The use of Texture Measurements to Model Skid Resistance

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RPUG Road Profile Users' Group

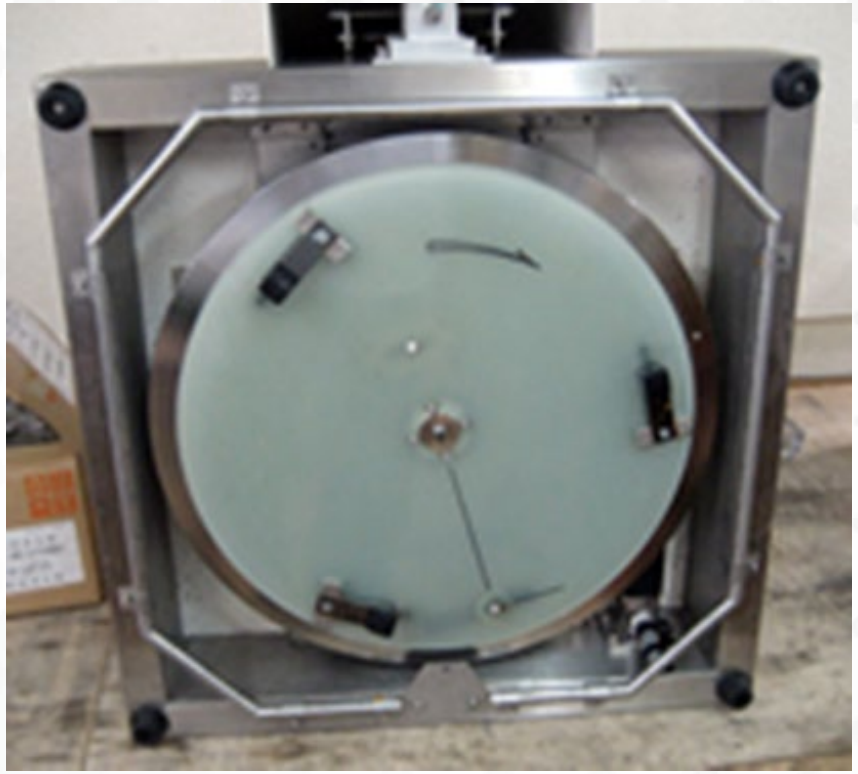
Tire-Pavement friction affects safety

- Tire-pavement friction has a critical impact on safety for highways and runways
  - With increased traffic levels and speeds there is a need for higher grip to stop vehicles at a shorter distance
  - With the recent requirements for short stop distances on runways and increased landing overruns on contaminated runways there is a need to revise the surface friction requirements

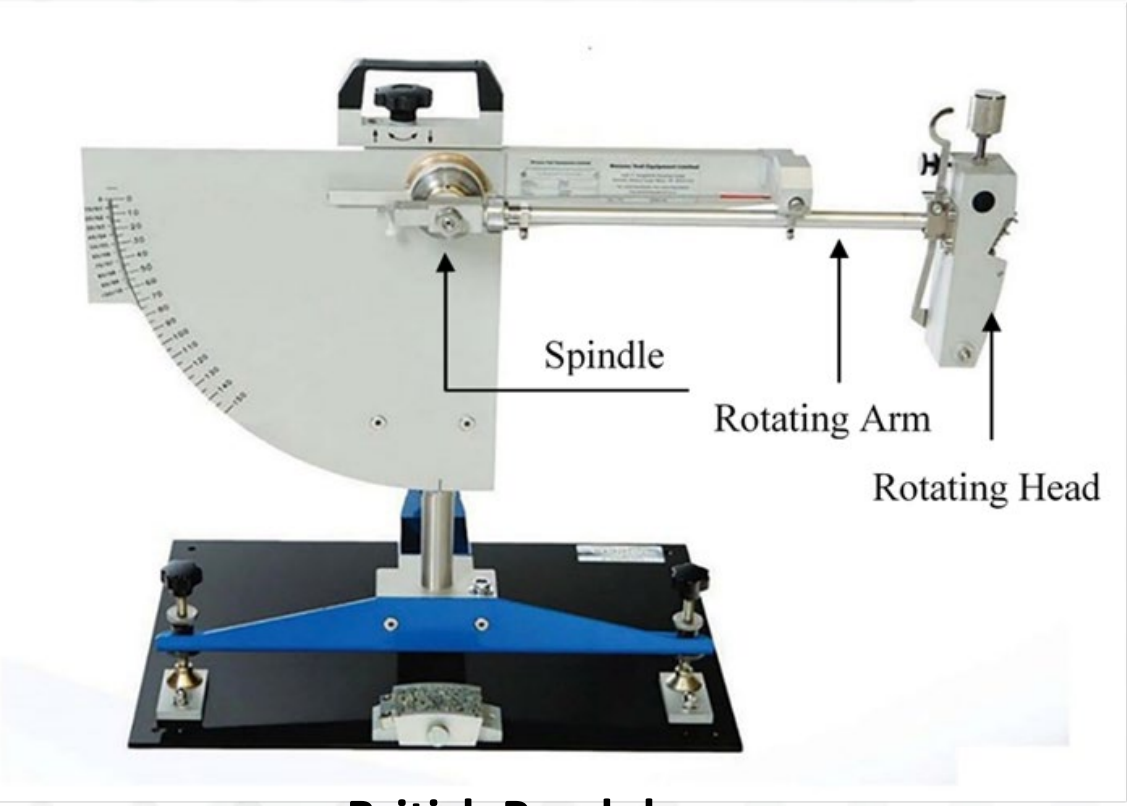
Understanding how friction develops will improve practices

- There are significant ongoing efforts to improve data collection and establish friction management programs.
- There is a gap in our understanding of how friction emerges at the tire-pavement interface under different conditions.
- There is still a gap in understanding and quantifying the impact of texture on friction.

Friction Measurement (1/3)



Dynamic Friction Tester (after Nippo Sangyo Co., Ltd)



British Pendulum

Friction Measurement (2/3)

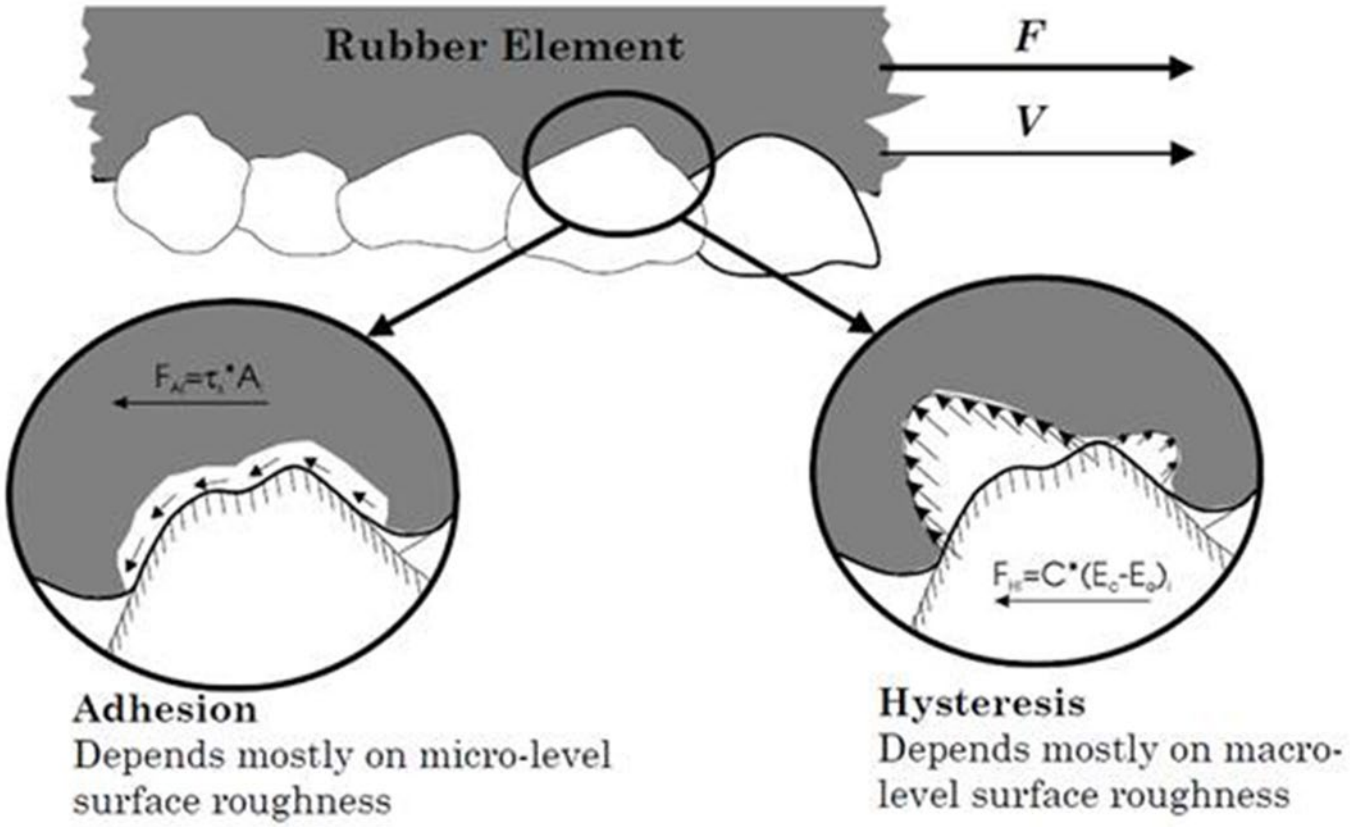
Locked Wheel Skid Tester

Friction Measurement (3/3)

Sideway-Force Coefficient Routine Investigation Machine (FHWA)

Fundamentals of friction and skid resistance

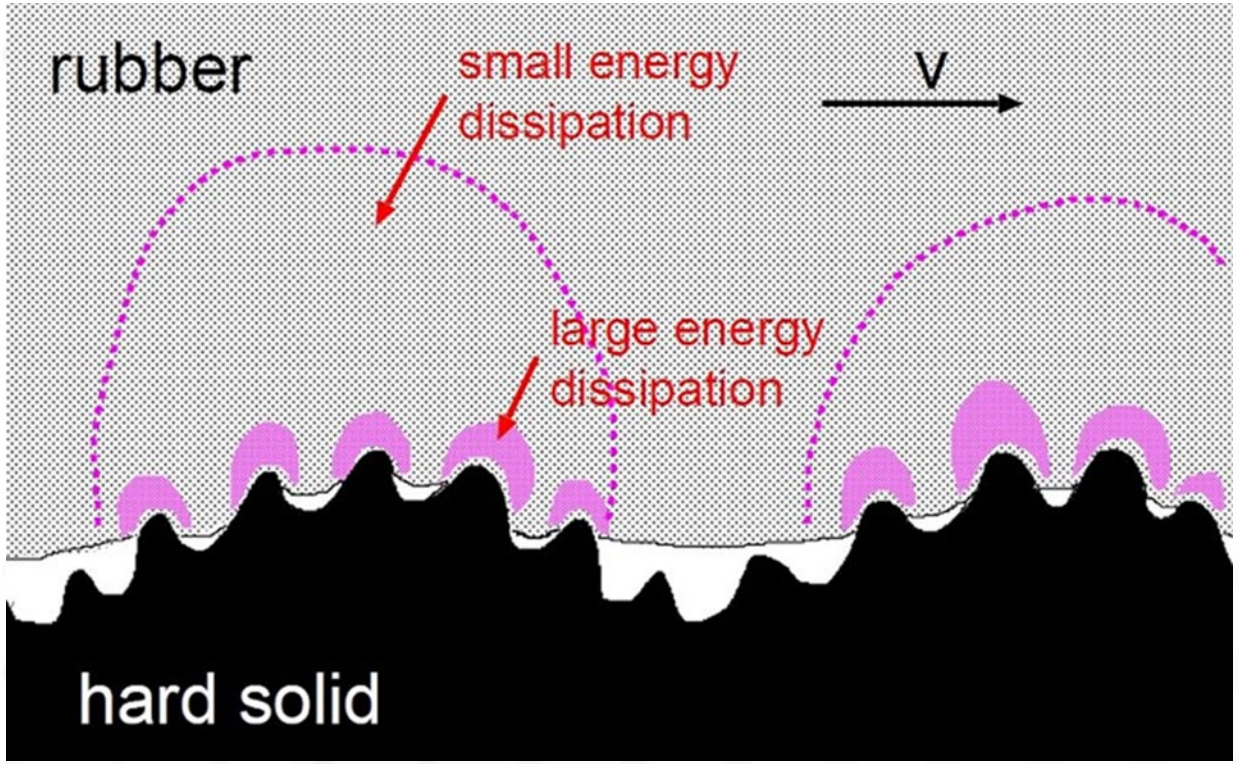
- Friction develops at the tire-pavement interface due to two major mechanisms: Adhesion and Hysteresis
- Many of the traditional models were generic and did not always provide a fundamental formulation to quantify these interactions



Hall 2009

Quantitative models relating texture to friction

- Persson's friction model provided a closed form solution to estimate the coefficient of friction from surface texture.



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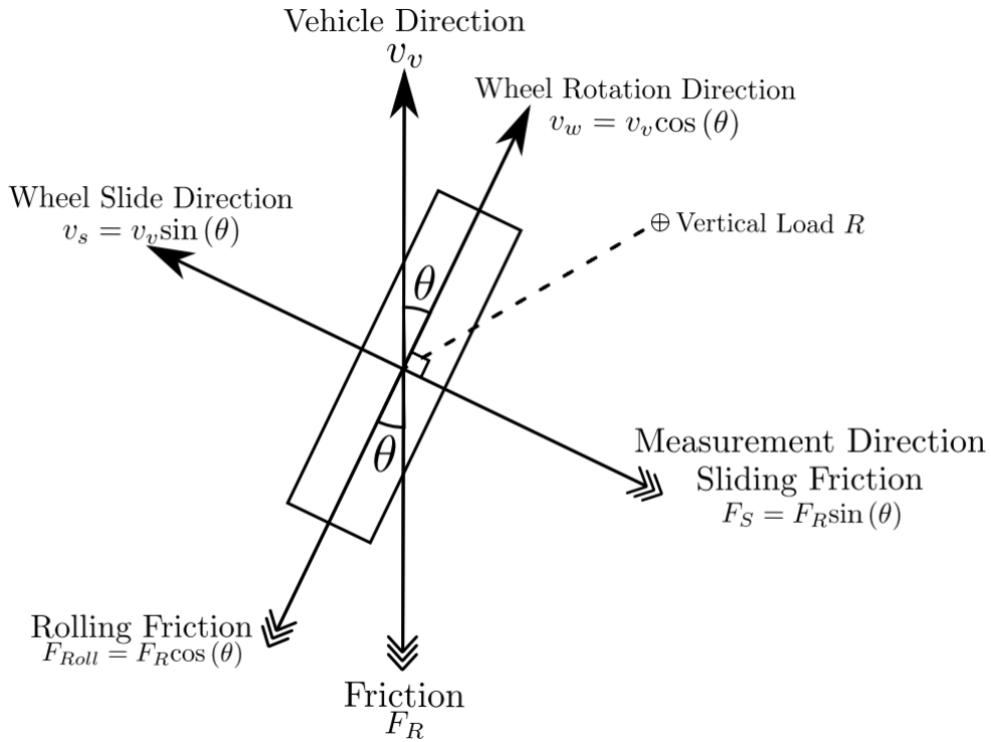
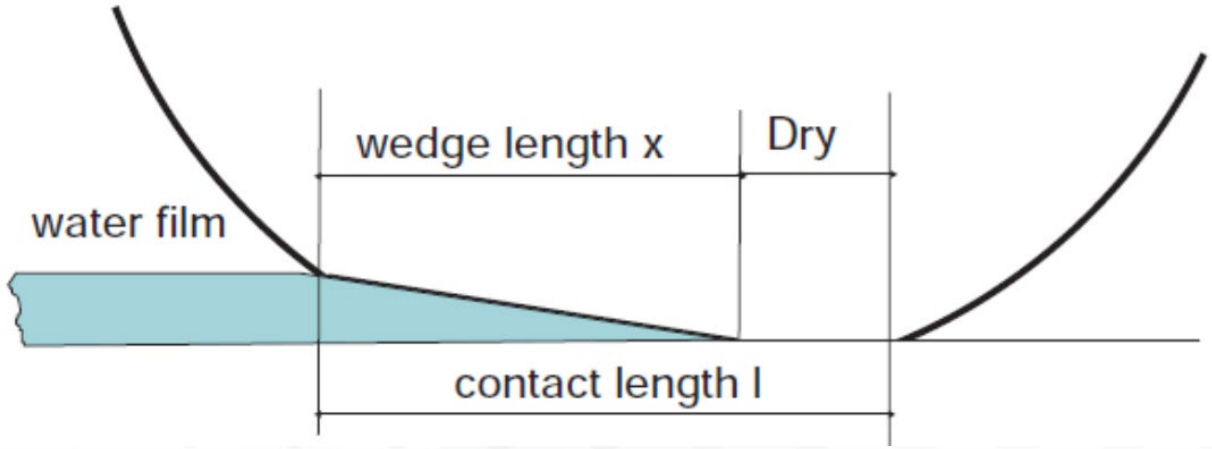
Total traction is affected by other factors



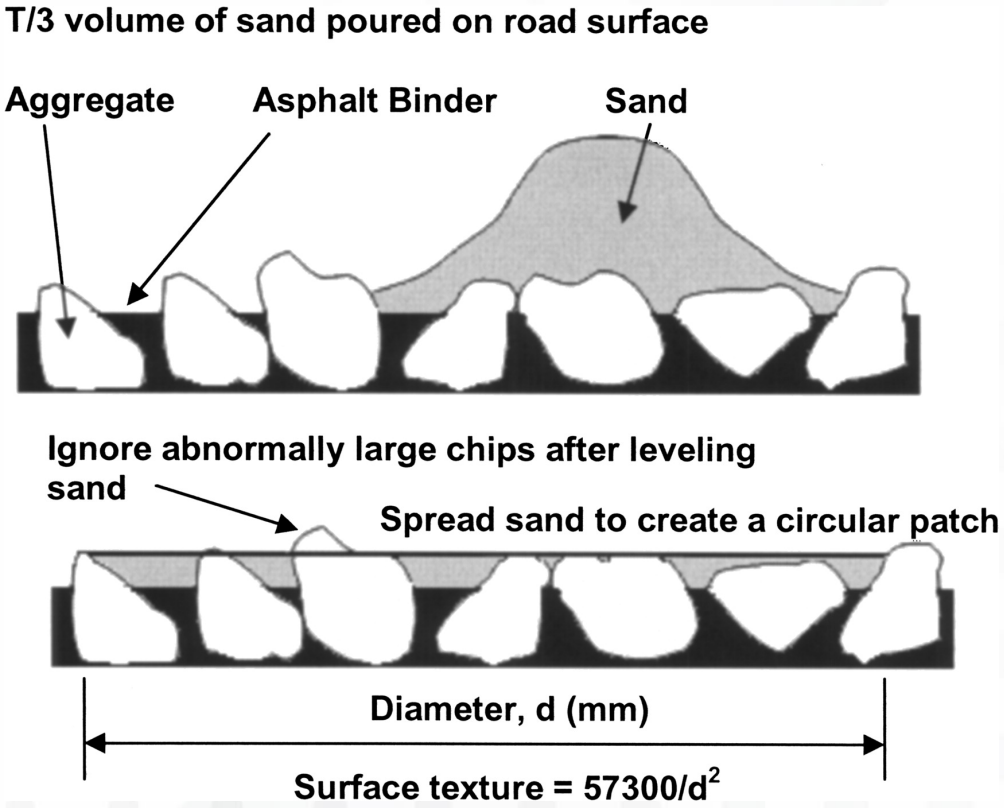
Characterising the measurements made by sideways-force skid resistance devices 2020



The Pneumatic Tire 2006

How is texture captured in the field?

Sand Patch Test

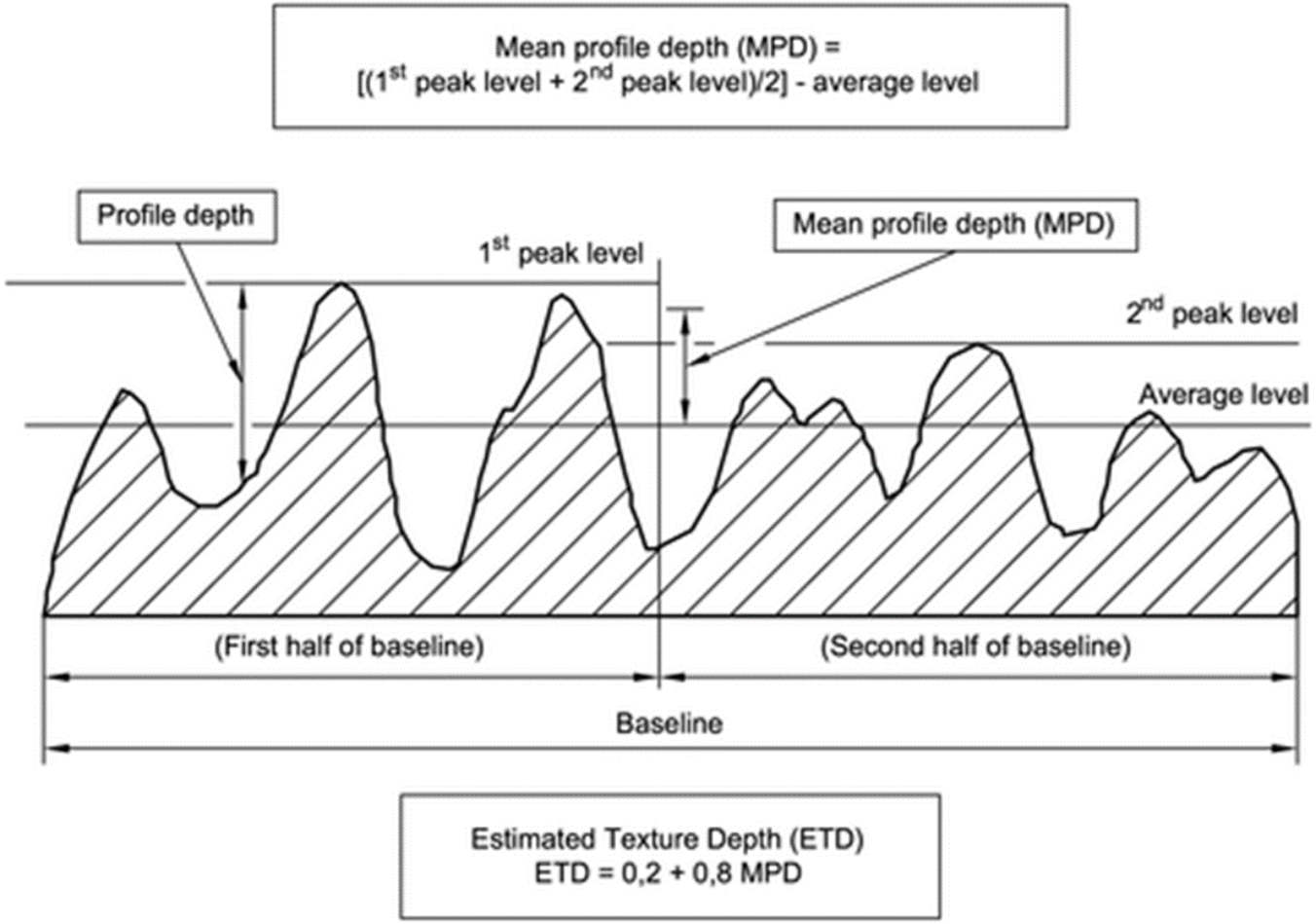


Douglas D. Gransberg (2007)

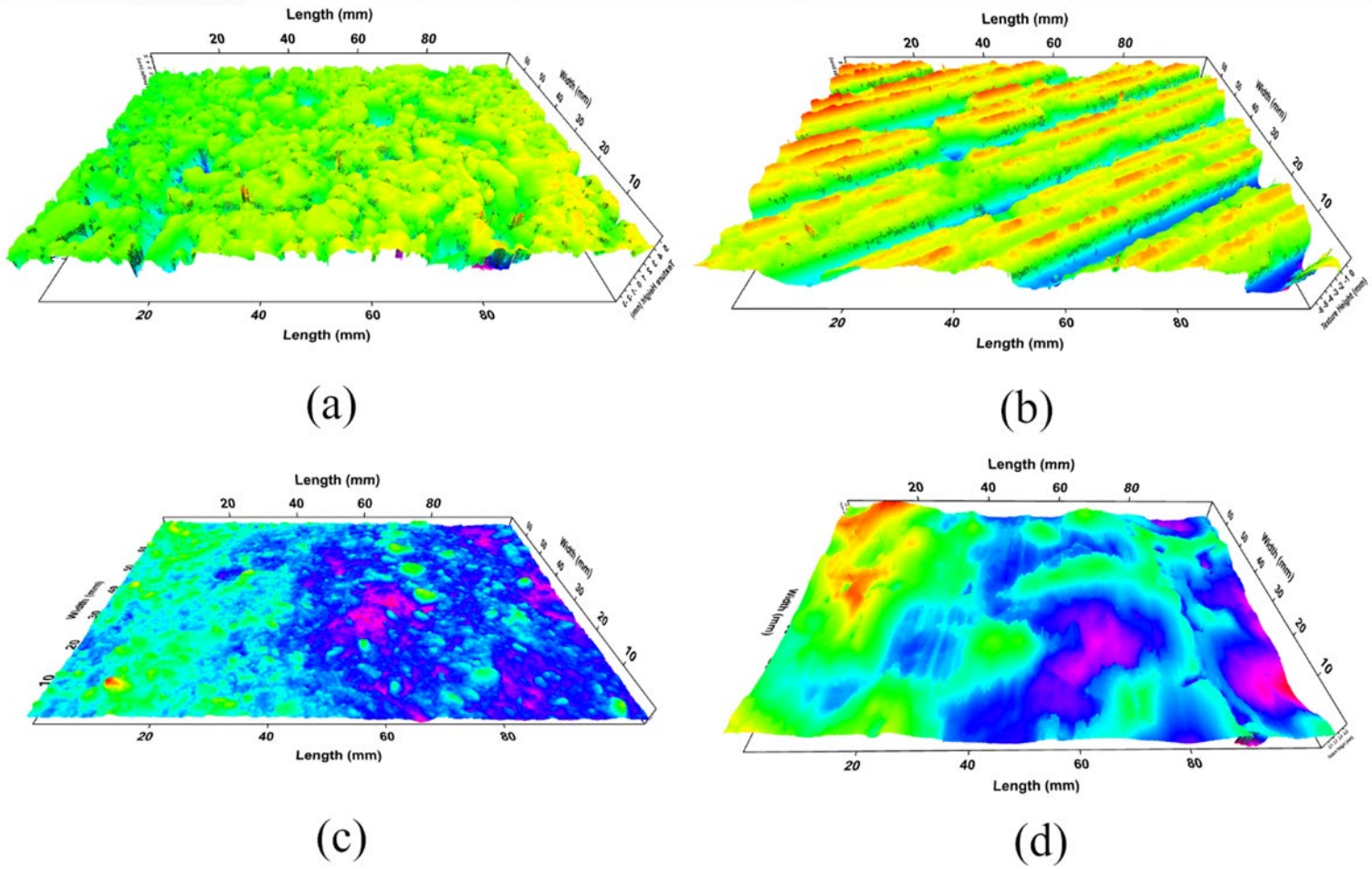
Non-Contact texture measurements

Texture characterization from surface profiles

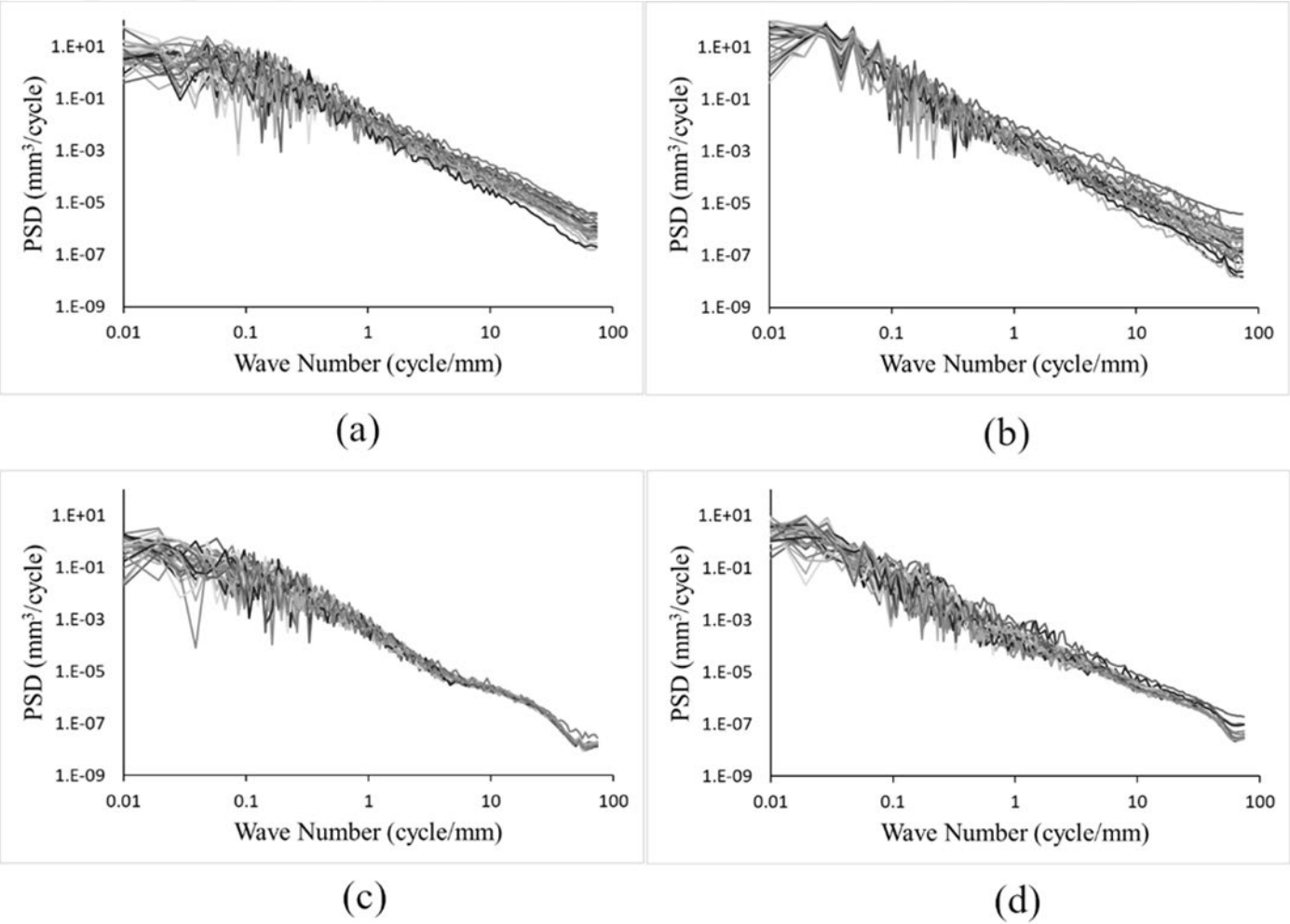
ISO 13473-2:2002



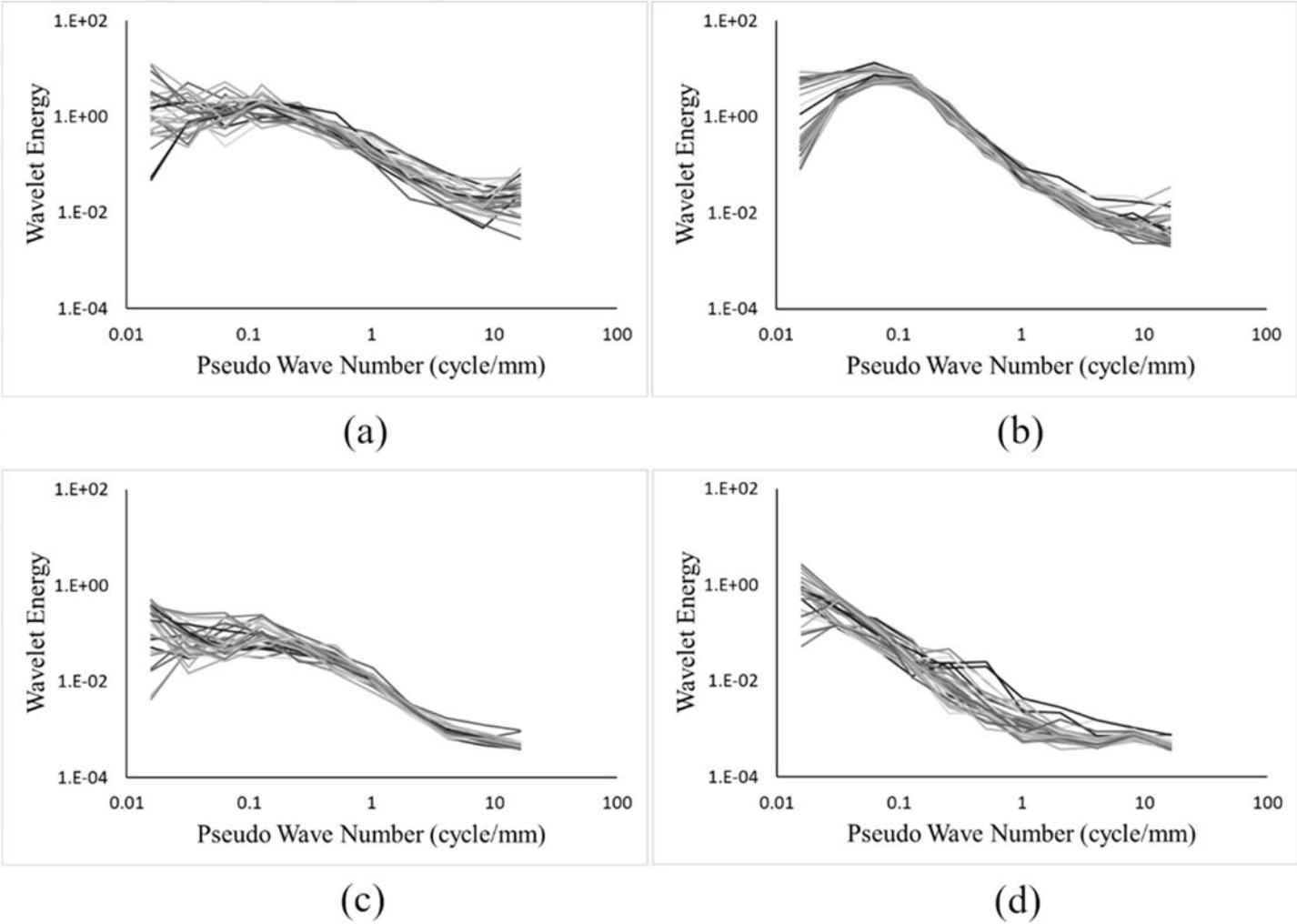
High resolution profiles can provide greater details



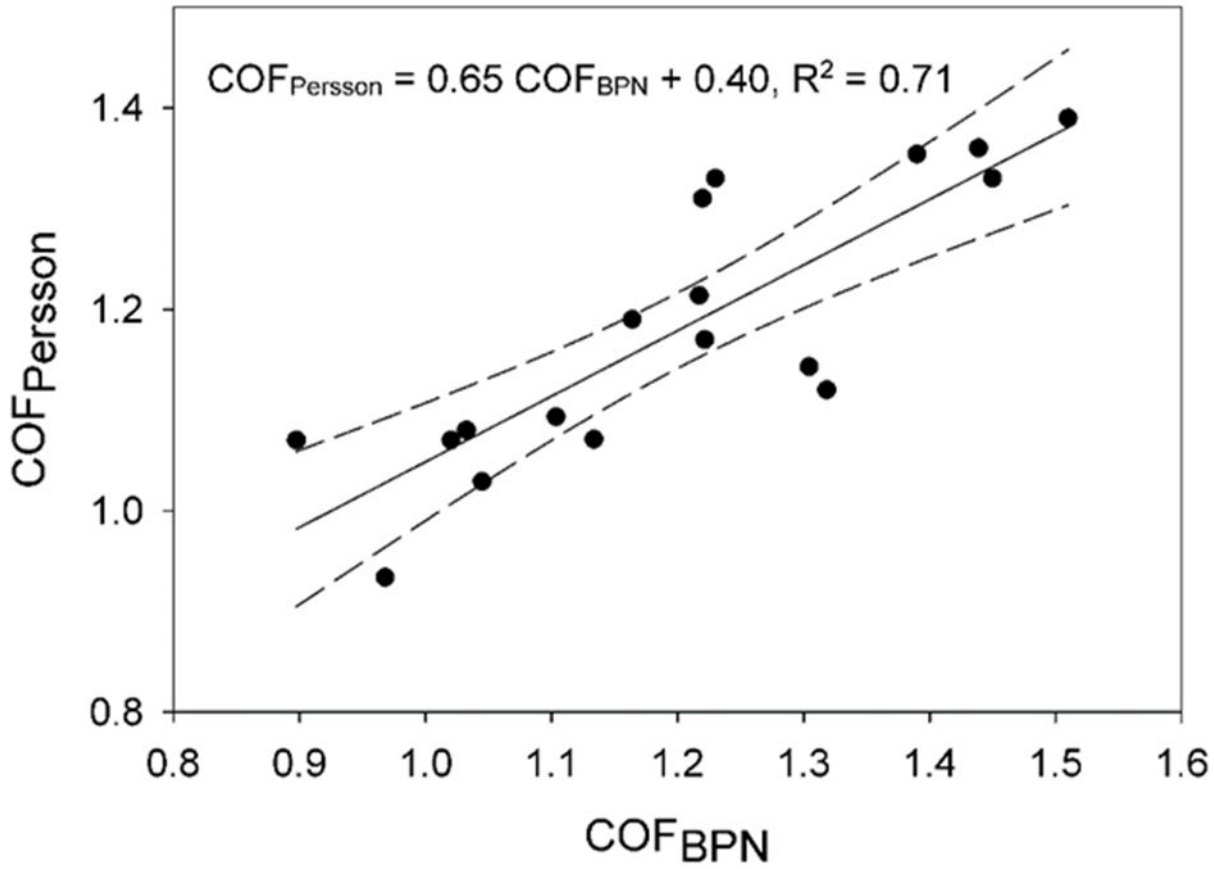
Power spectral density is used in Persson's model

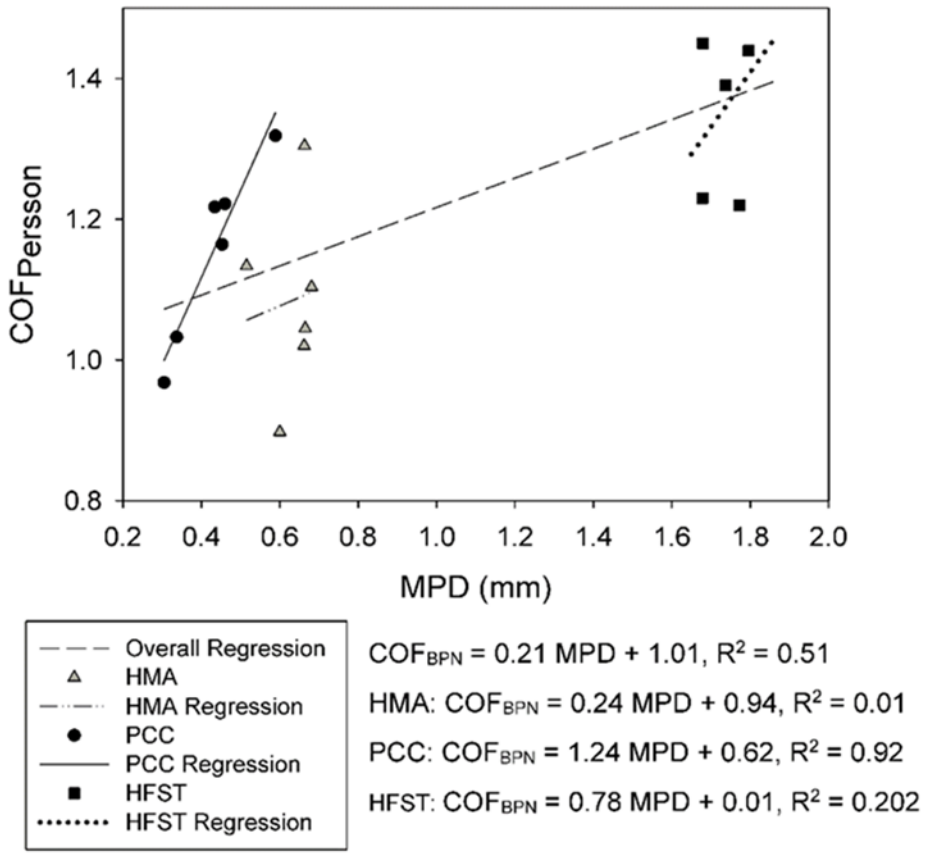


Wavelets provide more unique signatures

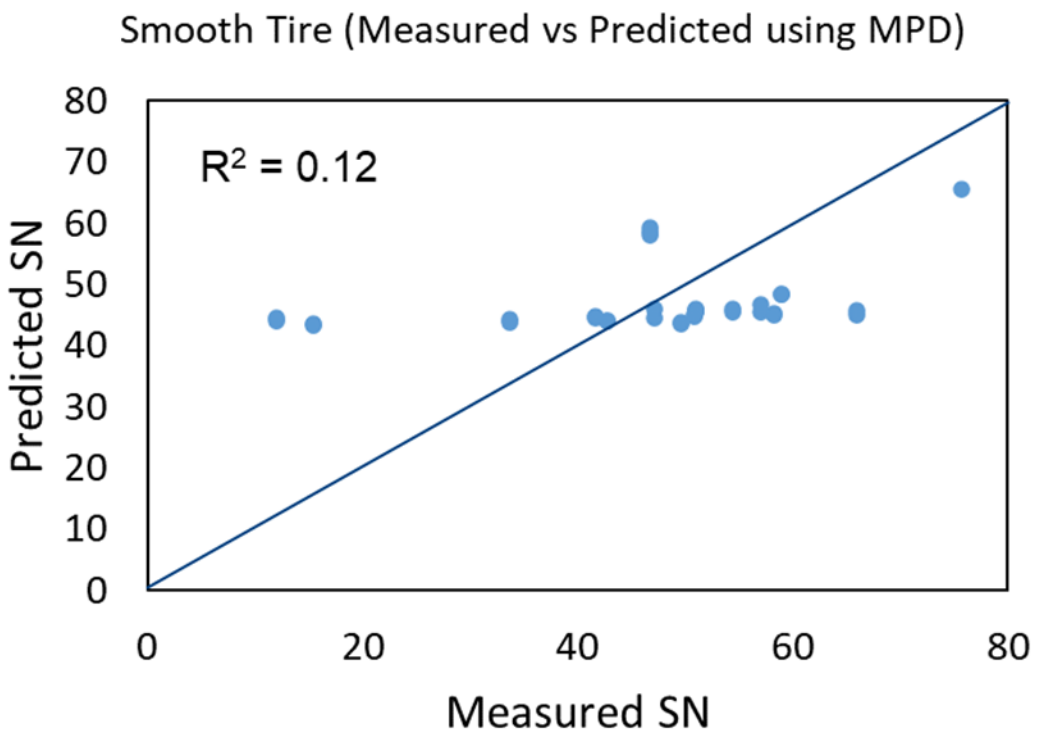


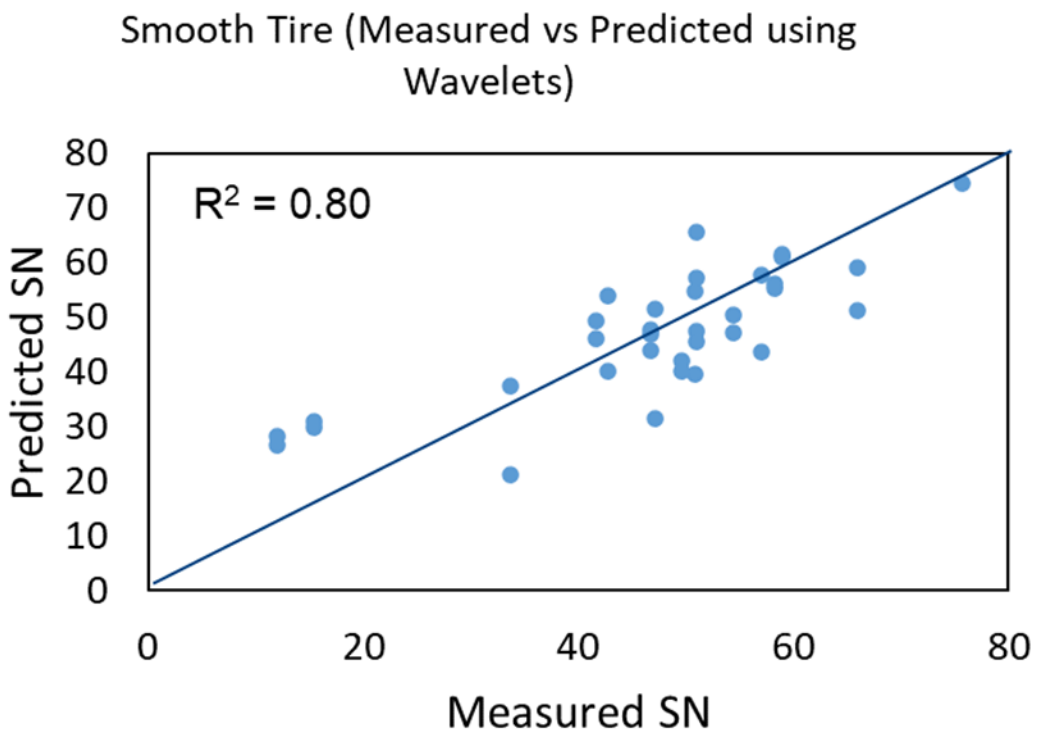
Analytical models capture a wide range of surfaces



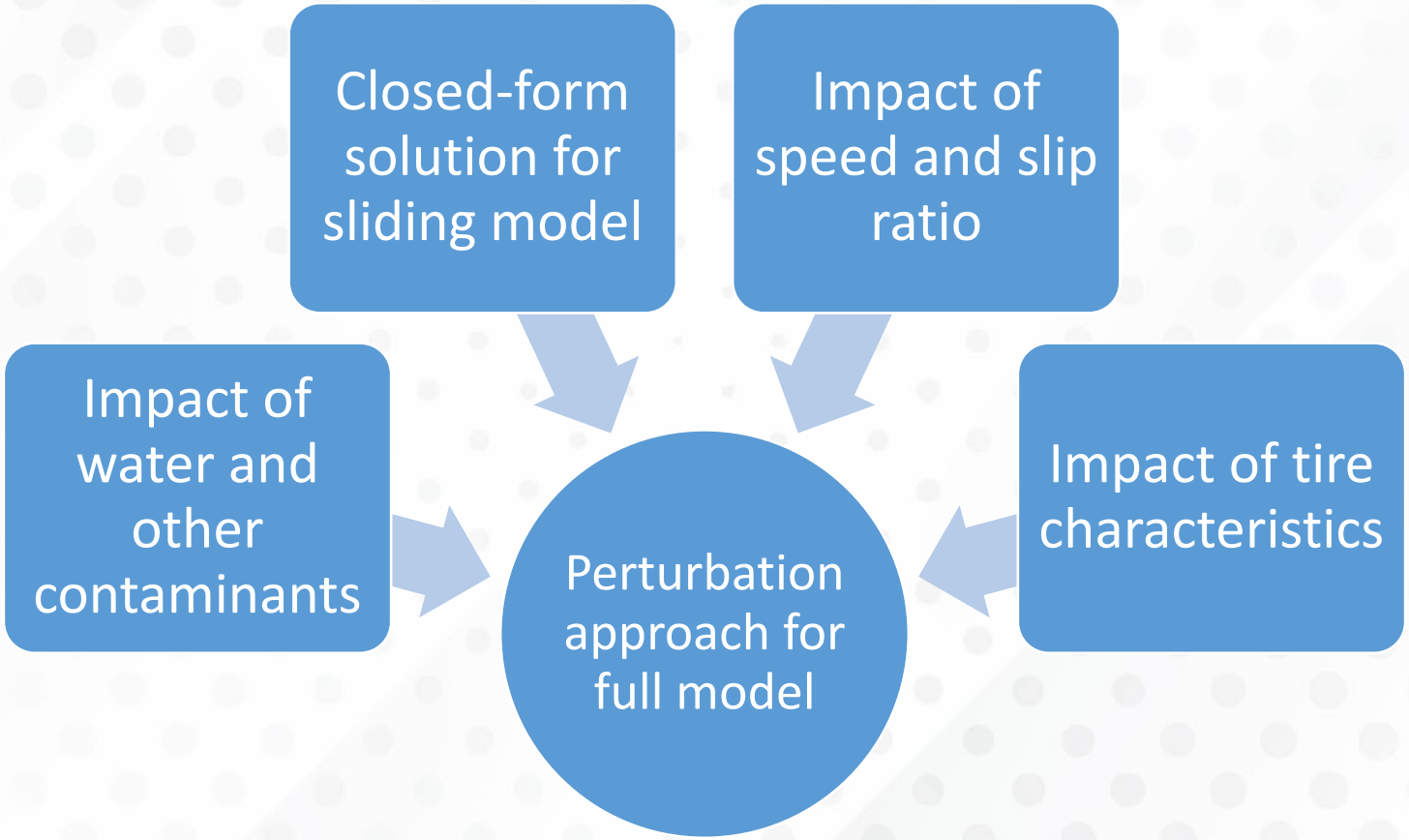


Simple correlation analysis is promising





An innovative approach to complex problem



Summary and future research

- ARA is building on previous observations to create general and practical solutions:
  - Revising and improving our understanding of the texture-friction relation will play a critical role in designing surfaces and improving maintenance practices
  - Combined analytical and empirical solutions can provide a new solution to sophisticated problems
  - The team is investigating the texture-friction solution in highway and runway applications

Question and Discussion