Using High Speed Macrotexture Profilers for Full Scale Texture Characterization

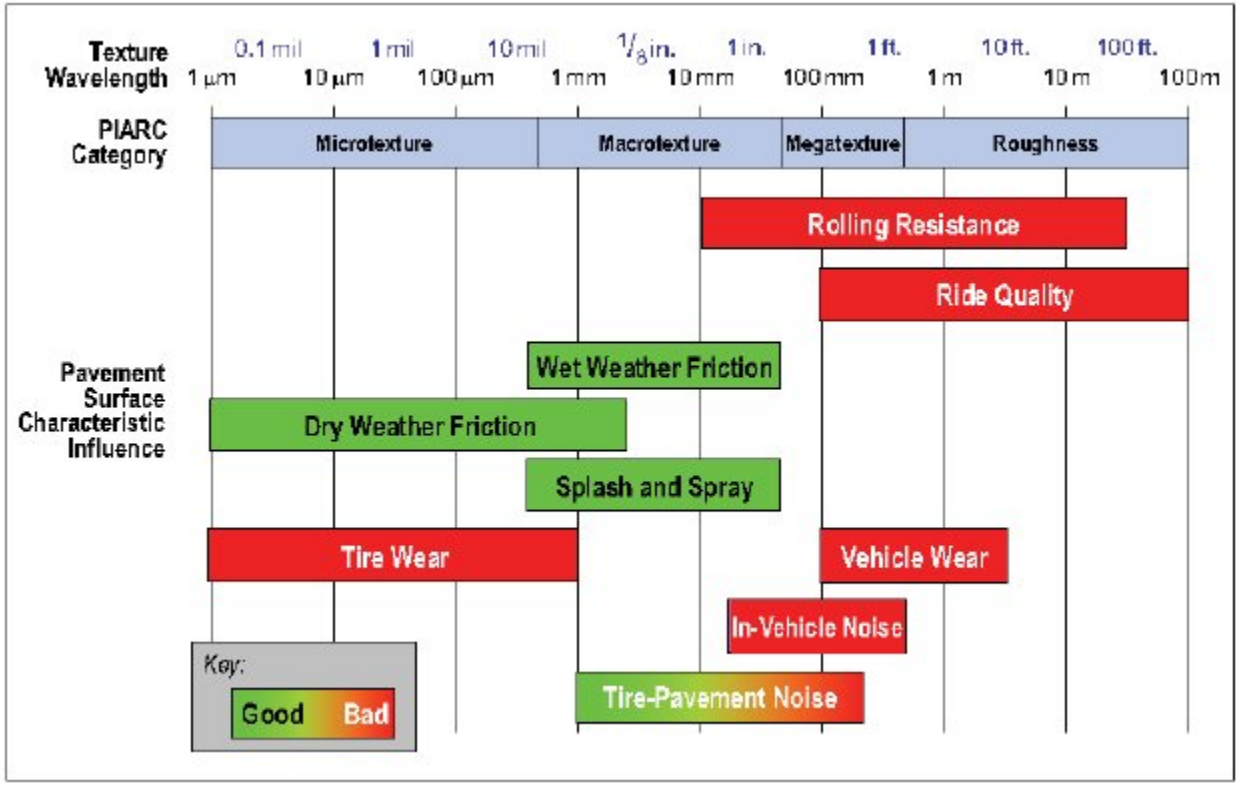
By

Ahmad Alhasan

Acknowledgments

- Coauthor:
  - Omar Smadi.
- Ames Engineering.

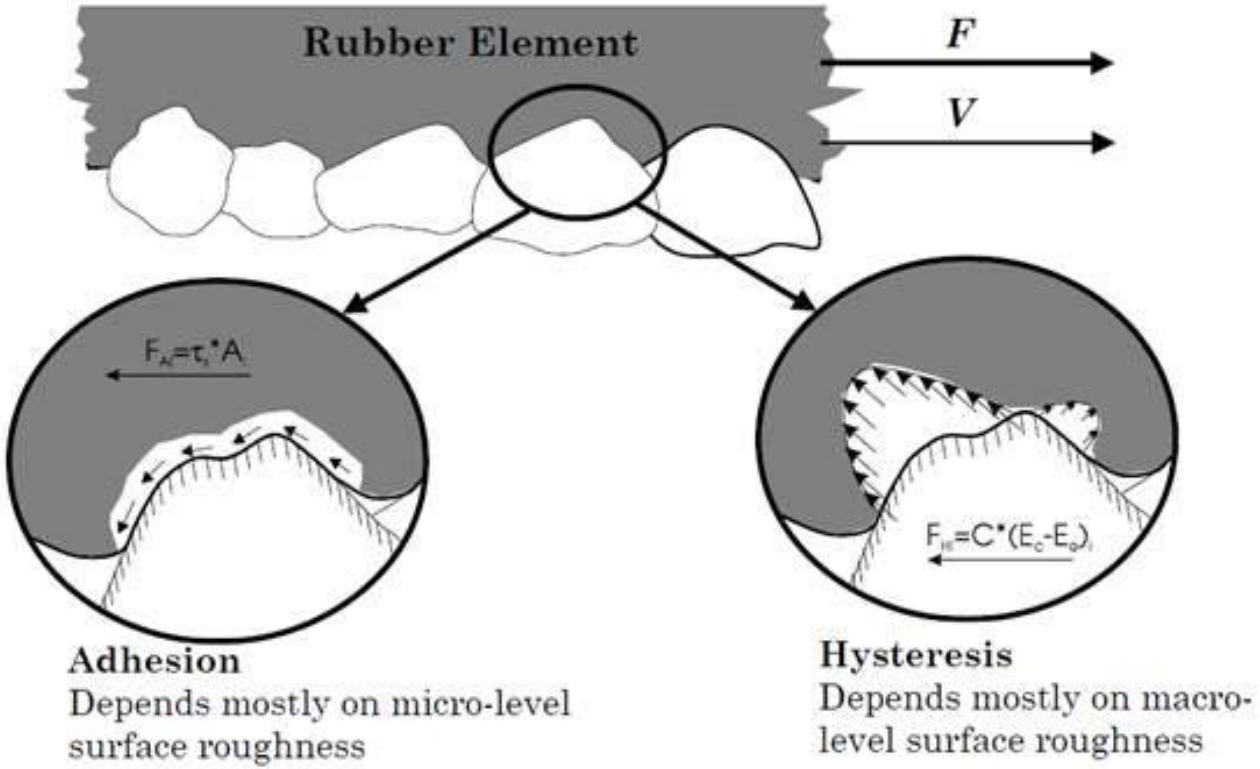
Pavement surface texture impacts pavement performance at different levels.



Pavement surface texture impacts pavement performance at different levels.

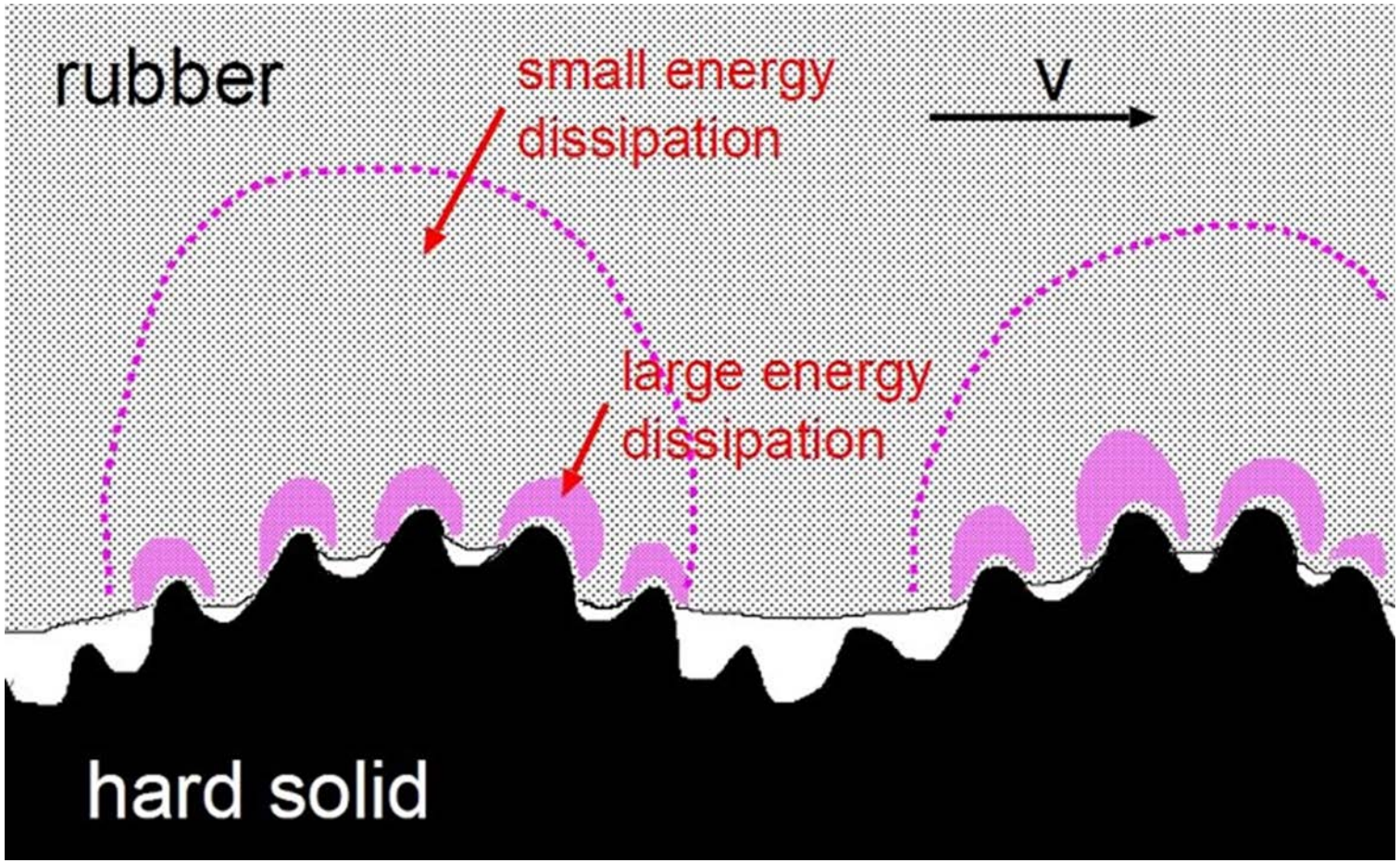
Pavement surface texture impacts pavement performance at different levels.

Different views have been proposed to model tire friction behavior and contact models.

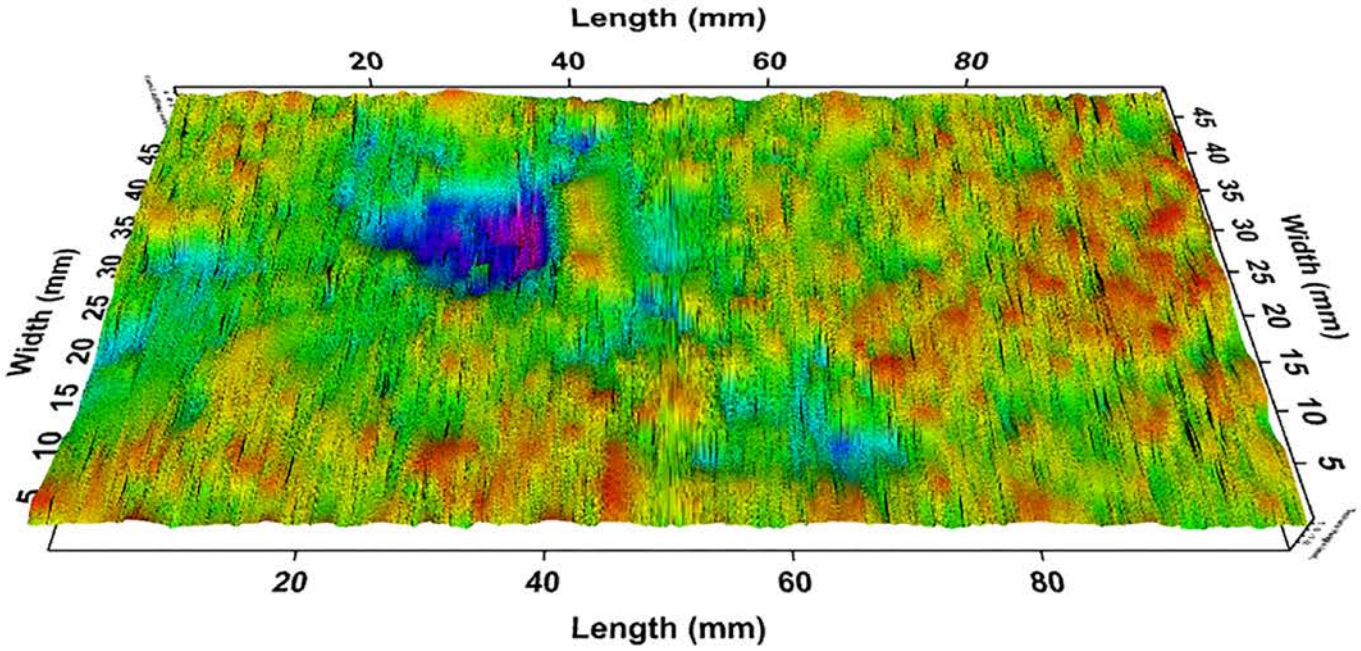


Pirelli.com

Different views have been proposed to model tire friction behavior and contact models.



High resolution scans can capture the pavement texture with high details.



RPUG Road Profile Users' Group

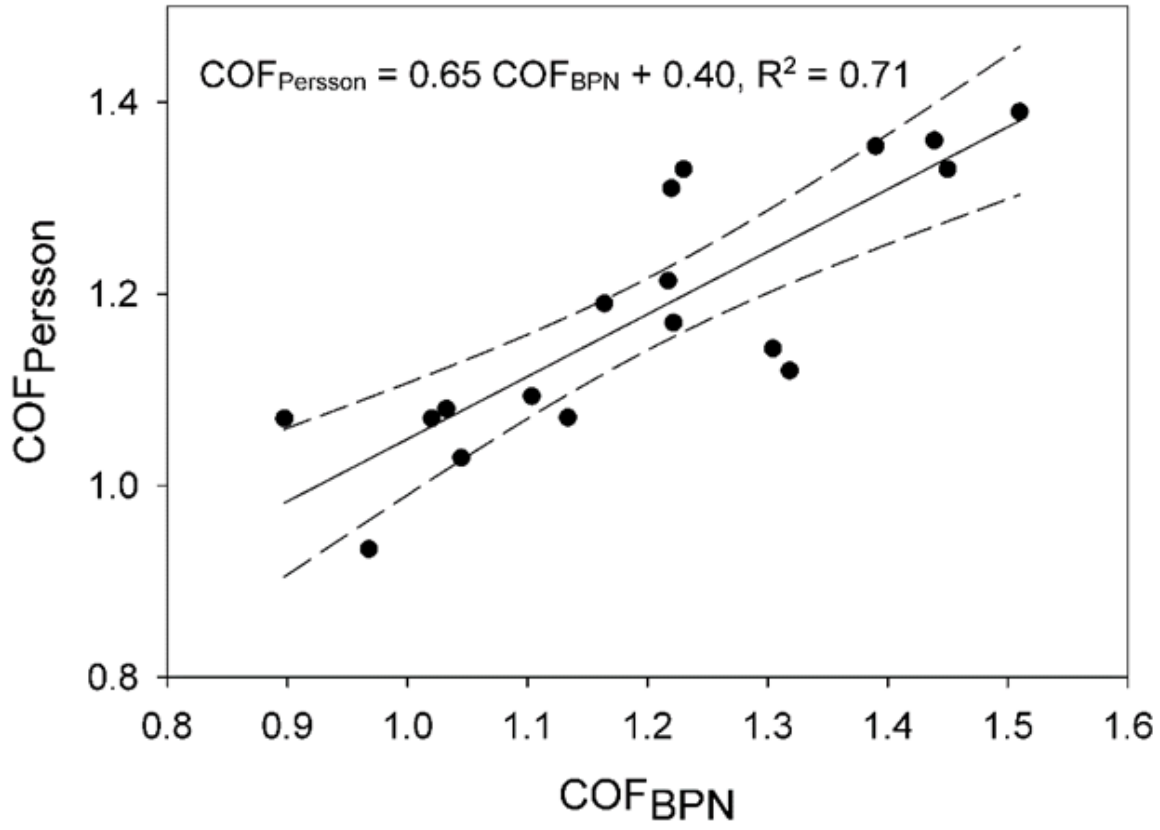
High speed profilers might give insights to microtexture.

Power spectral density function can provide sufficient information to describe tire contact.

$$COF_{hyst} = \mu_{hyst} \approx \frac{1}{2}\int_{q_0}^{q_1} dq\, q^3 C(q) S(q) P(q) \int_0^{2\pi} d\phi \cos\phi \,\mathrm{Im}\frac{E(qv\cos\phi)}{(1-\upsilon^2)\sigma_0}$$

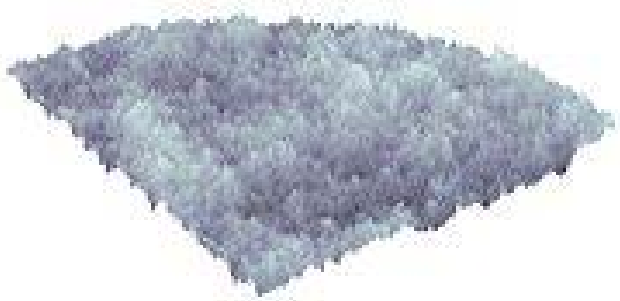
$$C(q) \approx \frac{H}{2\pi}\left(\frac{h_0}{q_0}\right)^2\left(\frac{q}{q_0}\right)^{-2(H+1)} = k\, q^{-2(H+1)}$$

We tested the Persson friction model in field conditions.



Fractal geometries have a unique characteristic.

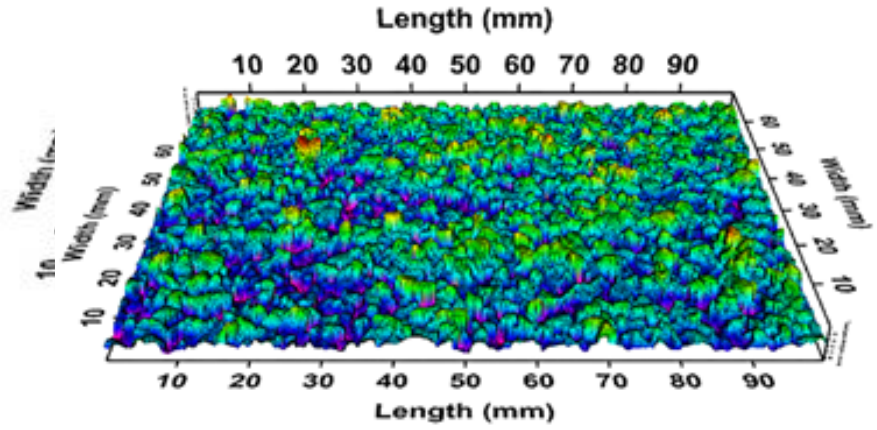
$H = 0.2$

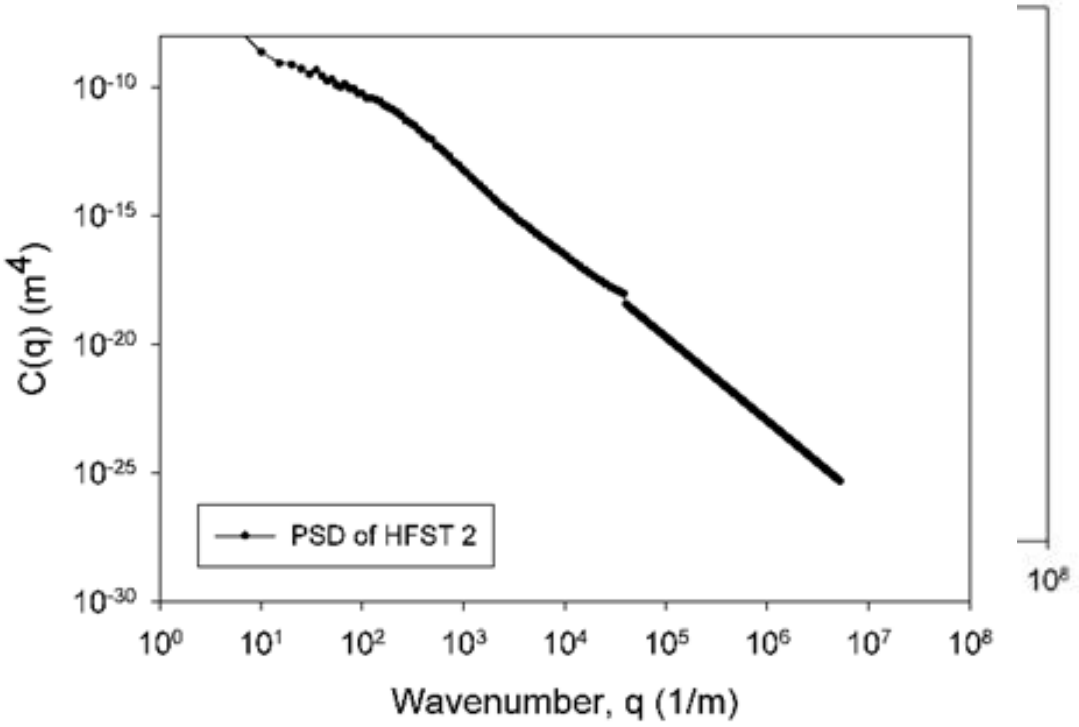


$H = 0.5$

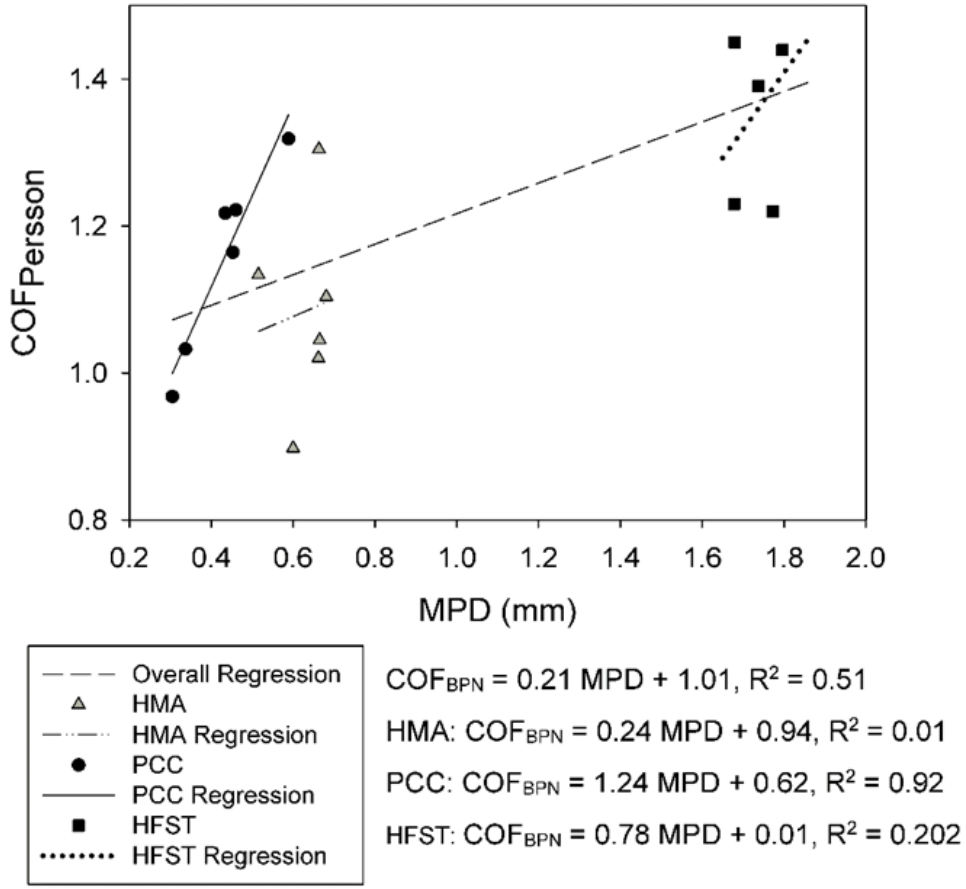
$H = 0.8$

Various pavements exhibit fractal characteristics.

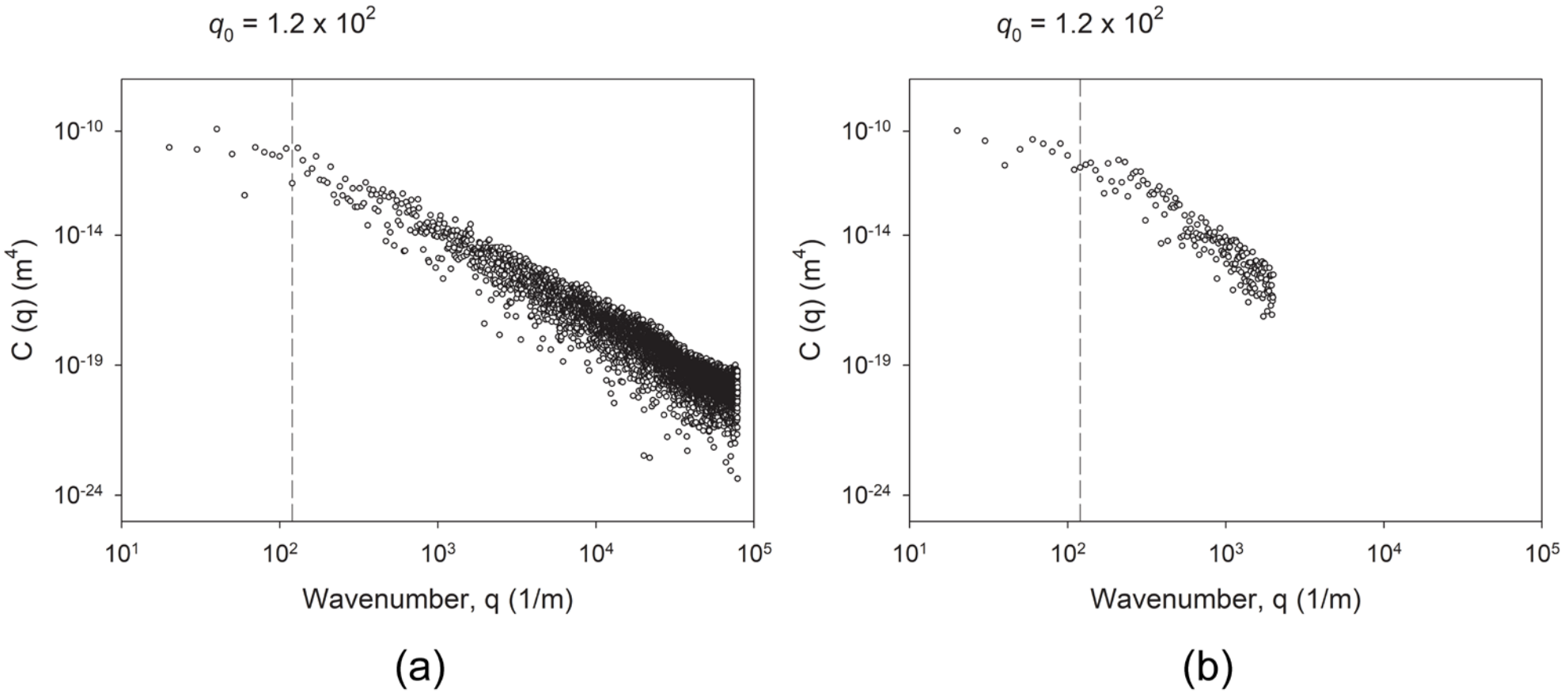




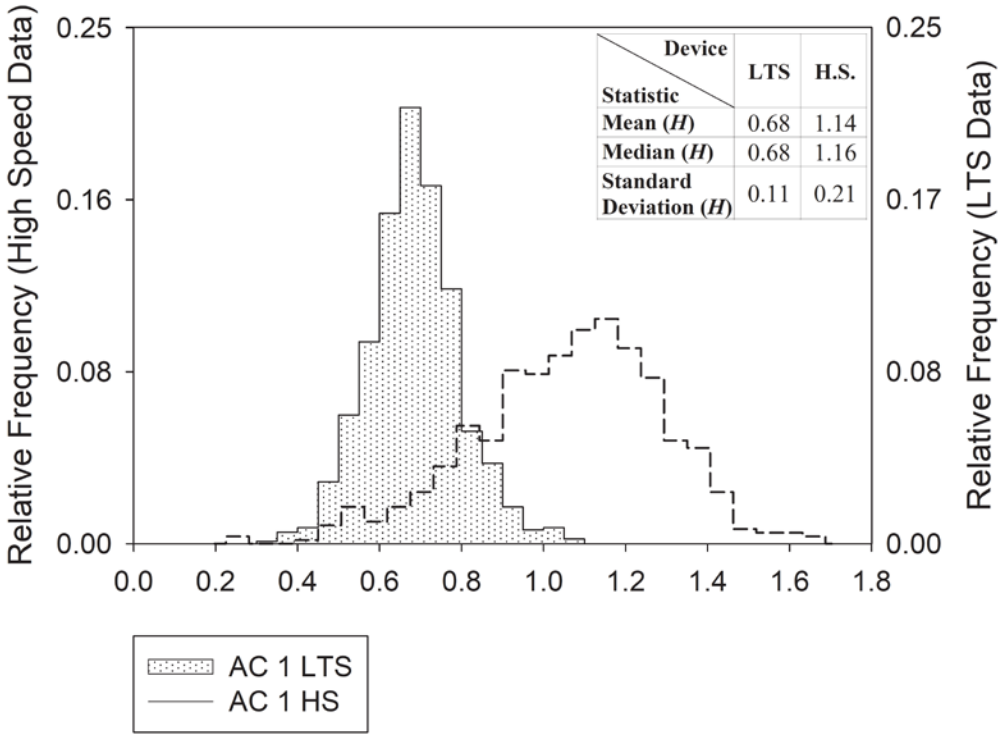
Typical texture statistics work for homogeneous groups but not across groups.

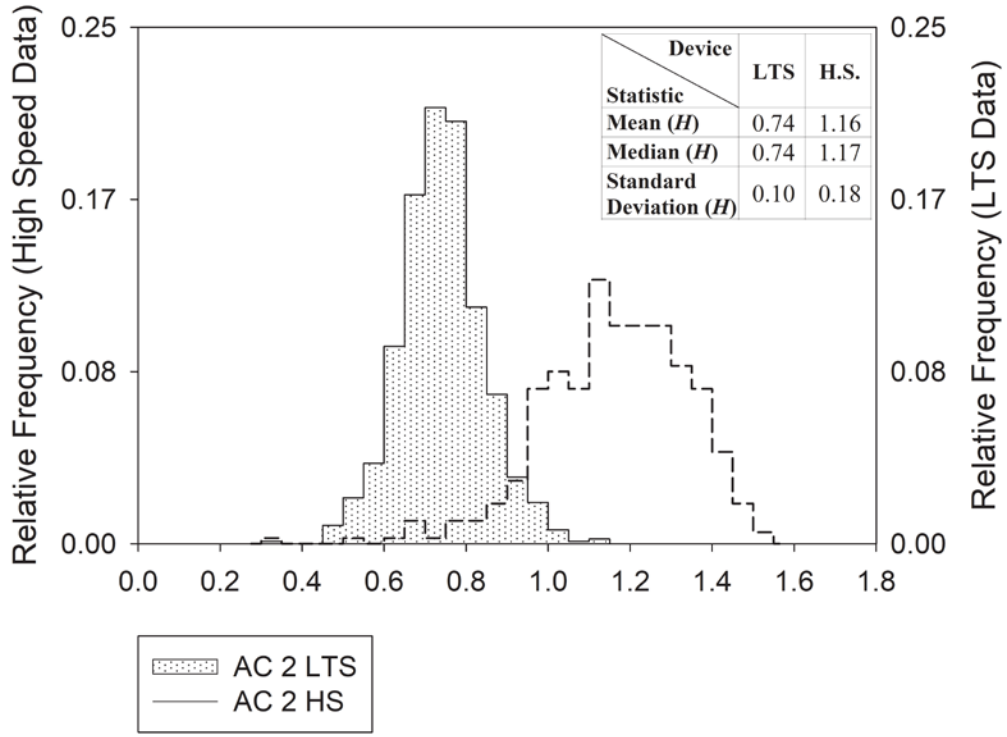


Fractal behavior could be detected in high speed profiler data.

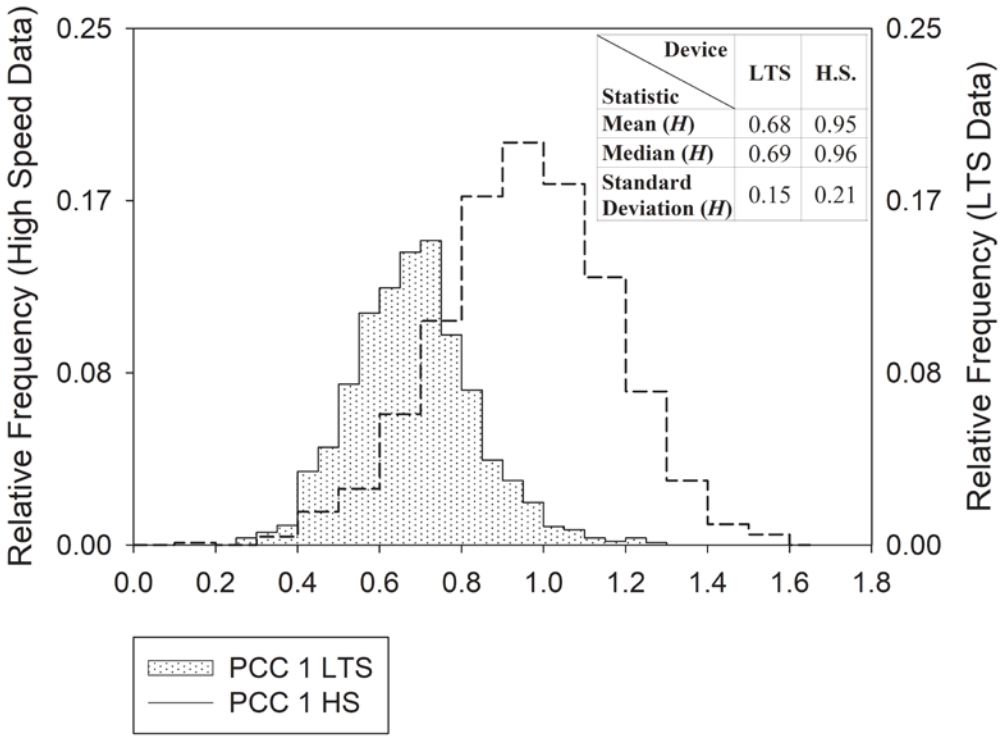


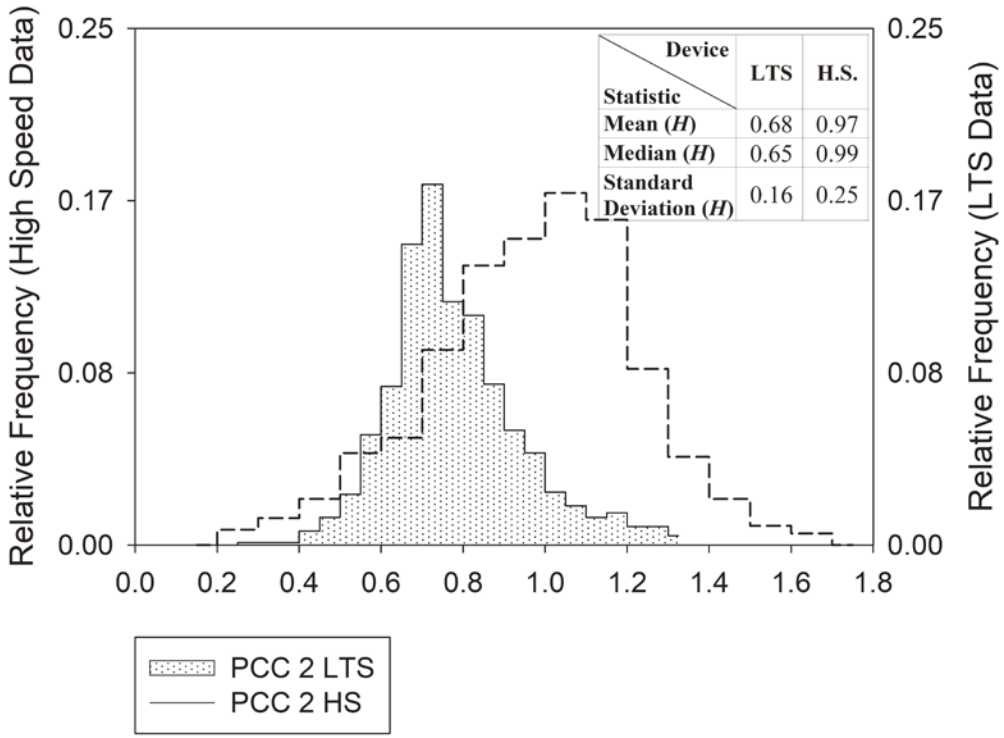
Texture characteristics vary across a short segment.



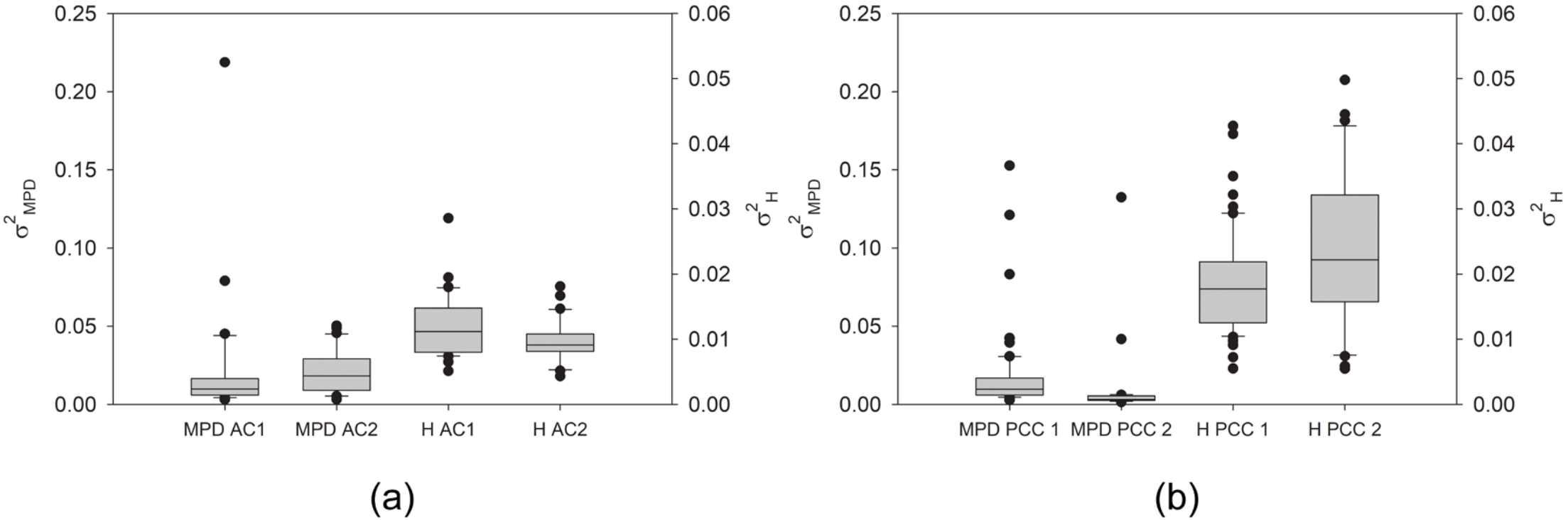


Texture characteristics vary across a short segment.



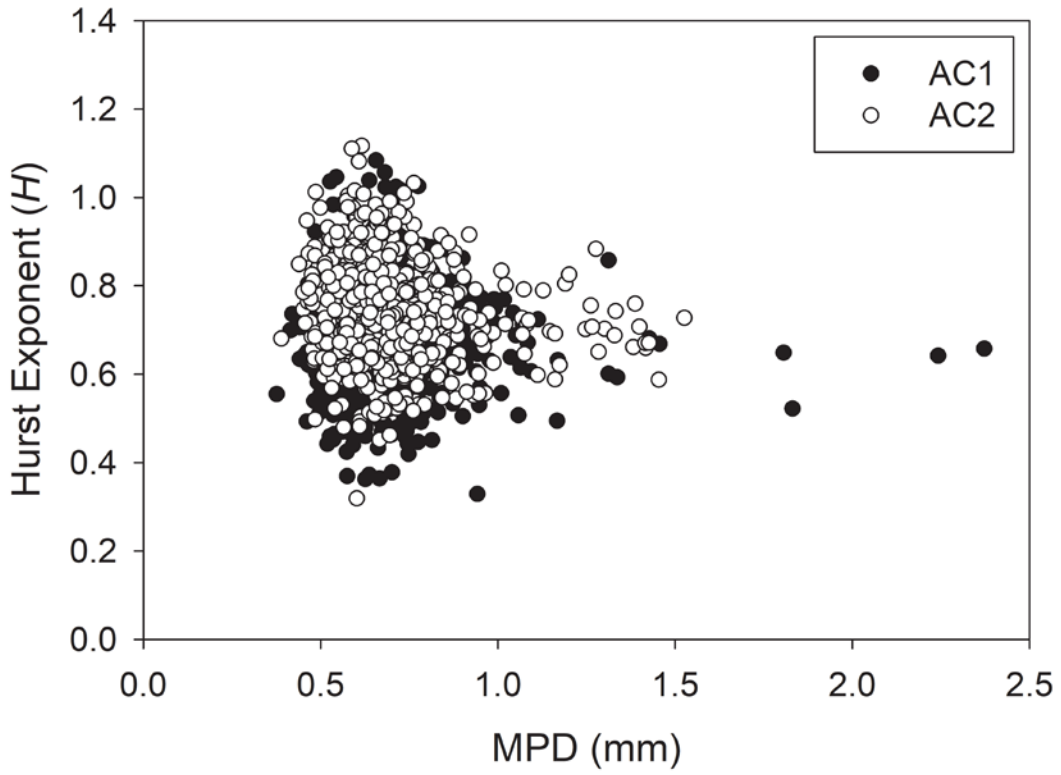


Texture characteristics vary across a short segment.

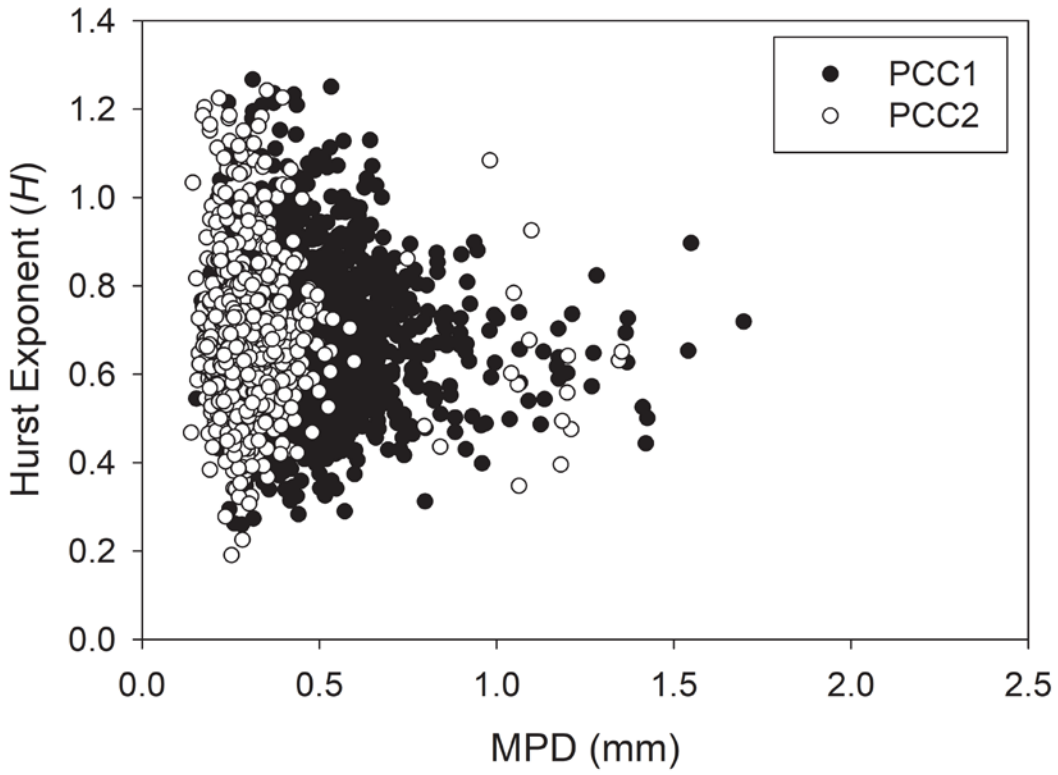


RPUG Road Profile Users' Group

Unique summary statistics are necessary for universal models.

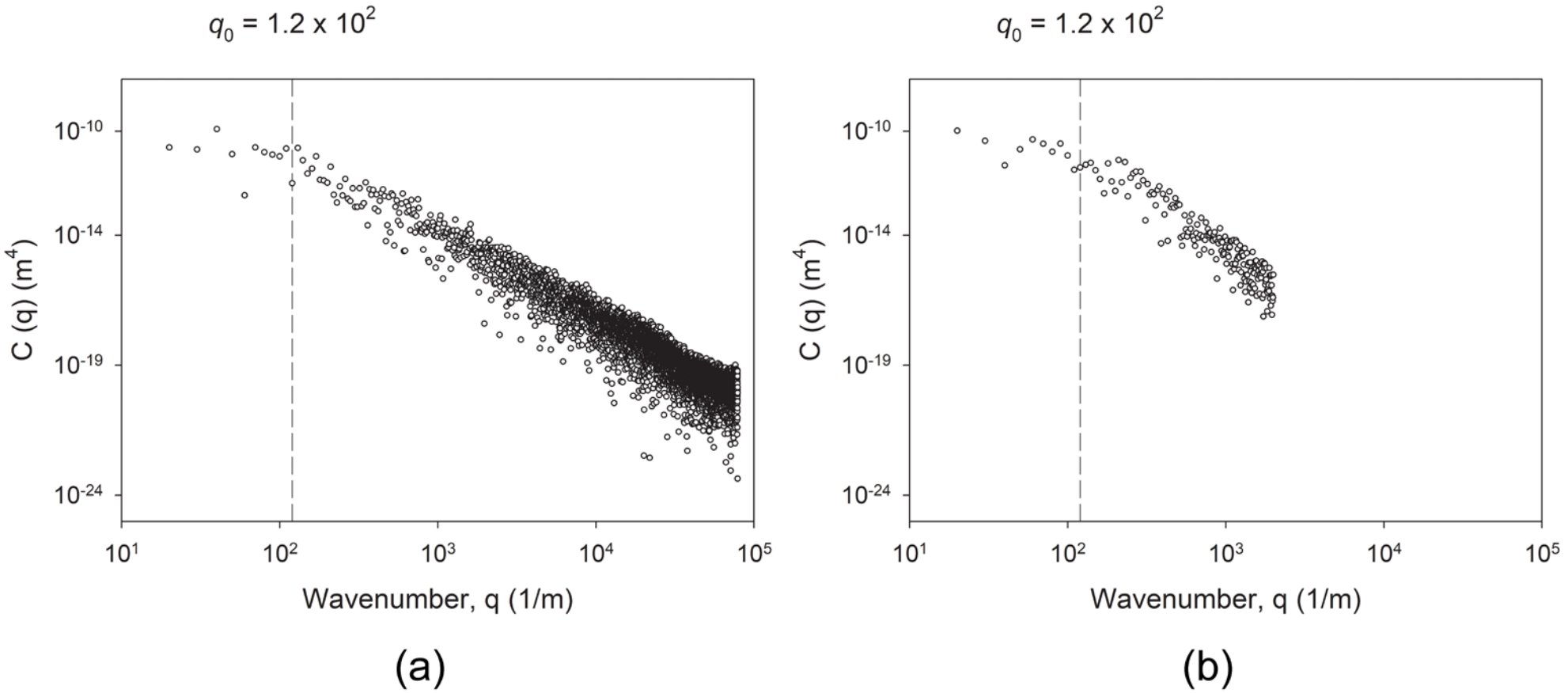


(a)



(b)

High speed profiles can be tuned to reflect reality.



Transfer functions are independent operators.

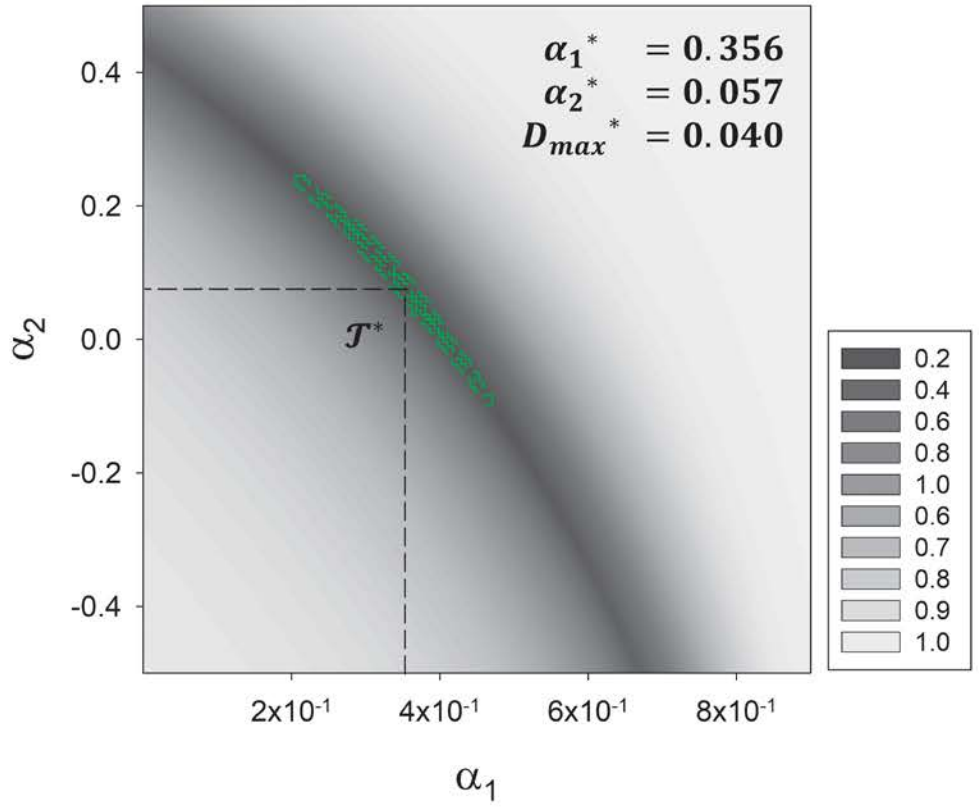
$$C = kq^{-2(H+1)}$$

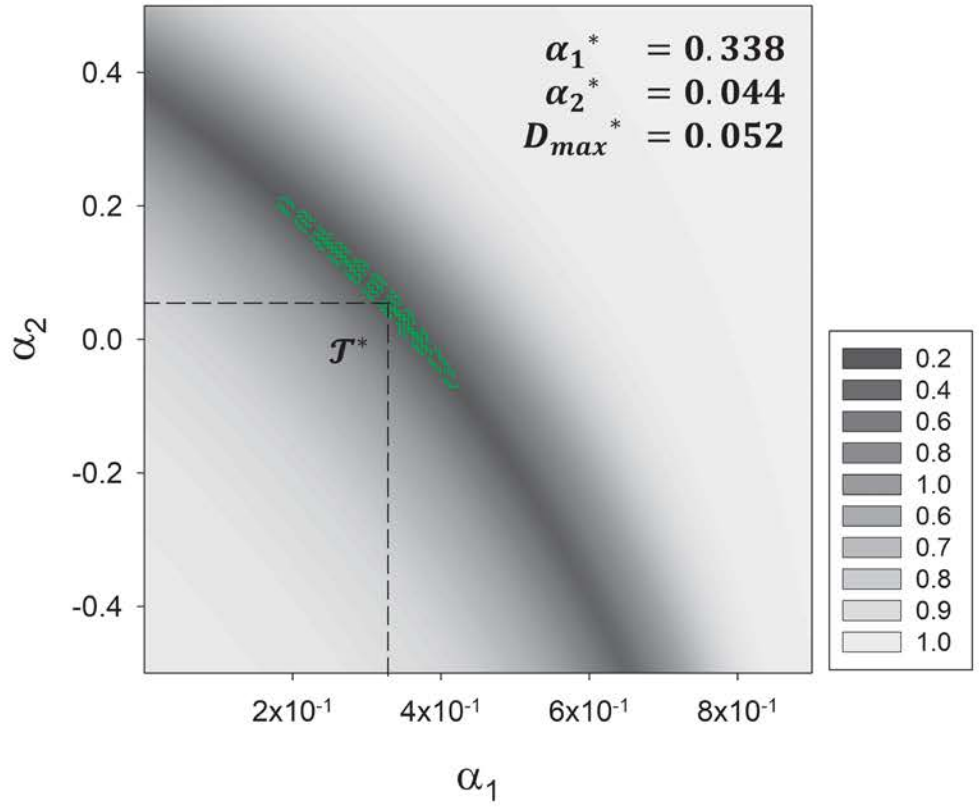
$$\widetilde{C_{HS}} = \mathcal{T}(C_{HS}) = \mathcal{T}_k\mathcal{T}_H\left(k_{HS}(q-q_0)^{-2(H_{HS}+1)}\right)$$

$$\widetilde{C_{HS}} = \mathcal{T}_k\left(k_{HS}(q-q_0)^{-2(\widetilde{H_{HS}}+1)}\right)$$

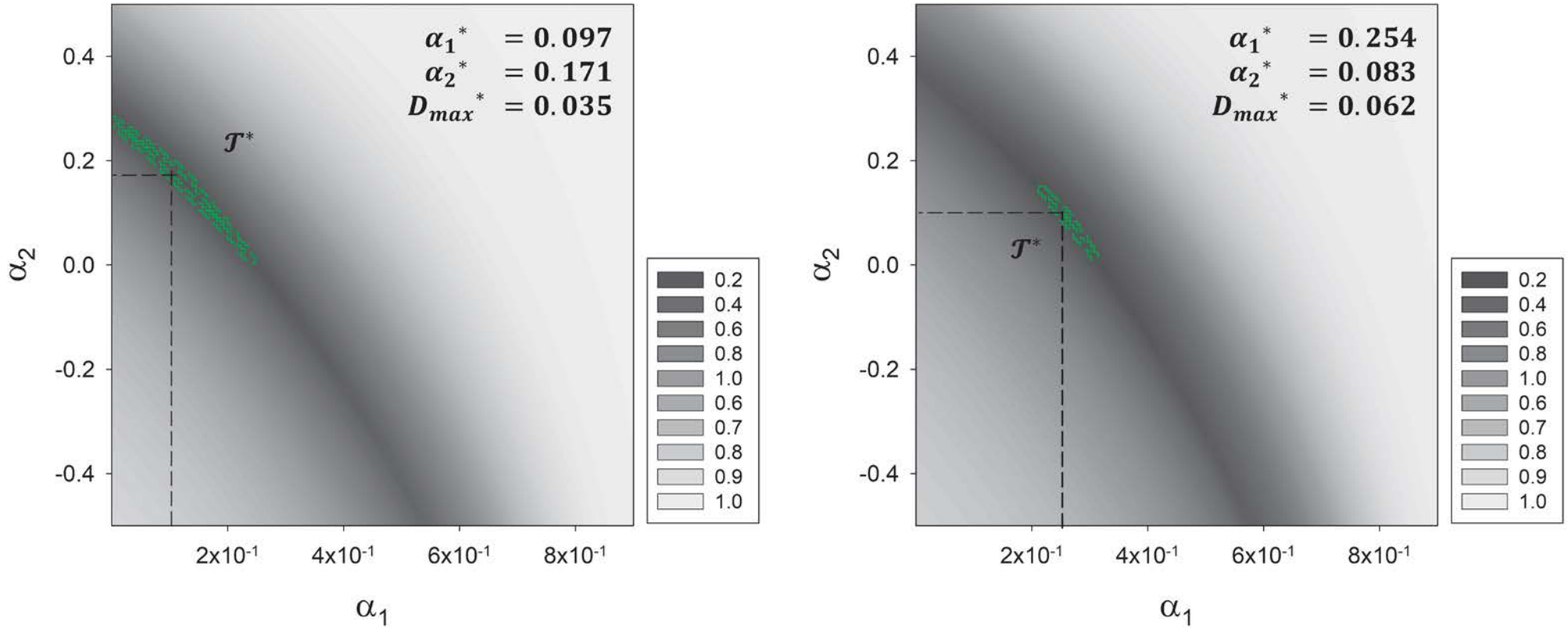
$$\widetilde{H_{HS}} = (1-\alpha_1)H_{HS}e^{-\alpha_2 H_{HS}}$$

Permissible solutions overlap for different pavements surfaces of the same surface type.





Permissible solutions overlap for different pavements surfaces of the same surface type.



RPUG Road Profile Users' Group

Remarks:

- The PSD provides a unique characteristic that can be used in multiple tire-pavement contact models and in estimating pavement skid resistance.
- Although MPD can provide general insights into the pavement texture, the non-uniqueness of the MPD value can lead to the same measurements on different surfaces with different texture and physical characteristics.
- Texture models need more development to reach practical solutions.

References

- Henry, J. J. *NCHRP Synthesis 291: Evaluation of Pavement Friction Characteristics*. TRB, National Research Council, Washington, D.C., 2000.
- Flintsch, G., E. de Leon, K. McGhee, and I. Al-Qadi. Pavement Surface Macrotexture Measurement and Applications. *Transportation Research Record: Journal of the Transportation Research Board*, No. 1860, 2003, pp. 168–177.
- Persson, B. N. J. Theory of Rubber Friction and Contact Mechanics. *The Journal of Chemical Physics*, Vol. 115, No. 8, 2001, pp. 3840–3861. https://doi.org/10.1063/1.1388626.
- Lorenz, B., Y. R. Oh, S. K. Nam, S. H. Jeon, and B. N. J. Persson. Rubber Friction on Road Surfaces: Experiment and Theory for Low Sliding Speeds. *The Journal of chemical physics*, Vol. 142, No. 19, 2015.