Enhancing Pavement Surface Macrotexture Characterization

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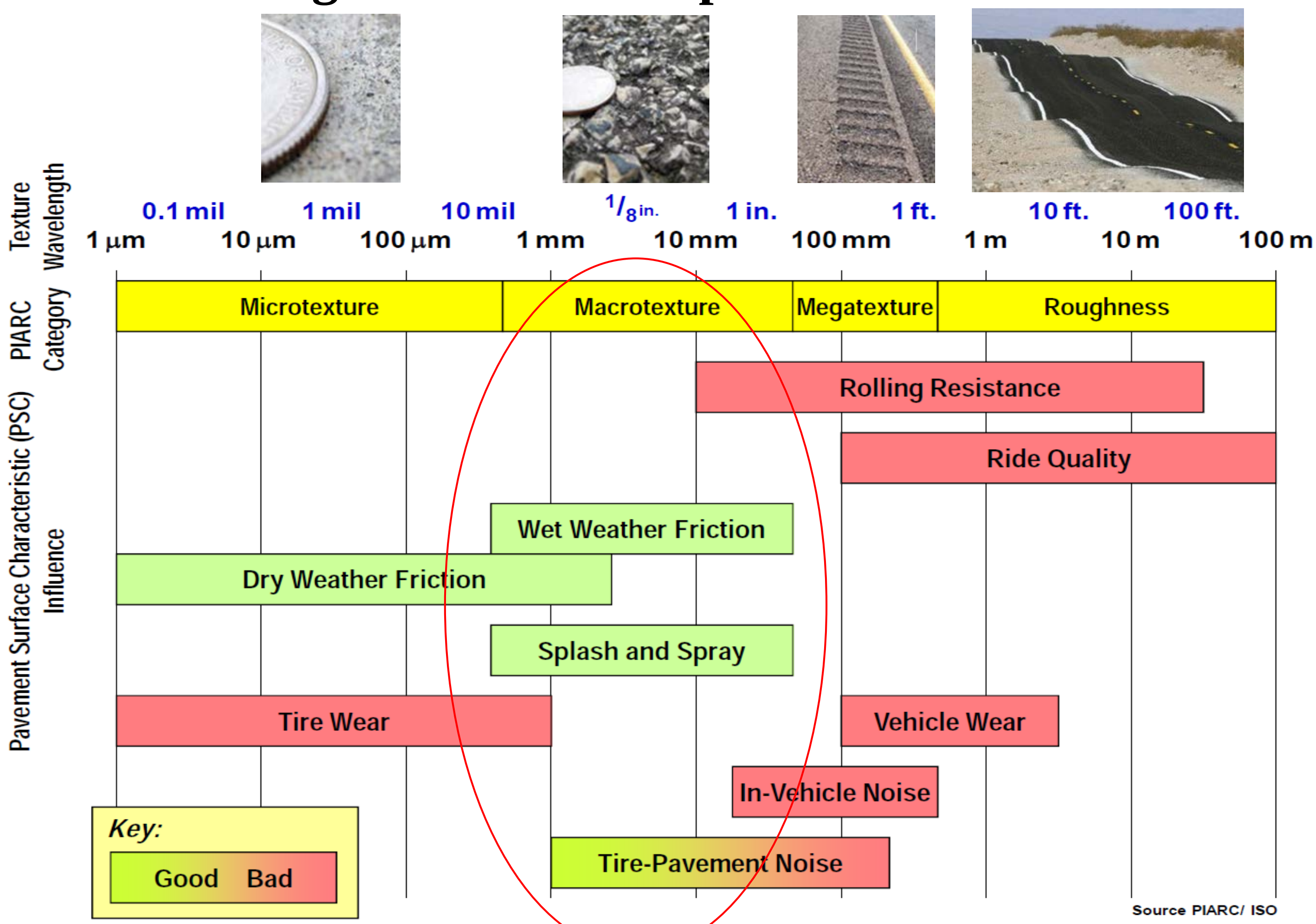
Background

Texture Wavelength Influence on pavement surface characteristics

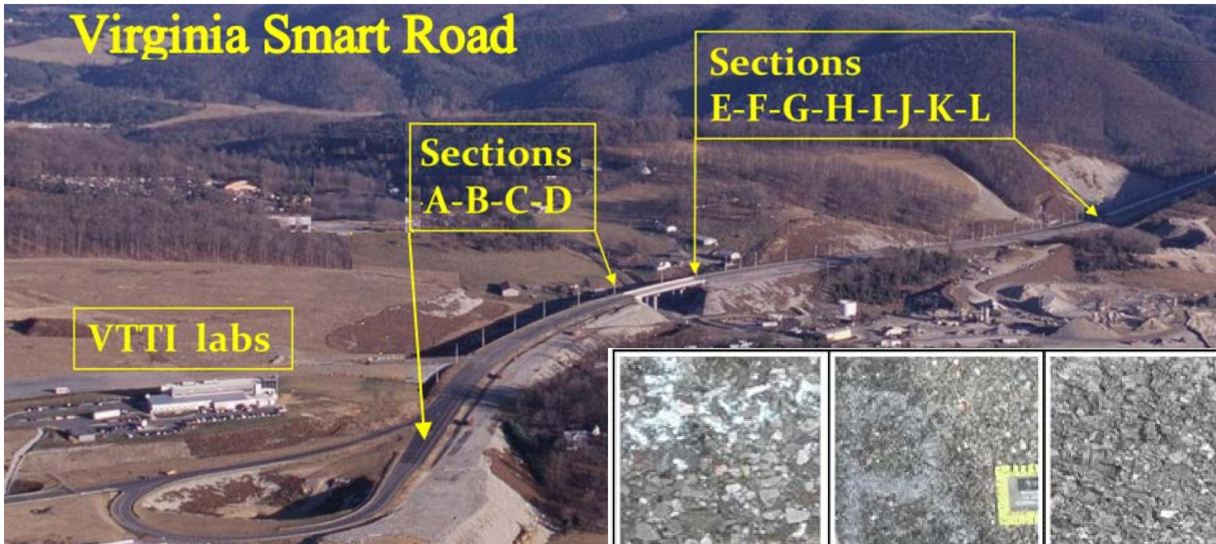


Objective

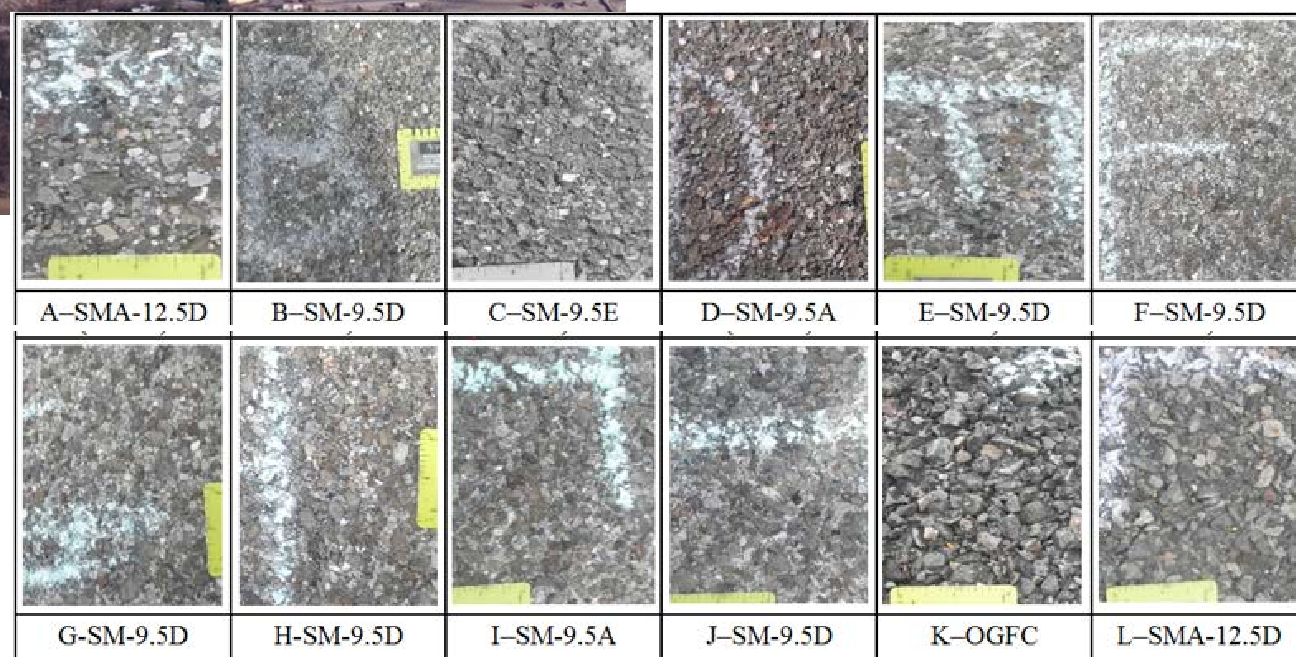
- **propose an enhanced macrotexture characterization index that:**
  - **(a) estimates the Effective Area for Water Evacuation (EAWE) better than current Mean Profile Depth method, and**
  - **(b) provides stronger correlations with the corresponding pavement surface properties affected by macrotexture (friction and rolling noise).**

Methodology

- **32 Sites (1/2): Virginia Smart Road** **& VQPIP**

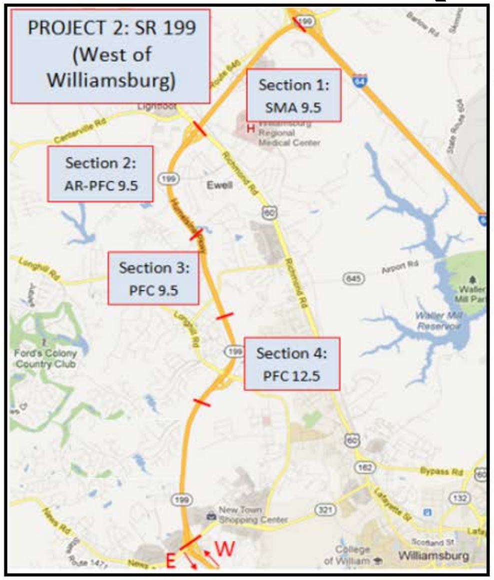


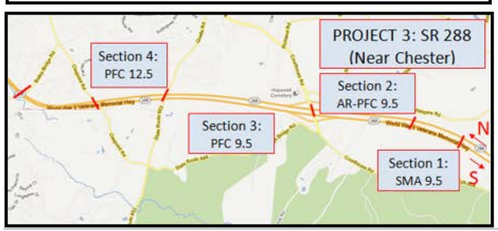
12 of the 32 sites



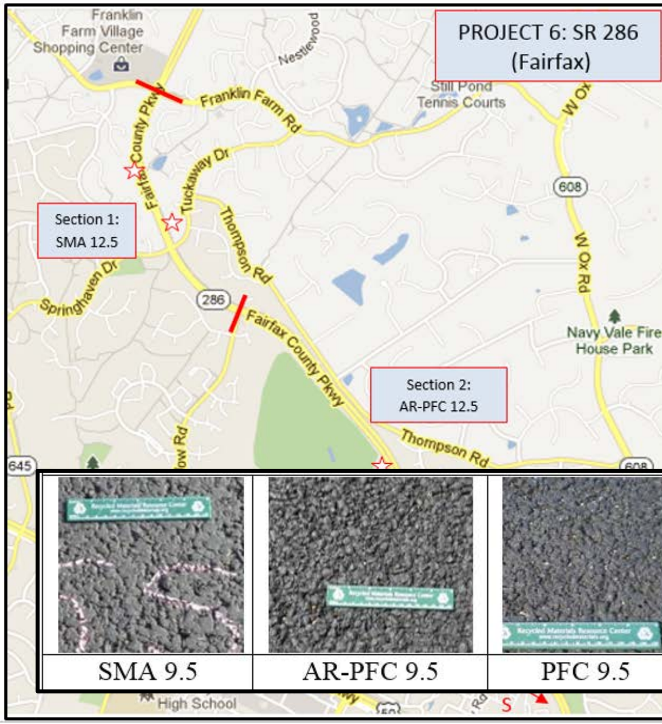
Methodology

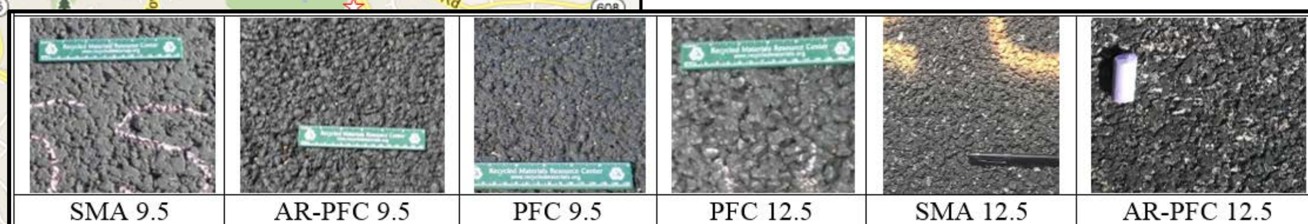
- **32 Sites (2/2): Virginia Smart Road & VQPIP**





Virginia Quiet Pavement Implementation Program





20 of the 32 sites

Section names:

SR-199 SMA 9.5 – E SR-199 SMA 9.5 – W SR-288 SMA 9.5 – N SR-288 SMA 9.5 – S	SR-199 AR-PFC 9.5 – E SR-199 AR-PFC 9.5 – W SR-288 AR-PFC 9.5 – N SR-288 AR-PFC 9.5 – S	SR-199 PFC 9.5 – E SR-199 PFC 9.5 – W SR-288 PFC 9.5 – N SR-288 PFC 9.5 – S	SR-199 PFC 12.5 – E SR-199 PFC 12.5 – W SR-288 PFC 12.5 – N SR-288 PFC 12.5 – S	SR-286 SMA 12.5 – N SR-286 SMA 12.5 – S	SR-286 AR-PFC 12.5 – N SR-286 AR-PFC 12.5 – S

Methodology

- **Equipment**

At least 10 on SR with each CTMeter:
→ at least 20.

At least 5 on VQPIP, each section (e.g. SMA9.5), each direction (e.g. N), each location (e.g. SR199).

(a) CTMeter *(4)*

12 runs on SR

3 runs on VQPIP, each section, each direction, each location.

40 mph, every 3ft.
16% slip speed

10 runs on 12 sections at SR,

3 runs on 20 sections at VQPIP,

Total 180 runs

64 kHz
Continuous/ 0.5 mm

SR:
2 valid runs -> K
3 valid runs -> A,L
5 valid runs -> B
7 valid runs -> E,F,G,H

VQPIP:
At least 3 valid runs each section.

Methodology

To compute the EAWE index (in mm^2)

1) Conduct spike-removal process over the 2) Define Enveloping profile, which is the profile that the tire creates when in contact with the surface of the pavement, and

2) Compute EAWE index (and the correspondent effective depth for water evacuation [EDWE]).

Results

2) Enveloping profile calculation

720 enveloping profiles → calculate proposed index (EAWE)

Different values for *d** (0.054, 0.027, 0.01) in mm/mm² were obtained by von-Meier during his empirical experimentation with different artificial surfaces (containing peaks and valleys with different amplitude and longitude).

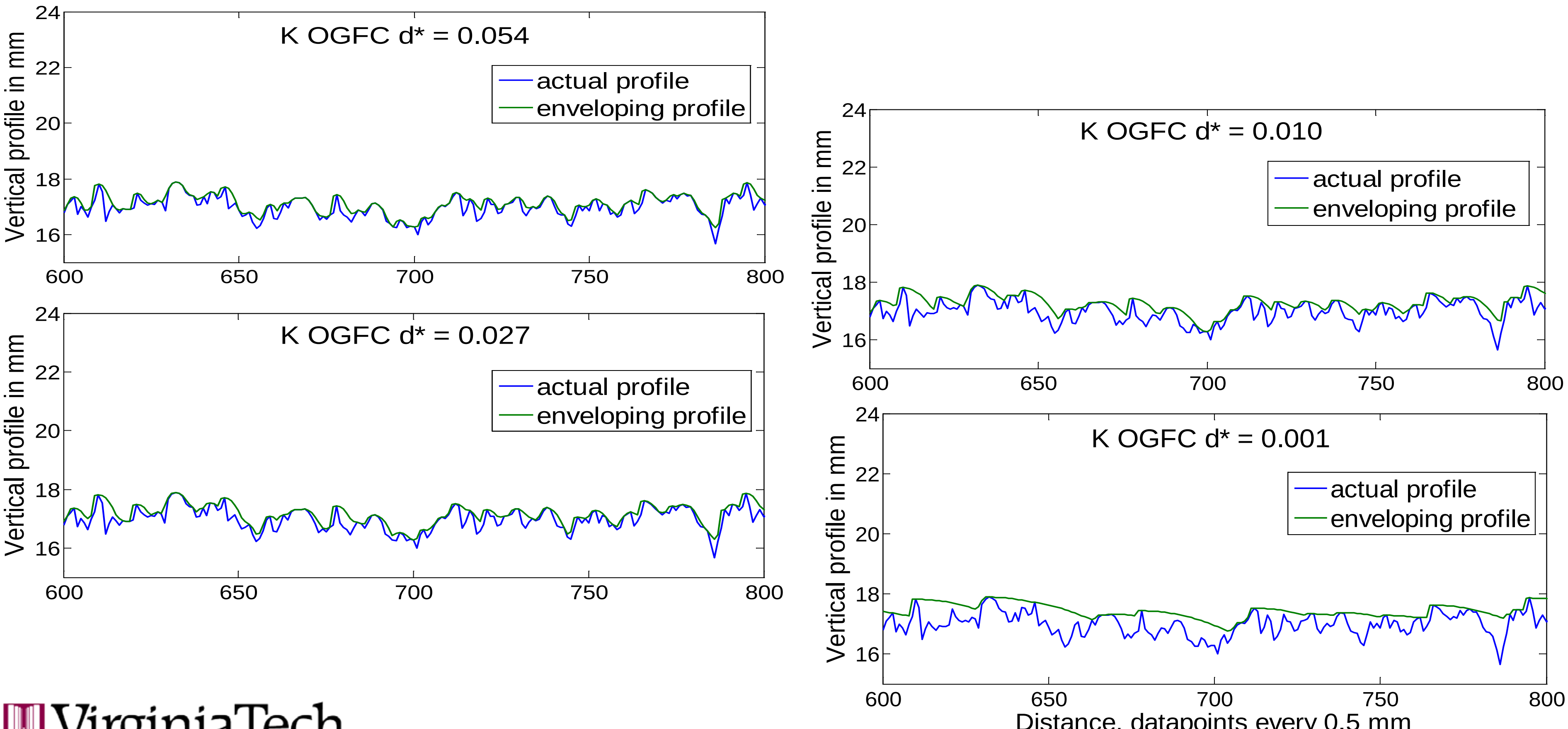
For this study, very small values for *d** (e.g., 0.001, representing significantly stiffer rubber tires) are also used in addition to the *d** values used by von Meier et al. to test the hypothesis about overestimation of the EAWE when using MPD

Therefore, the enveloping profile analysis was performed for all 180 denoised profiles using four different ***d** values (0.054, 0.027, 0.01, 0.001, which can be related to medium soft, medium hard, stiff, and significantly stiff tires***, respectively)

Results

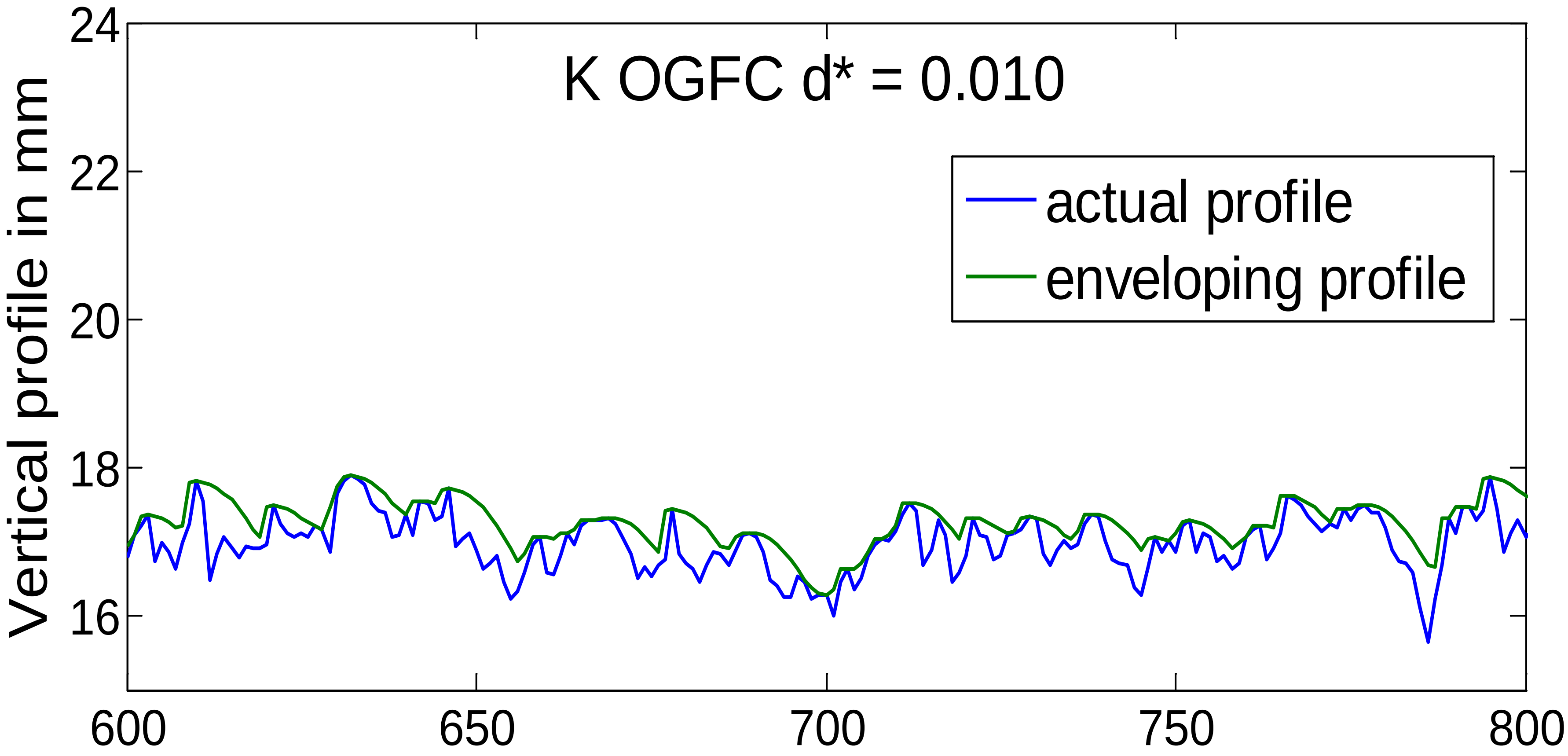
2) Enveloping profile calculation

Enveloping profile illustration calculated for different tire stiffnesses for a porous asphalt mix (e.g., 100 mm for Section K - OGFC):



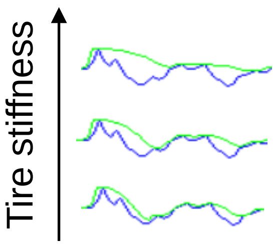
Results

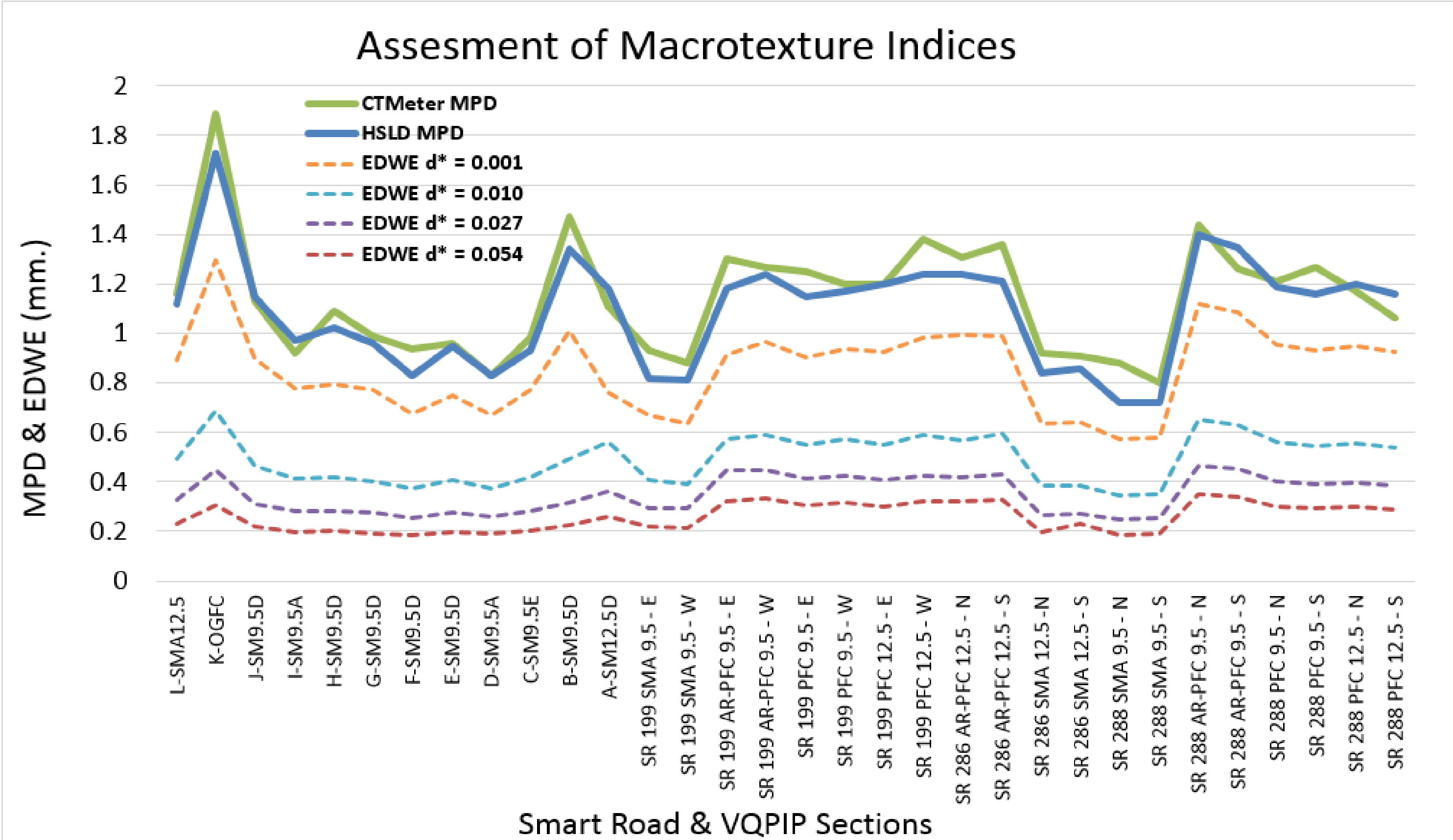
2) Enveloping profile calculation



Results

3) EAWE





Sensitivity analysis (varying tire stiffness) confirms the hypothesis, → MPD models the area similar to EAWE only when relatively no tire rubber deformation is allowed which is not what really happens.

Results

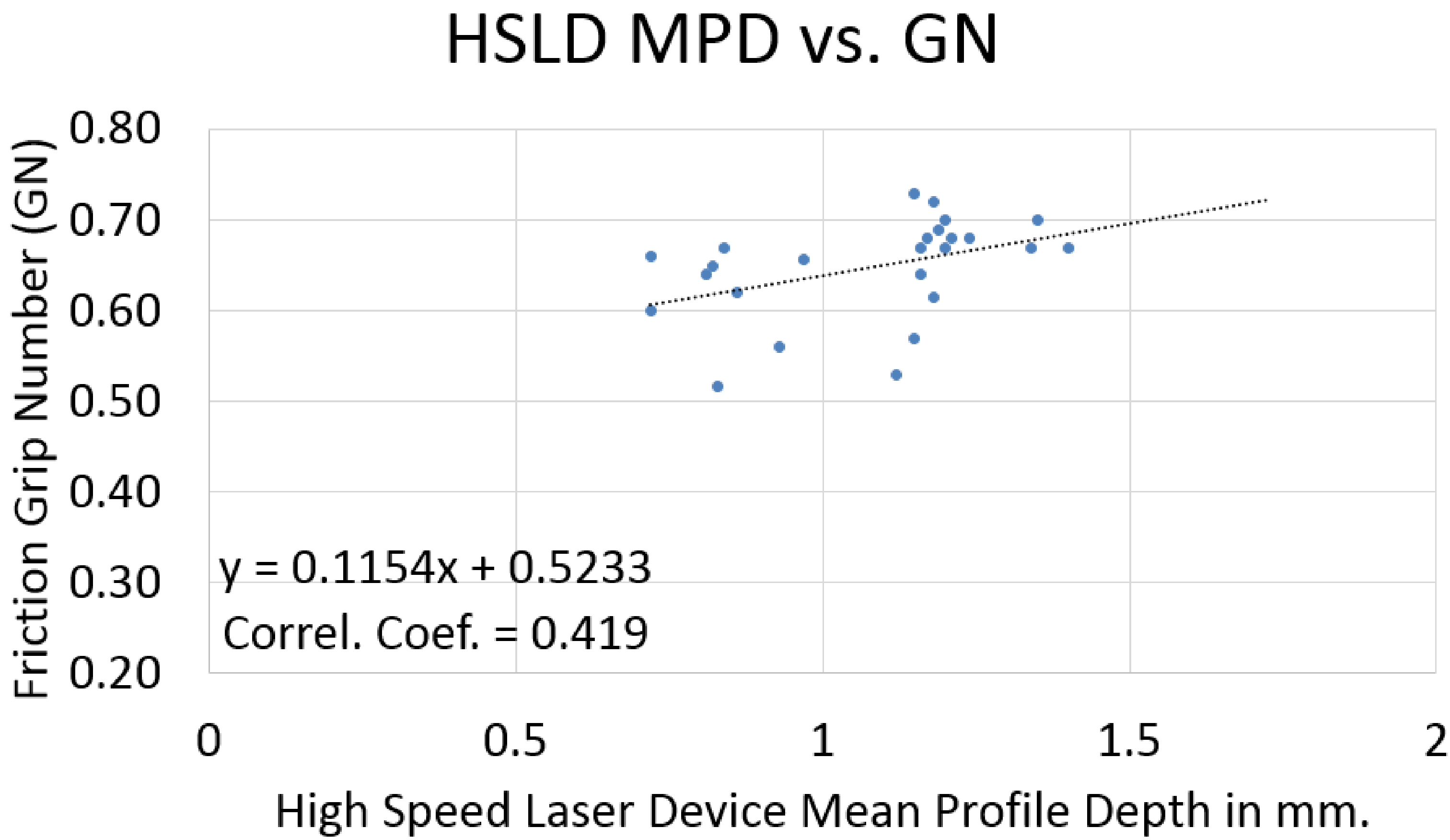
3) EAWE & EDWE

Sections	Macrotexture										Friction	Noise
	MPD (mm)		EAWE (mm)				EDWE (mm)				GN	IL
	CTMeter	HSLD	0.054	0.027	0.010	0.001	0.054	0.027	0.010	0.001		dBA
L-SMA12.5	1.16	1.12	23.29	33.09	49.14	89.33	0.23	0.33	0.49	0.89	0.53	101.1
K-OGFC	1.89	1.73	30.54	44.56	68.43	129.49	0.31	0.45	0.68	1.29		99.7
J-SM9.5D	1.13	1.15	21.92	31.30	46.52	89.85	0.22	0.31	0.47	0.90	0.57	
I-SM9.5A	0.92	0.97	19.72	28.14	41.34	77.78	0.20	0.28	0.41	0.78	0.66	
H-SM9.5D	1.09	1.02	20.00	28.34	41.75	79.58	0.20	0.28	0.42	0.80		102.3
G-SM9.5D	0.99	0.96	19.15	27.44	40.40	77.07	0.19	0.27	0.40	0.77		102.3
F-SM9.5D	0.94	0.83	18.42	25.65	37.10	67.40	0.18	0.26	0.37	0.67		102.3
E-SM9.5D	0.96	0.95	19.72	27.86	40.73	74.95	0.20	0.28	0.41	0.75		102.3
SR 199 PFC 9.5 - W	1.2	1.17	31.58	42.56	57.41	94.00	0.32	0.43	0.57	0.94	0.68	100.1
SR 199 PFC 12.5 - E	1.2	1.2	30.20	40.72	54.97	92.36	0.30	0.41	0.55	0.92	0.67	
SR 199 PFC 12.5 - W	1.38	1.24	32.08	42.51	58.84	98.31	0.32	0.43	0.59	0.98	0.68	100.9
SR 286 AR-PFC 12.5 - N	1.31	1.24	31.98	42.06	56.74	99.33	0.32	0.42	0.57	0.99		98.7
SR 286 AR-PFC 12.5 - S	1.36	1.21	32.94	43.18	59.54	98.90	0.33	0.43	0.60	0.99	0.68	97.5
SR 286 SMA 12.5 -N	0.92	0.84	19.68	26.51	38.66	63.32	0.20	0.27	0.39	0.63	0.67	103.1
SR 286 SMA 12.5 - S	0.91	0.86	23.06	26.91	38.77	64.28	0.23	0.27	0.39	0.64	0.62	103.2
SR 288 SMA 9.5 - N	0.88	0.72	18.60	24.89	34.32	57.51	0.19	0.25	0.34	0.58	0.66	103.3
SR 288 SMA 9.5 - S	0.8	0.72	18.89	25.30	34.94	58.09	0.19	0.25	0.35	0.58	0.60	103
SR 288 AR-PFC 9.5 - N	1.44	1.4	35.10	46.46	65.28	111.98	0.35	0.46	0.65	1.12	0.67	100.9
SR 288 AR-PFC 9.5 - S	1.26	1.35	33.88	45.22	63.21	108.40	0.34	0.45	0.63	1.08	0.70	101.2
SR 288 PFC 9.5 - N	1.21	1.19	30.17	40.10	56.14	95.18	0.30	0.40	0.56	0.95	0.69	101.7
SR 288 PFC 9.5 - S	1.27	1.16	29.35	39.00	54.60	93.03	0.29	0.39	0.55	0.93	0.67	102.2
SR 288 PFC 12.5 - N	1.17	1.2	30.06	39.86	55.65	94.84	0.30	0.40	0.56	0.95	0.70	101.2
SR 288 PFC 12.5 - S	1.06	1.16	28.98	38.53	53.96	92.65	0.29	0.39	0.54	0.93	0.64	100.6

Sections	Macrotexture										Friction	Noise
	MPD (mm)		EAWE (mm)				EDWE (mm)				GN	IL
	CTMeter	HSLD	0.054	0.027	0.010	0.001	0.054	0.027	0.010	0.001		dBA
L-SMA12.5	1.16	1.12	23.29	33.09	49.14	89.33	0.23	0.33	0.49	0.89	0.53	101.1

Results

Macrotexture vs Friction



Results

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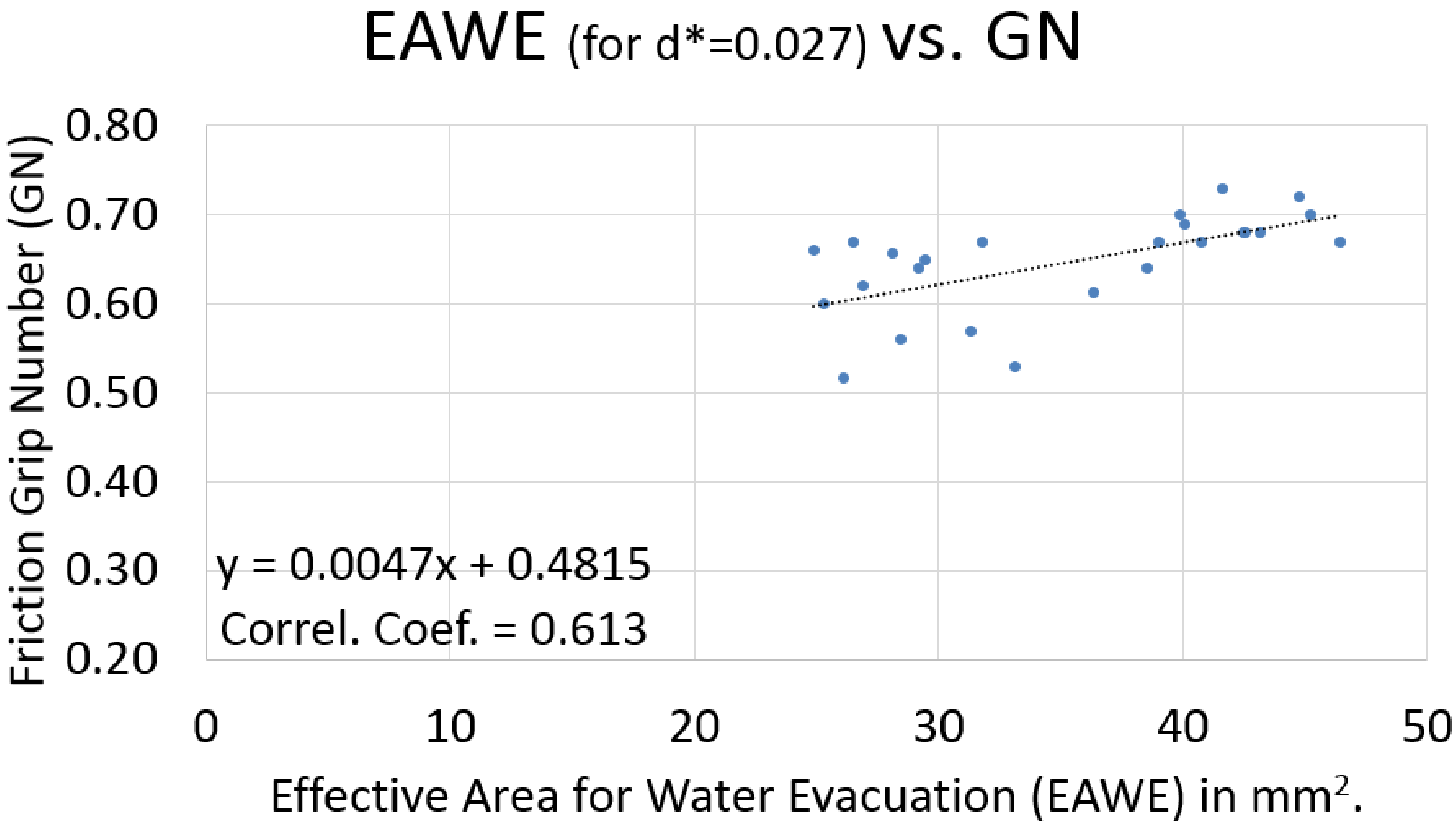
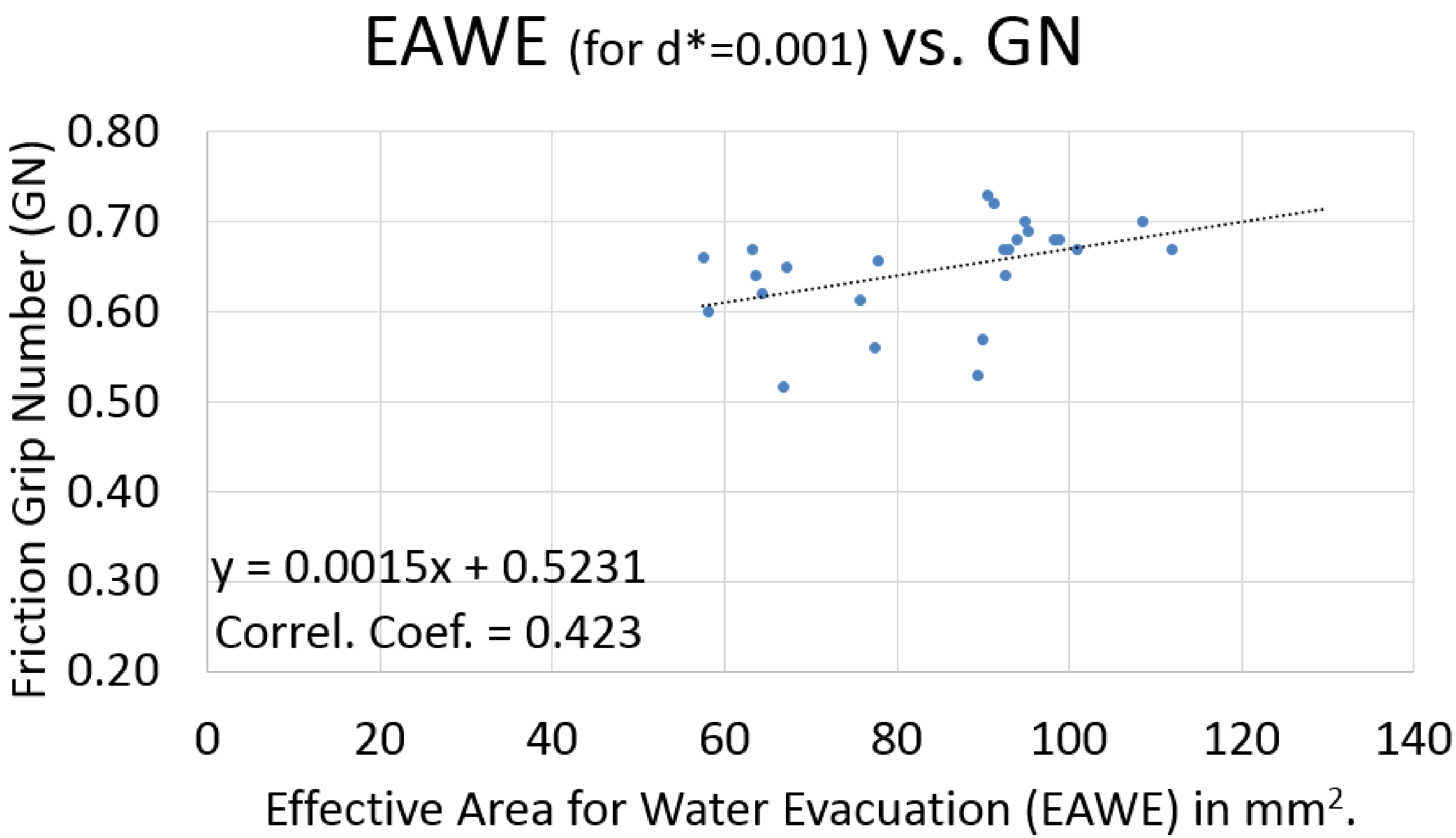


Results

Macrotexture vs Friction



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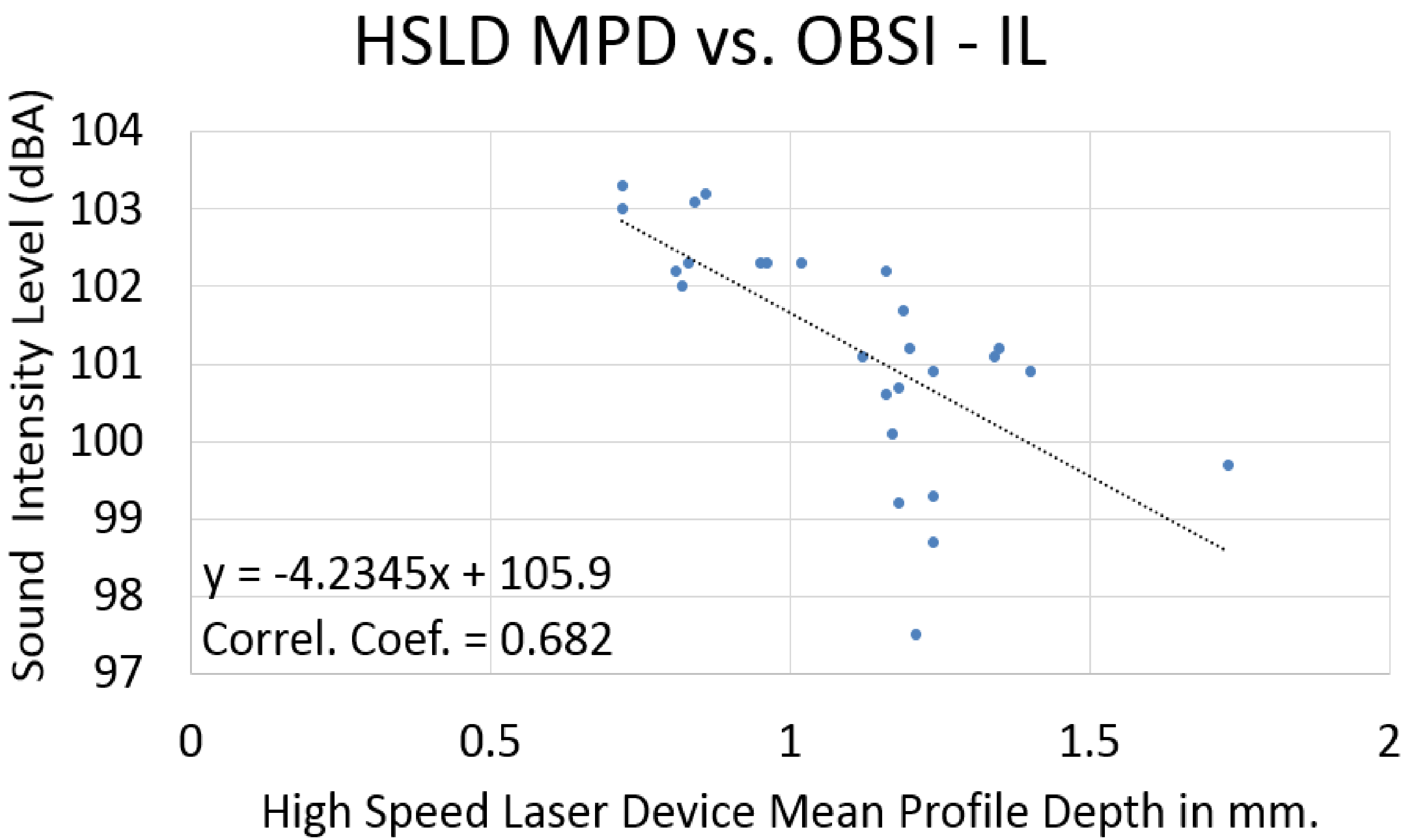

Results

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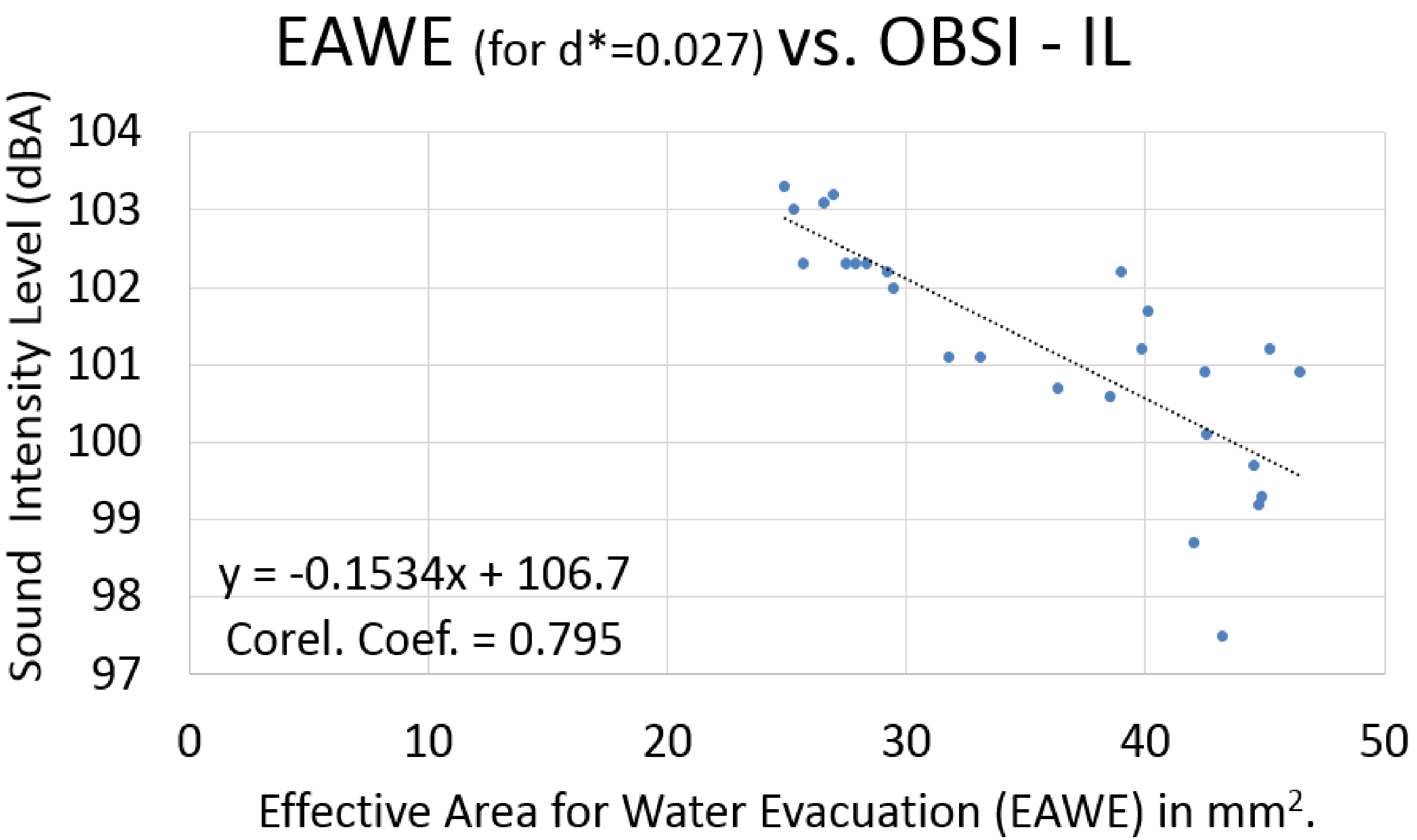
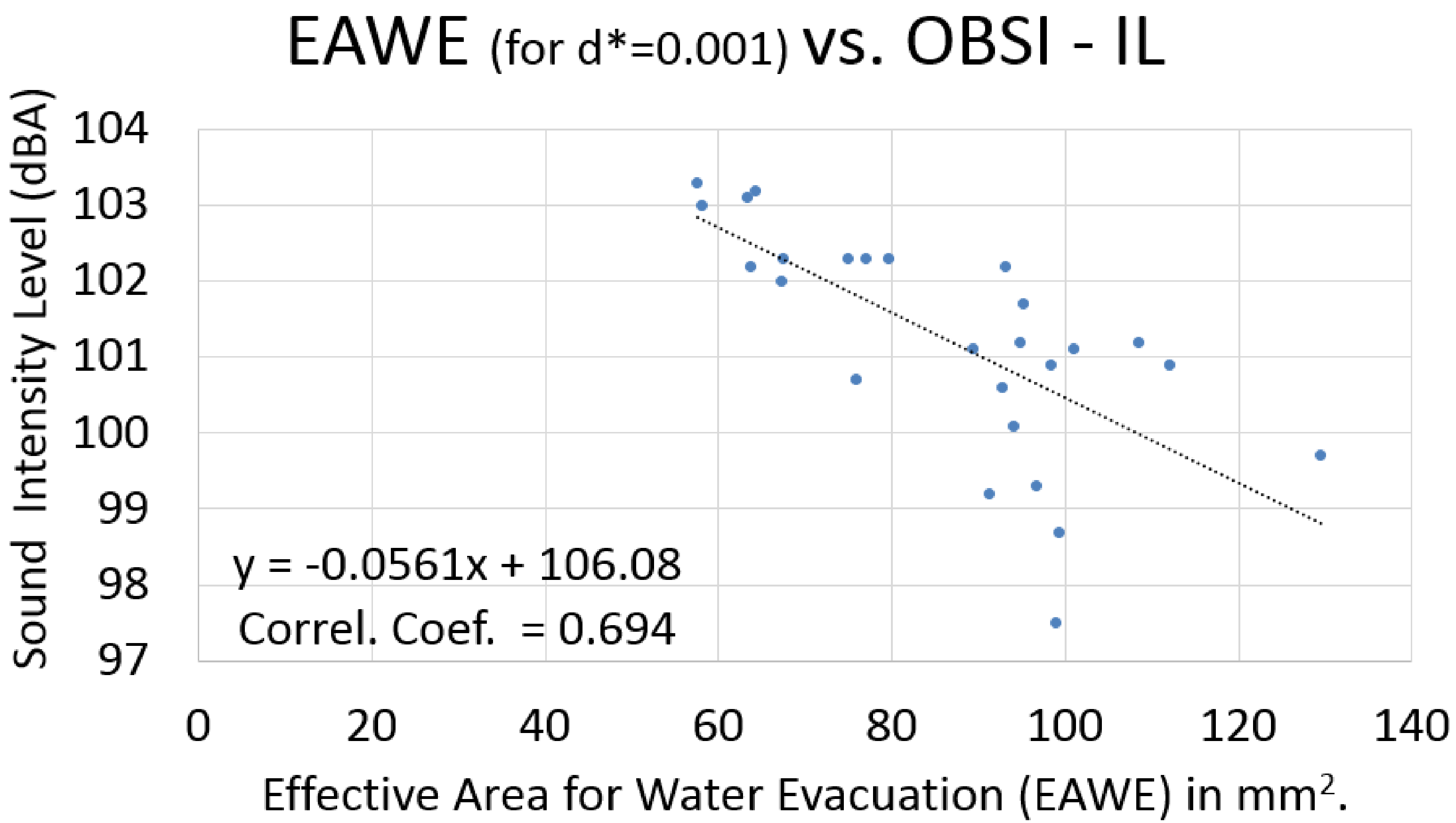


Results

Macrotexture vs Noise



Conclusions

- **It was possible to define a new index for characterizing macrotextureusing EAWE**
  - ✓ **has some advantages when compared with MPD**
- Comparisons between MPD and EAWE confirmed that:
  - ✓ MPD overestimates the ability of the pavement to drain water under a real tire
- **EAWE correlates better with friction and noise measurements than MPD**

Recommendations

For *future research:*

A sensitivity analysis to determine the optimal base lengths for results presentation

- ✓ Support macrotexture measurements at a network level.

Experimentally investigate different d* values over real pavement surfaces

Investigate another enveloping methodologies

Implement the method using 3D laser devices, as this laser technology improves and become more available

→ **A new index based on the Effective Volume for Water evacuation (EVWE)?**

Thank you for your attention