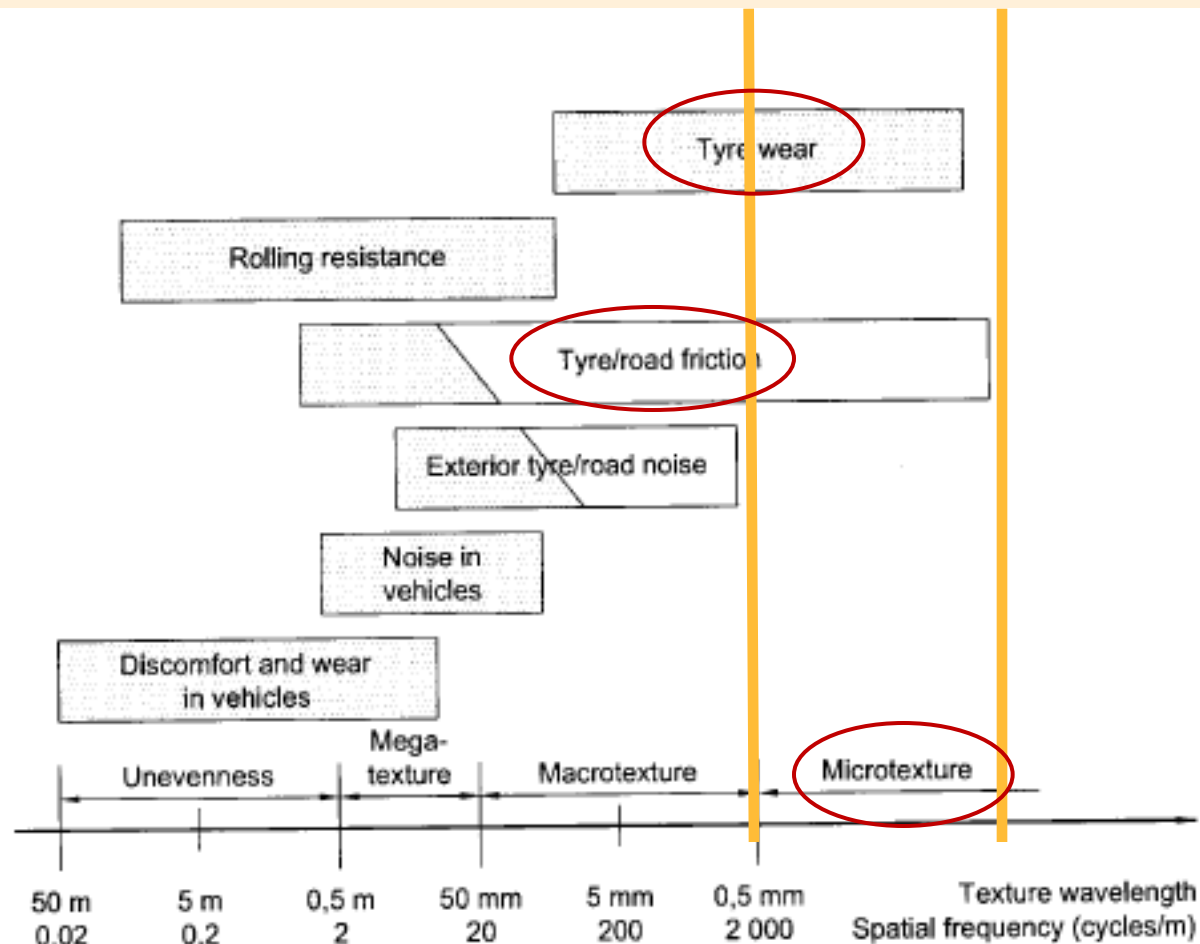
Effects of Texture Spectrum



Investigating Surface Texture

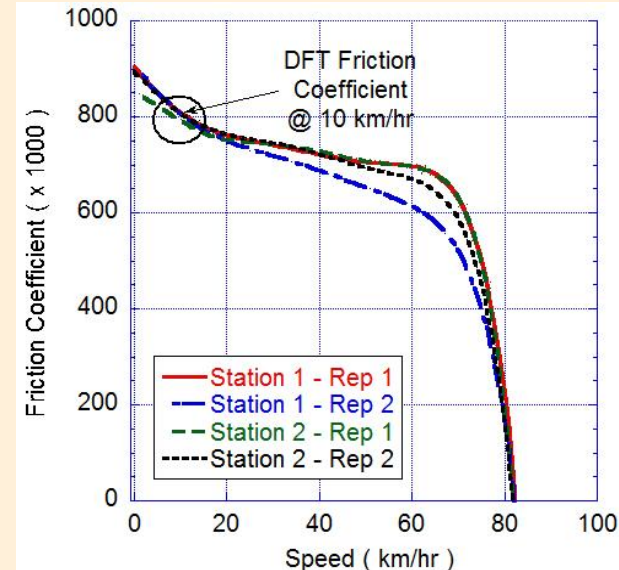
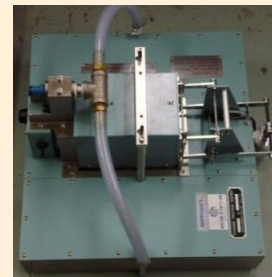
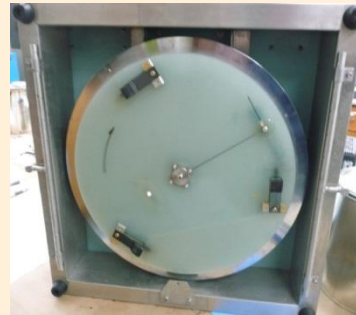
- **Micro-texture**
 - Rubber pad friction tests
- **Macro-texture**
 - Texture meter
 - Sand patch
 - Laser profilers
- **Mega-texture**
 - Skid trailers
 - Mobile profilers
- **Unevenness**
 - Mobile profilers
 - Full-scale ride testers

Effects of Texture Spectrum: Micro-Texture



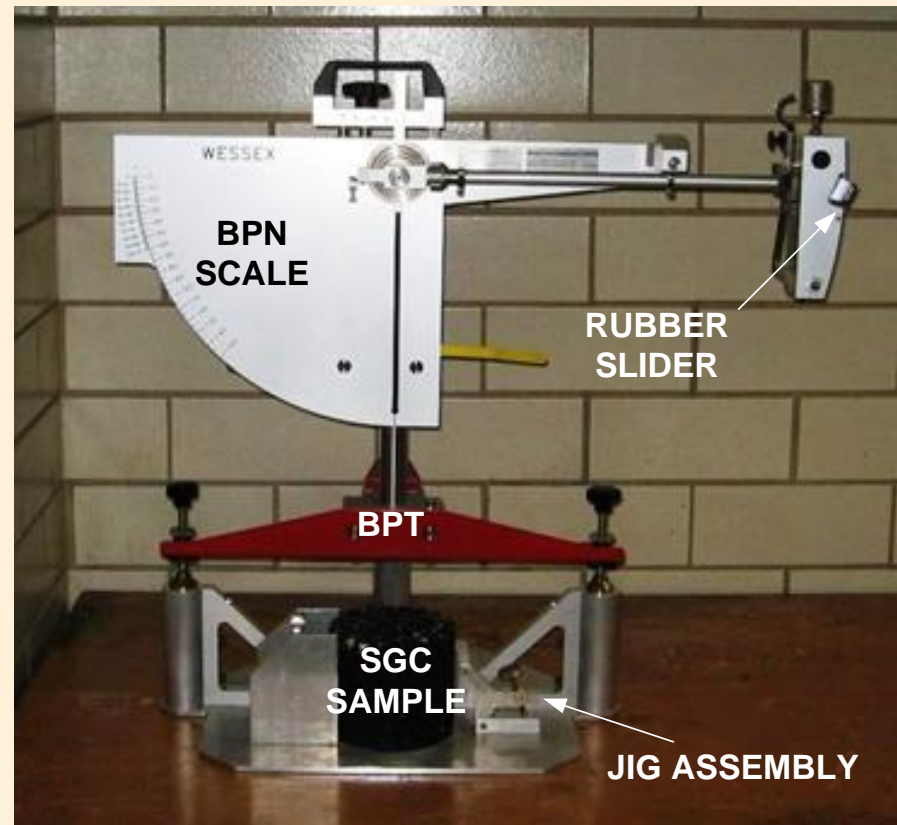
Dynamic Friction Tester (DF Tester)

- Rotating rubber sliders contact pavement surface to produce friction profile.
- Available for field tests.
- Requires water supply.

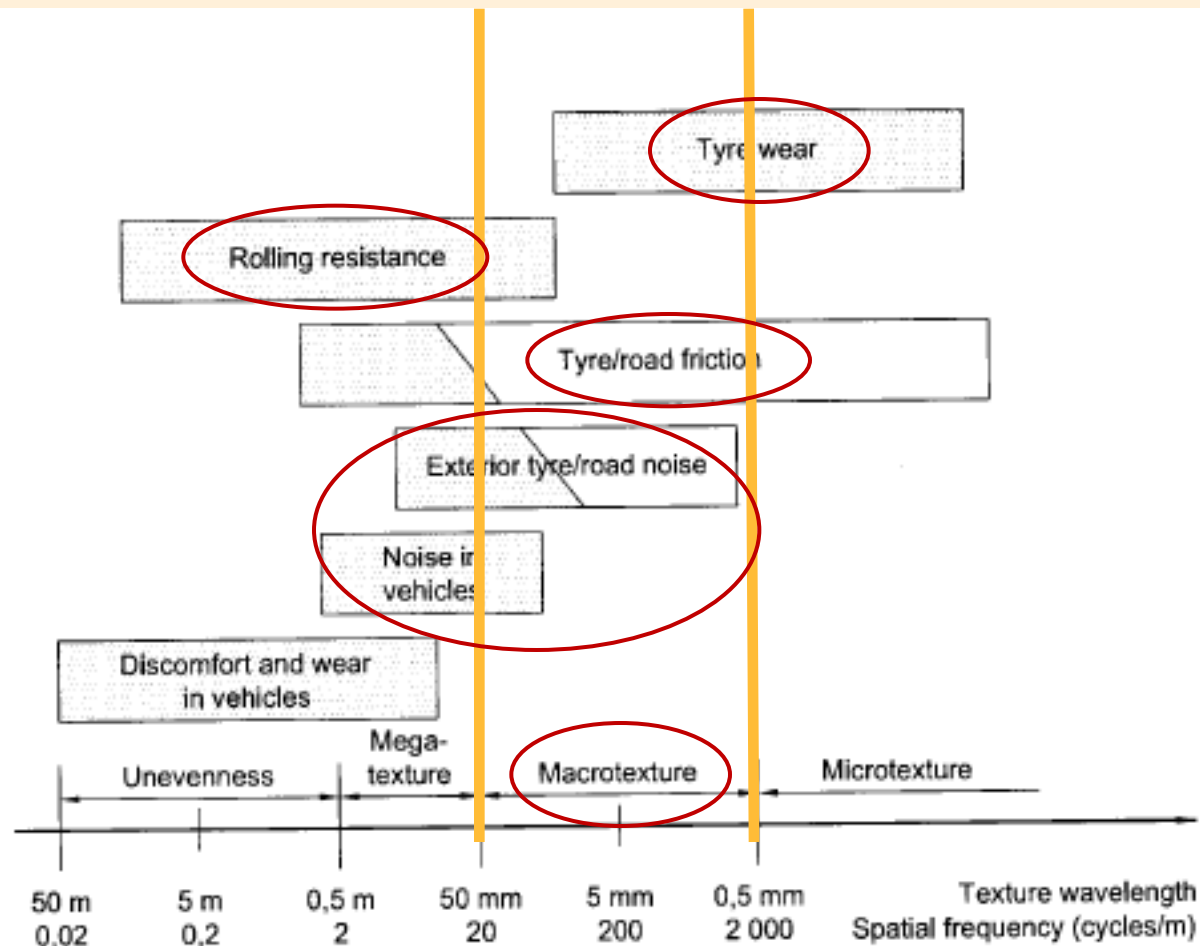


British Pendulum Tester (BPT)

- Rubber slider mounted on pendulum contacts pavement surface while raising pointer on BPN scale.
- Available for lab and field tests.



Effects of Texture Spectrum: Macro-Texture



Circular Track Meter (CTM)

- Laser traces circle, which is divided into 8 segments for analysis.
- When combined with the DF Tester, the CTM can be used to calculate IFI values.



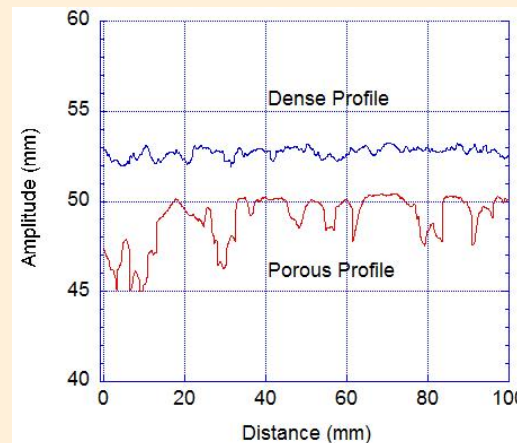
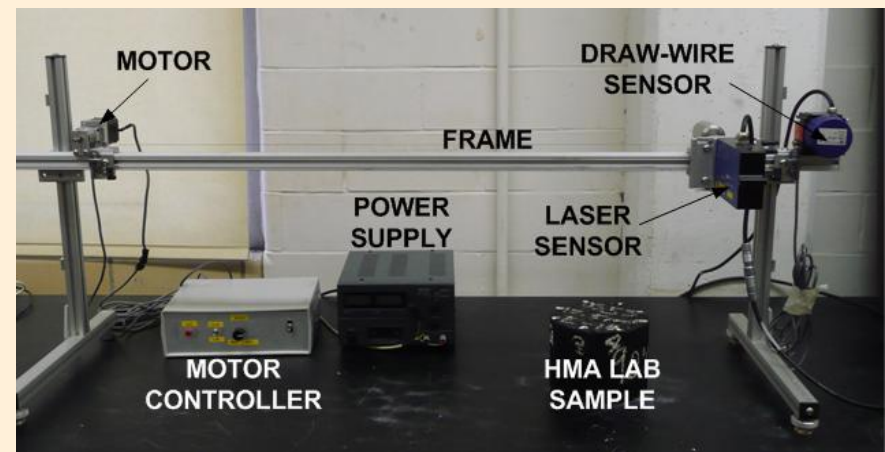
Sand Patch Test

- **Basic, widely used test to estimate pavement mean texture depth (MTD).**
- **Spread circle of sand on pavement, measure circle diameter, calculate MTD.**

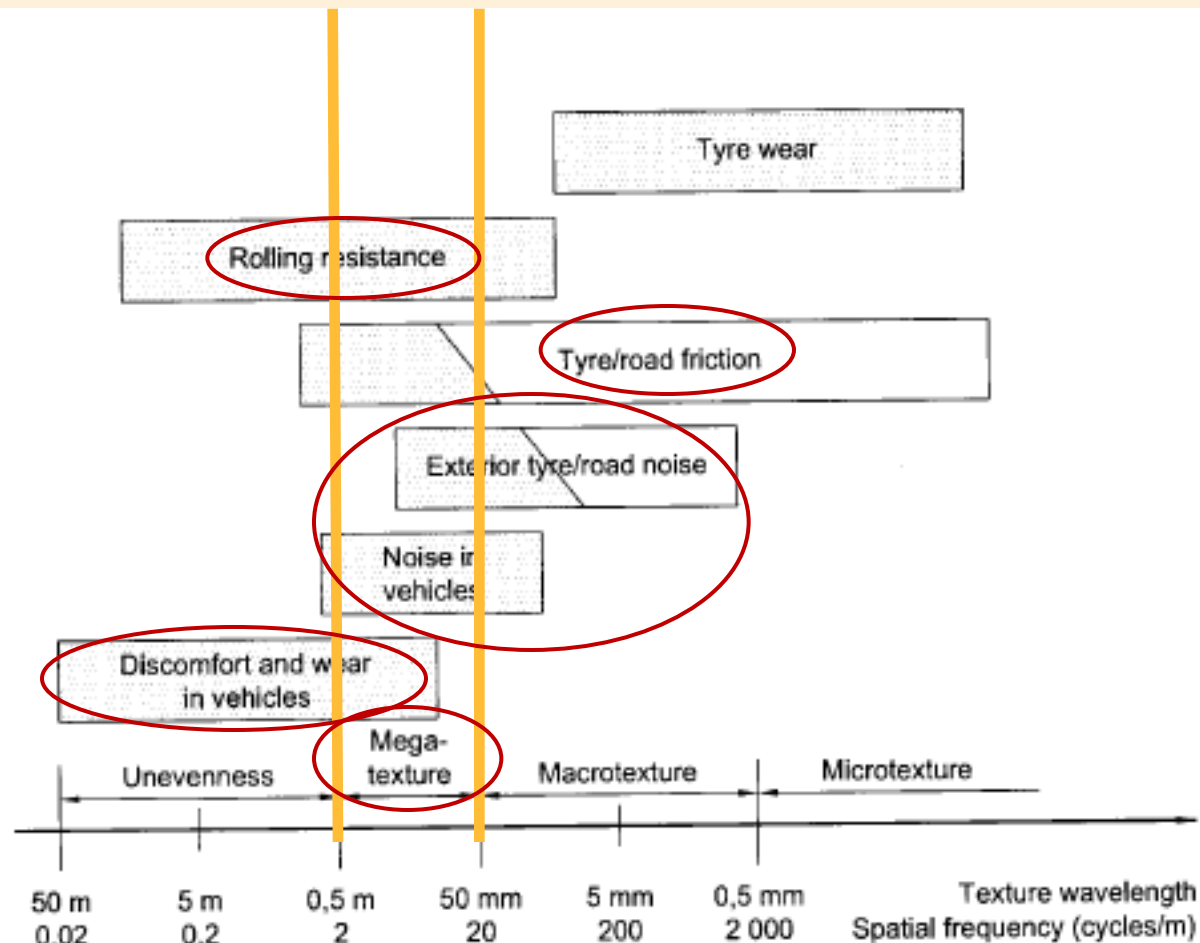


Stationary Linear Profiler (SLP)

- Assembly developed by UW-Madison for FHWA's ARC program.
- Evaluate in-service pavements, HMA cores and SGC lab samples.
- Obtain profiles for TSA evaluation.



Effects of Texture Spectrum: Mega-Texture



Mobile Profiling Equipment

- Automated data collection vehicle (ARAN)
- Laser profiler in front, imaging cameras in back
- GPS and GPR integration

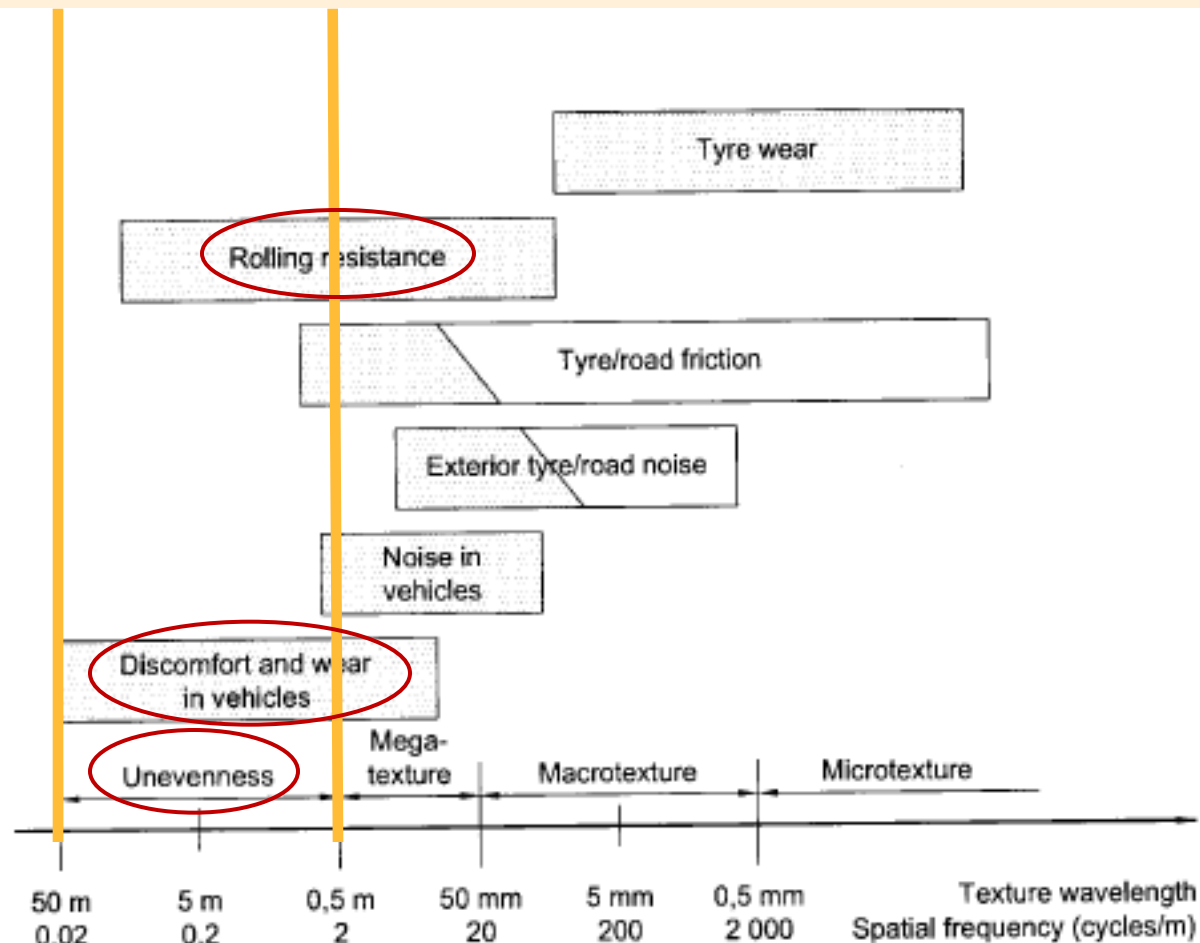


Skid Testing

- States contracting network-level skid projects to inform asset management strategies.
- Requires two people, tow vehicle, skid trailer, data processing.



Effects of Texture Spectrum: Unevenness



How do we link all this together?

- **Texture spectral analysis**

Pavement “Fingerprinting”

- A person’s fingerprint distinguishes them from billions of other people.
- Texture spectral analysis (TSA) techniques allow for unique identification of pavement surface characteristics.

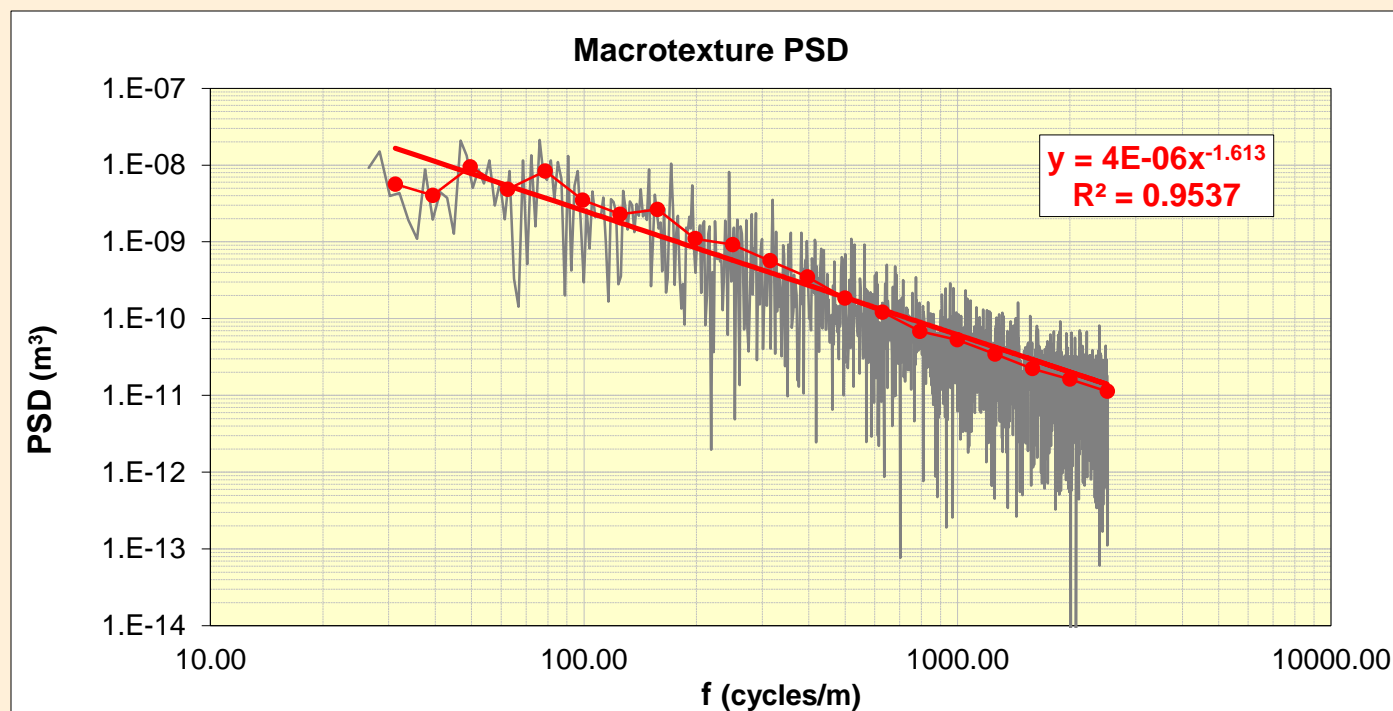


Pavement “Fingerprinting”: TSA

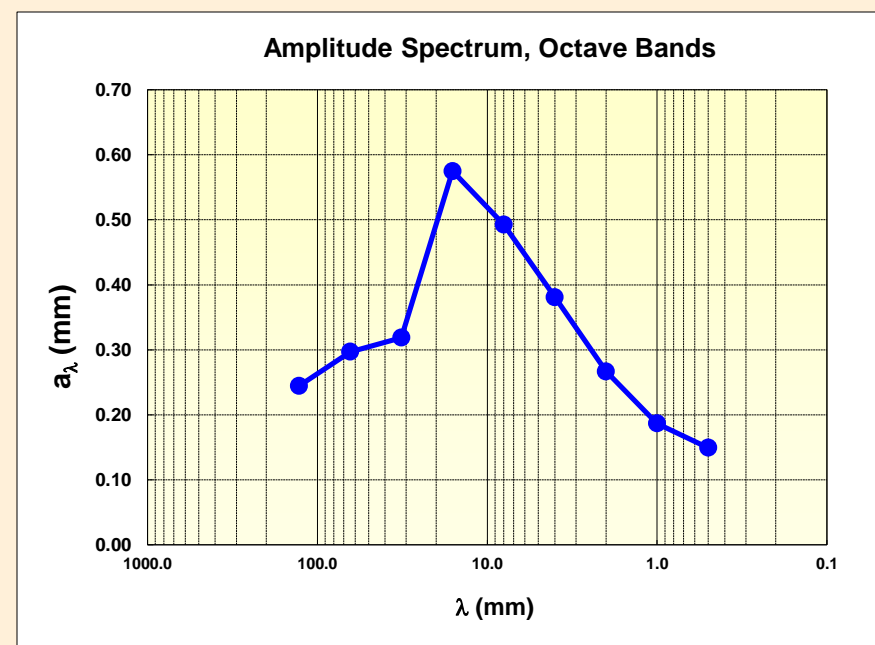
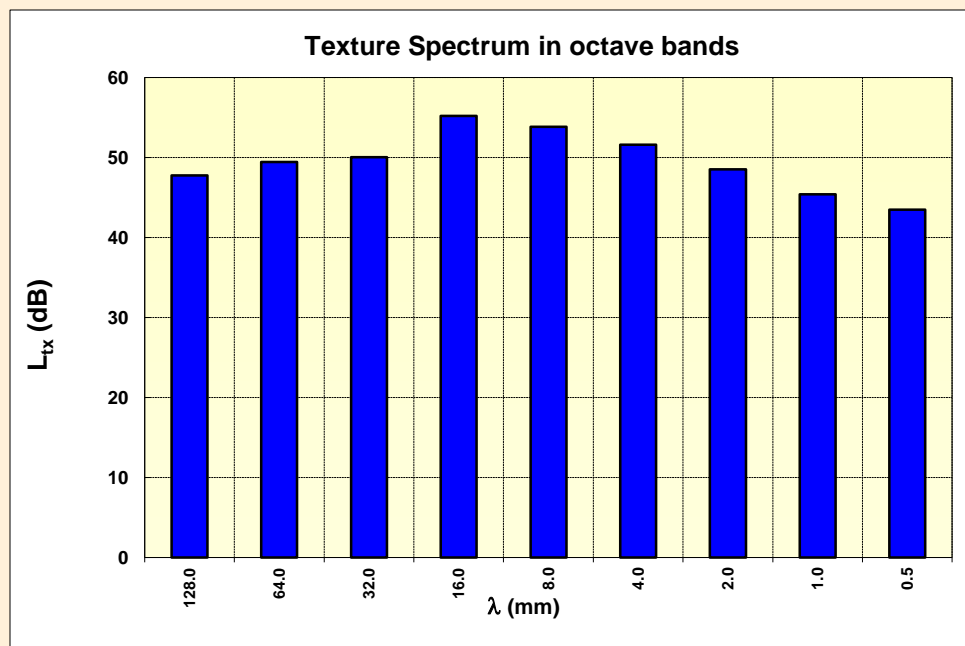
- Utilize a stationary linear profiler (SLP).
- Analyze profile using Discrete Fourier Transform to produce the power spectral density (PSD).
- Two types of spectra derived from the PSD:
 - Amplitude Spectrum
 - Texture Level Spectrum

Power Spectral Density

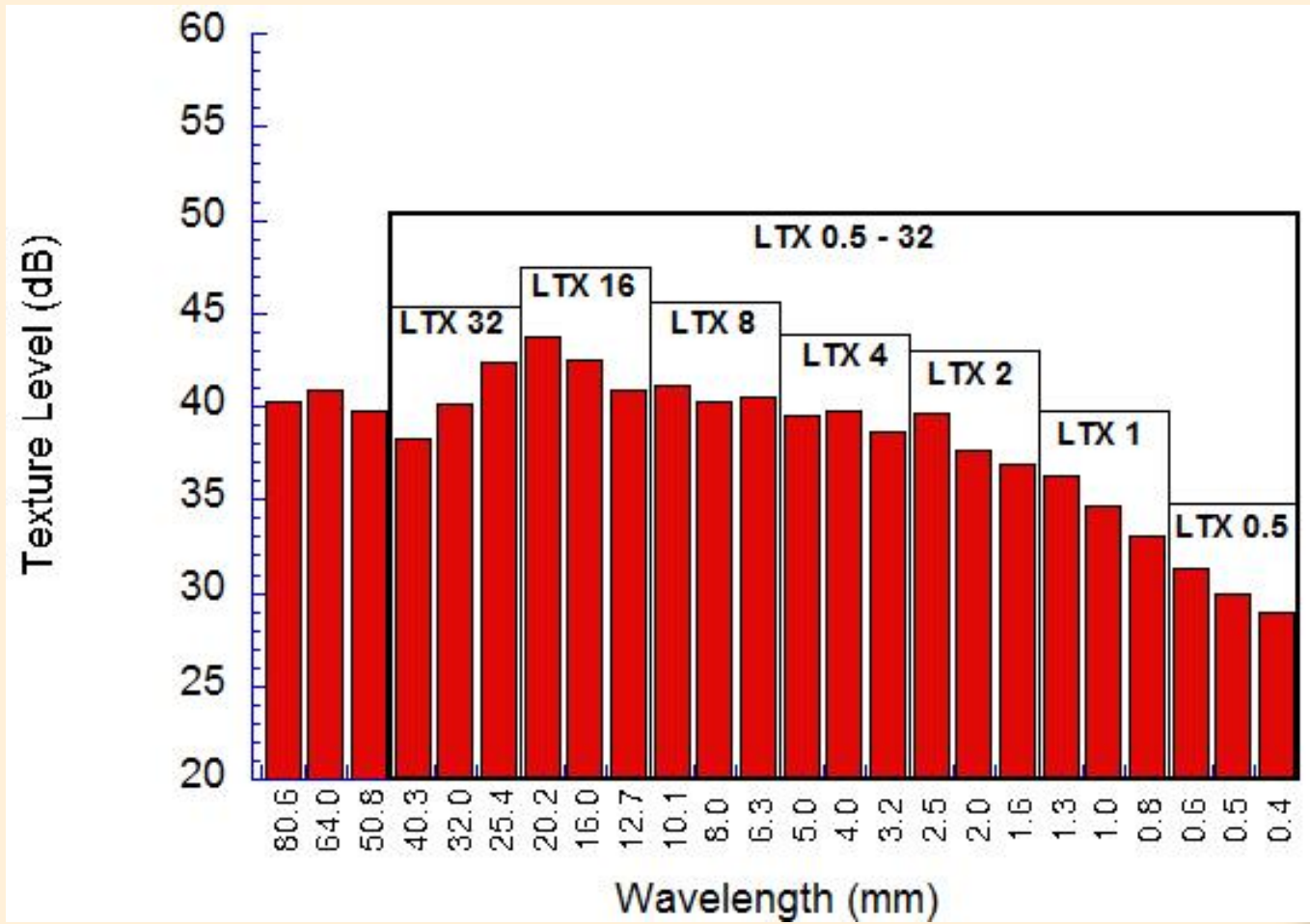
- Describes frequency content of pavement signal



Amplitude & Texture Spectra



Texture Level Distribution



Lessons Learned

- **Need full-scale field experimentation for validation!**
- **Lab work demonstrates texture-friction relationship to micro-texture and macro-texture at low end of spectrum.**
- **Questions remain at high end of spectrum with mega-texture and unevenness.**

Next Steps

- **Expand data collection efforts to other states and regions.**
- **Validate findings at existing test tracks.**
- **Develop pooled-fund proposal among state agencies.**

Acknowledgements

- **Asphalt Research Consortium,
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- **Fugro Consultants, Inc.**

Thanks for listening!

Questions?

Comments?

Other Feedback?