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St. Louis, MO / Southern Illinois

THE GATEWAY

TO KNOWLEDGE ABOUT SURFACE CHARACTERISTICS

Texture Performance Models for North Carolina's Primary Road Network

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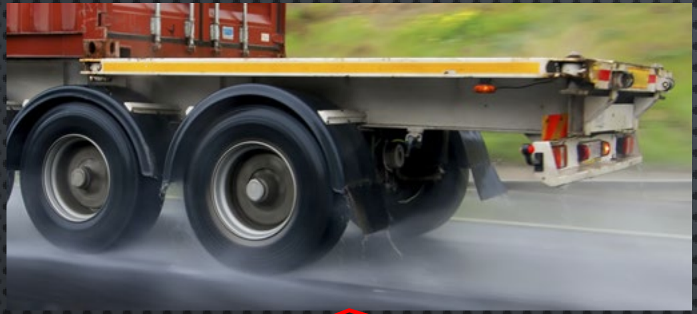
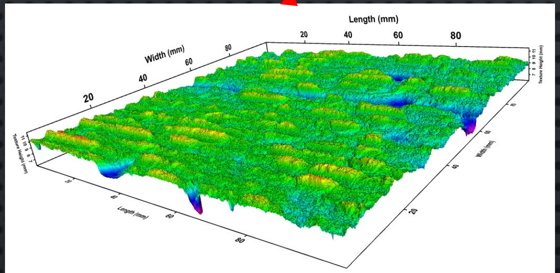
  - This presentation represents the opinions of the author and is not meant to represent the position or opinions of the NCDOT or its members.

OUTLINE

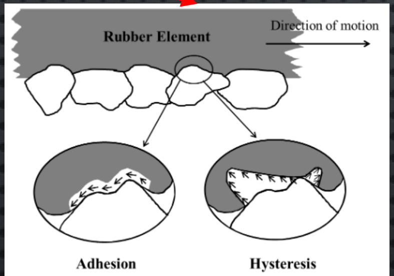
- ❑Role of Pavement Macrotexture on Highway Safety
- ❑Data
- ❑Performance Curve
- ❑Model Validation
- ❑Conclusions

ROLE OF PAVEMENT MACROTEXTURE ON HIGHWAY SAFETY





Texture



Friction

Pavement surface characteristics play an important role in road safety, especially at wet conditions

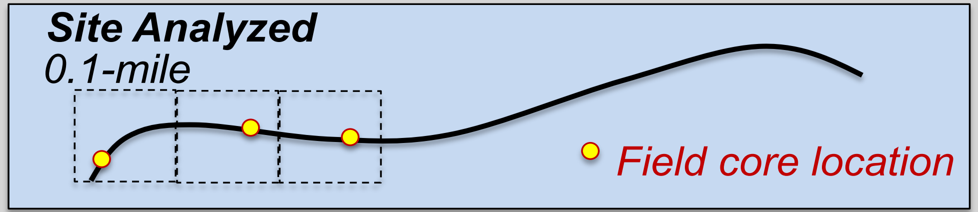
- Measuring the surface macrotexture is relative easier than measuring friction.
- NCHRP Report 964 (2021): "Protocols for Network-Level Macrotexture Measurement".
- The MPD/MTD have been used in different models to evaluate the hydroplaning potential.
- Different authors have used MPD as a predictor in a SPF.

DATA

Device: **AMES - HSIP**	
Speed	Posted speed limit
Location	• RWP • Center of the lane
Frequency	3 m (10 ft)

- ❑ **GROUP-1:** 36 SITES FOR SHORT-TERM PERFORMANCE
- ❑ **GROUP-2:** 117 SITES FOR LONG-TERM PERFORMANCE

Processing Method

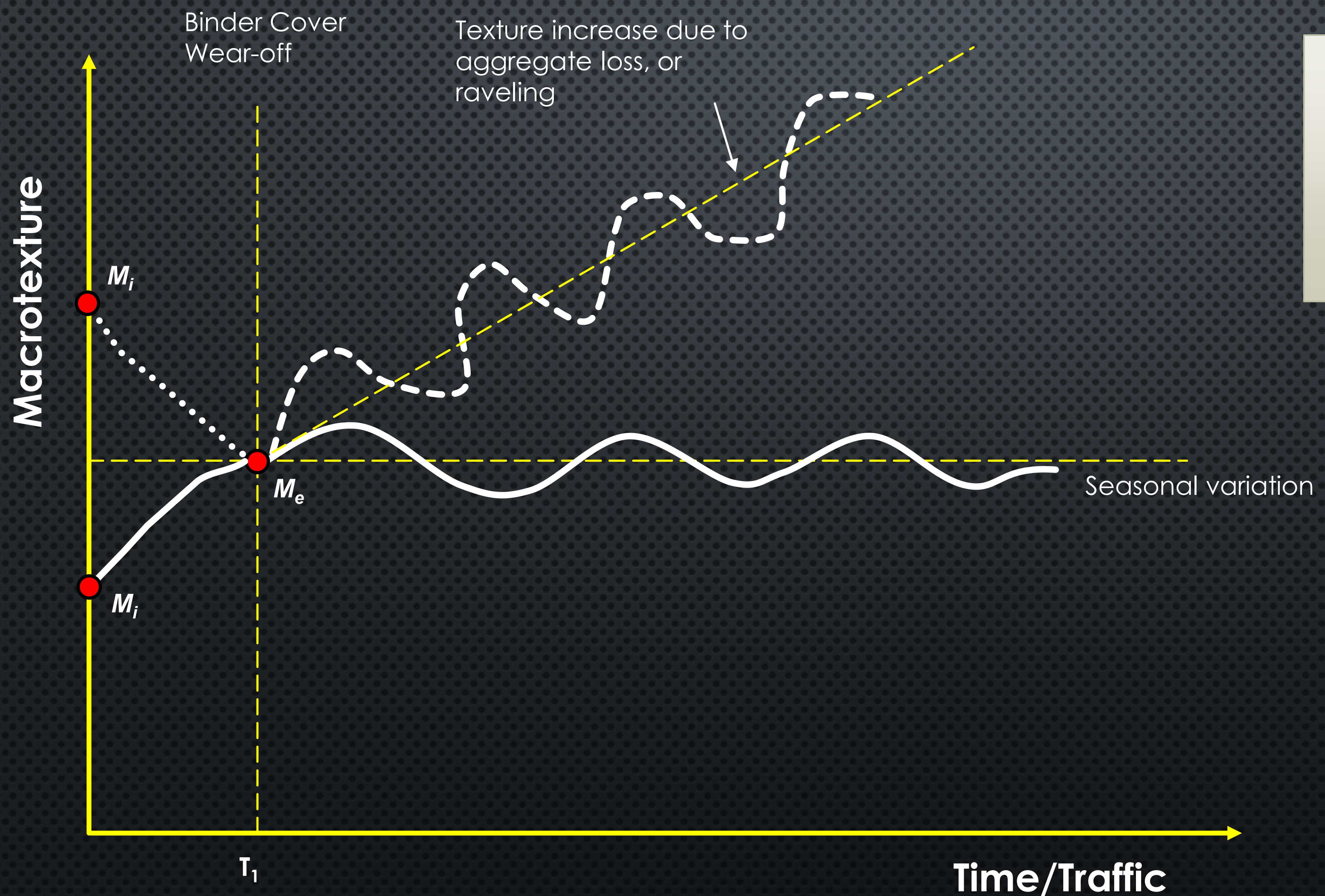


Continuous friction and texture measurements were grouped into 0.1-mile segments. A statistical analysis was made to identify the best descriptor for each index.

Texture

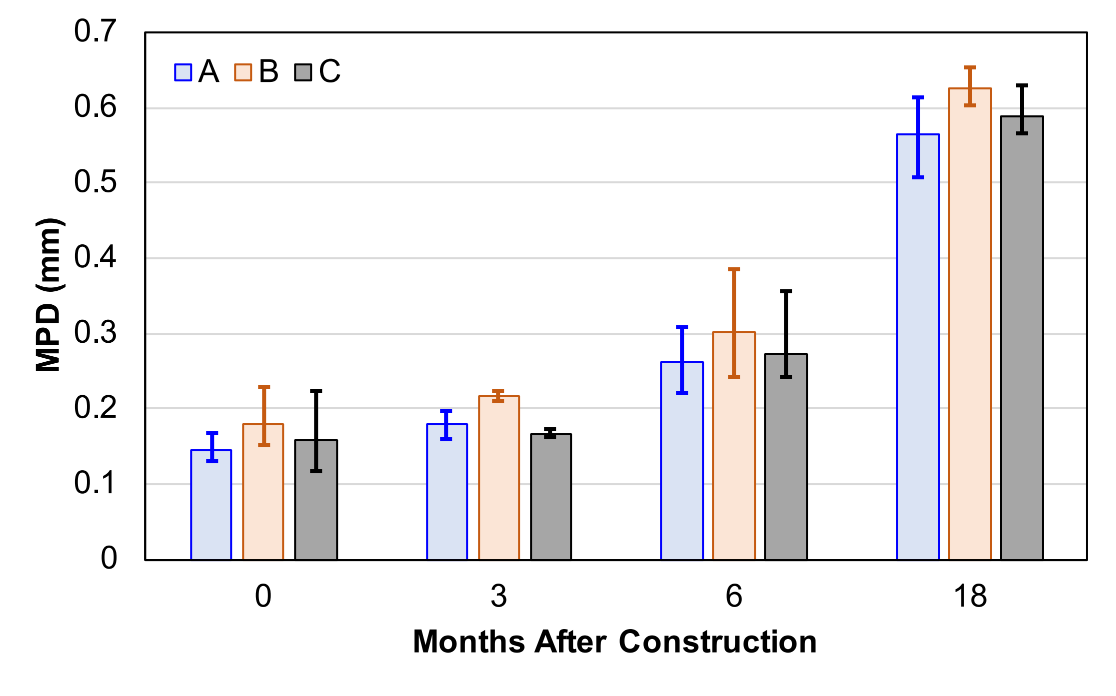
- 0.1-mile segments: 50th percentile
- Representative value: average of individual 0.1-mile values

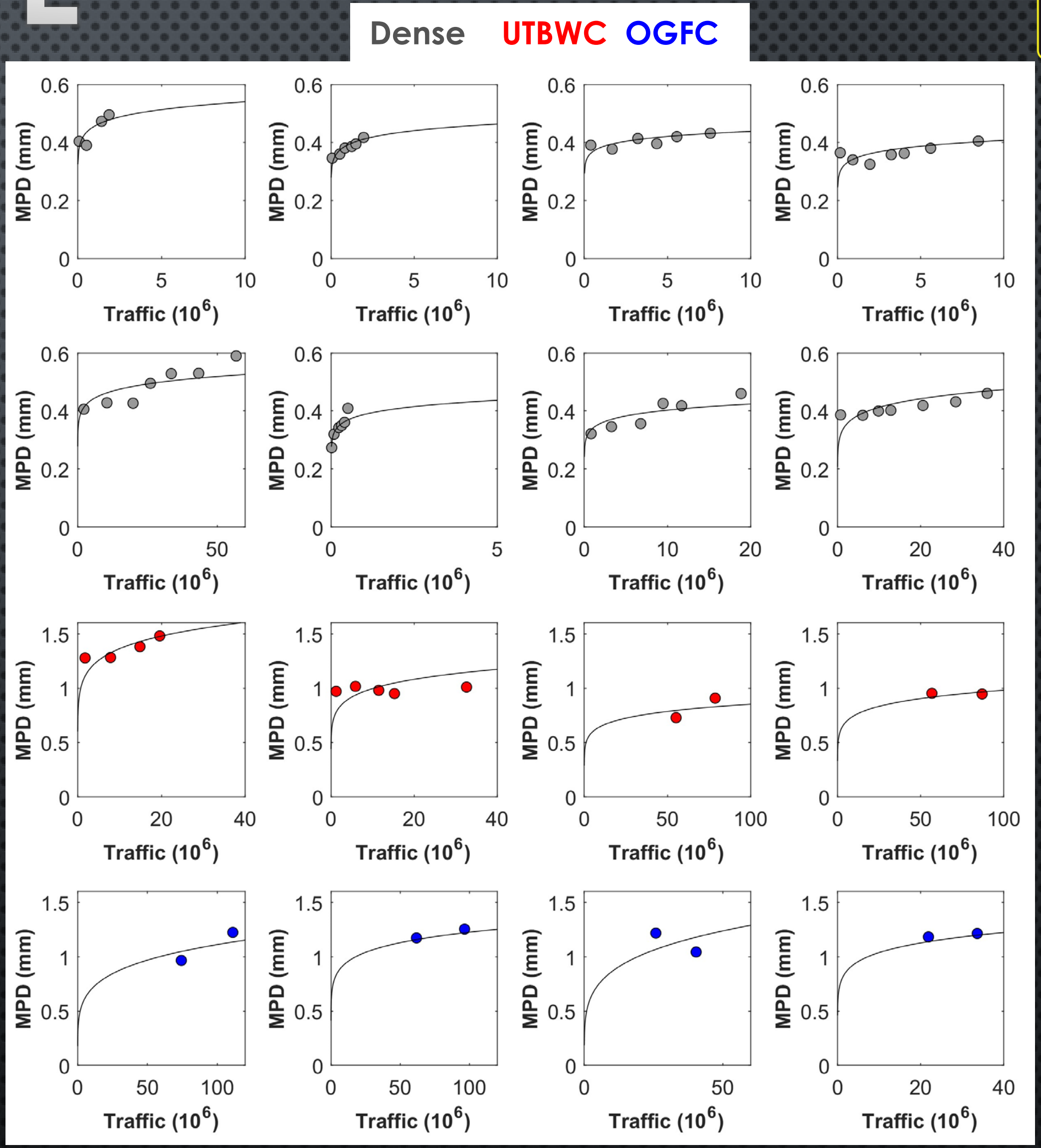
PERFORMANCE CURVE



Goenaga, B., Underwood, B. S., Castorena, C., & Rogers, P. (2023). Early Friction and Texture Evolution After an Asphalt Overlay. *Transportation Research Record*, 03611981221149436.

PERFORMANCE CURVE





- ❑ The NCDOT has three testing sections in NCAT's accelerated performance facility.
- ❑ Field cores have been extracted in different points in time.
- ❑ Static texture measurements were obtained.

PERFORMANCE CURVE

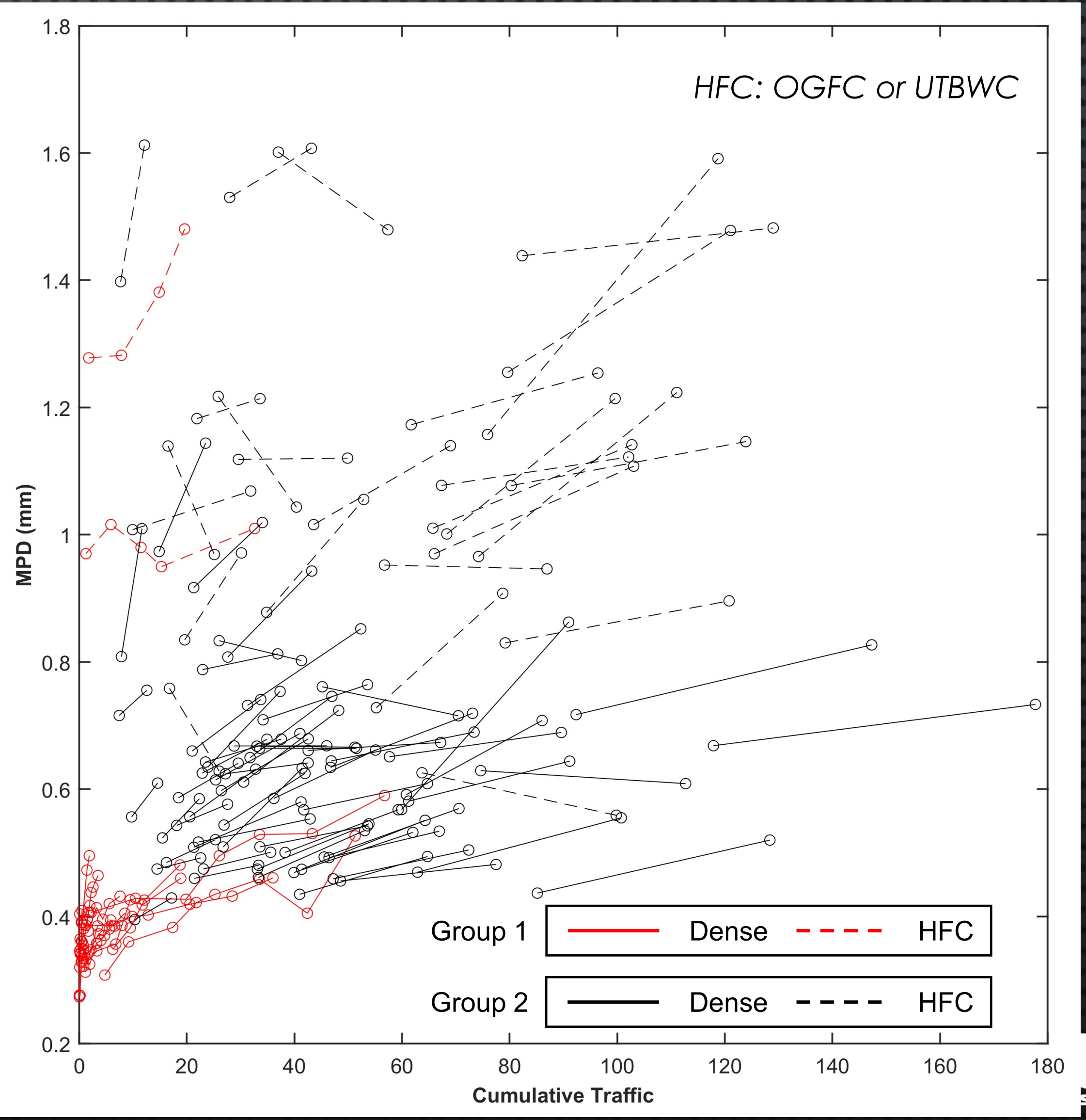
- 103 out of the 153 sites were used for model calibration.
  - Some sites were removed based on their surface type, and
  - Based on the surface condition (excessive raveling).

- For validation, 9 sites have two observations, not used during the calibration process. Additionally, three new sites were included for validation.

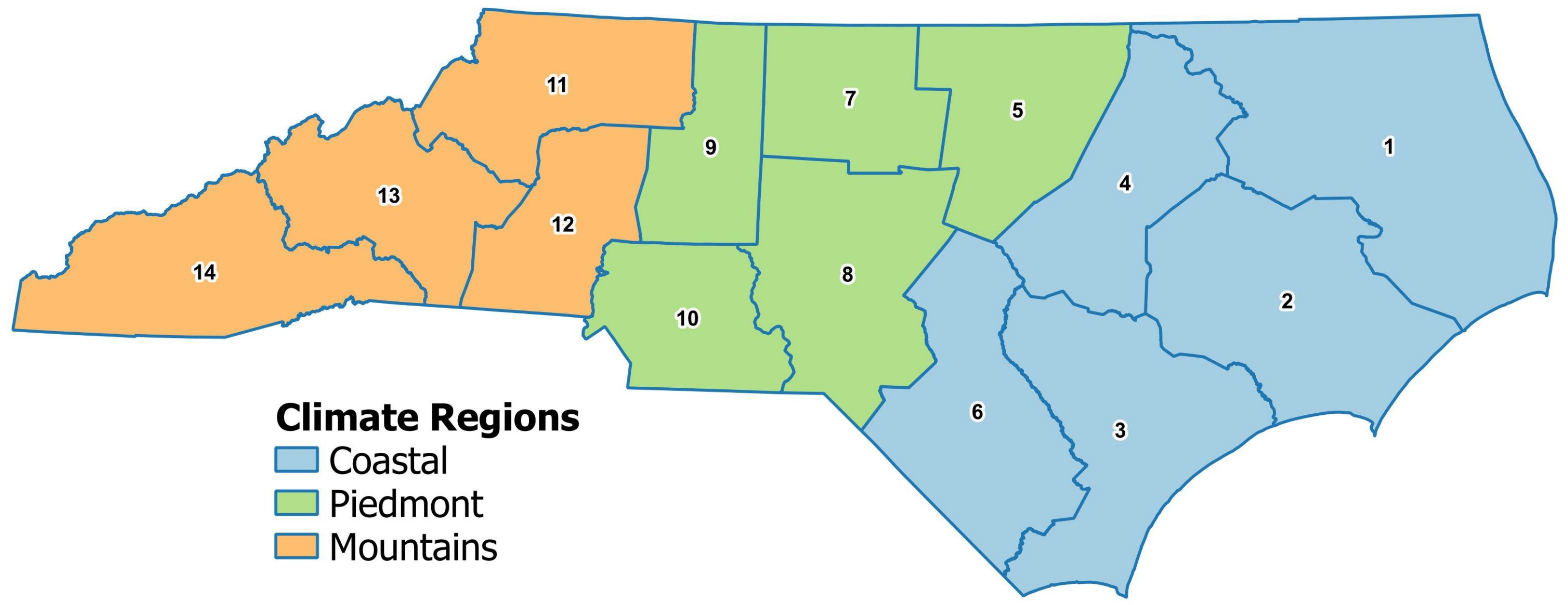
$$MPD = \left(a + \Delta a_{site}\right) \cdot T^{\left(b + \Delta b_{family}\right)}$$

Random Effect in the initial texture

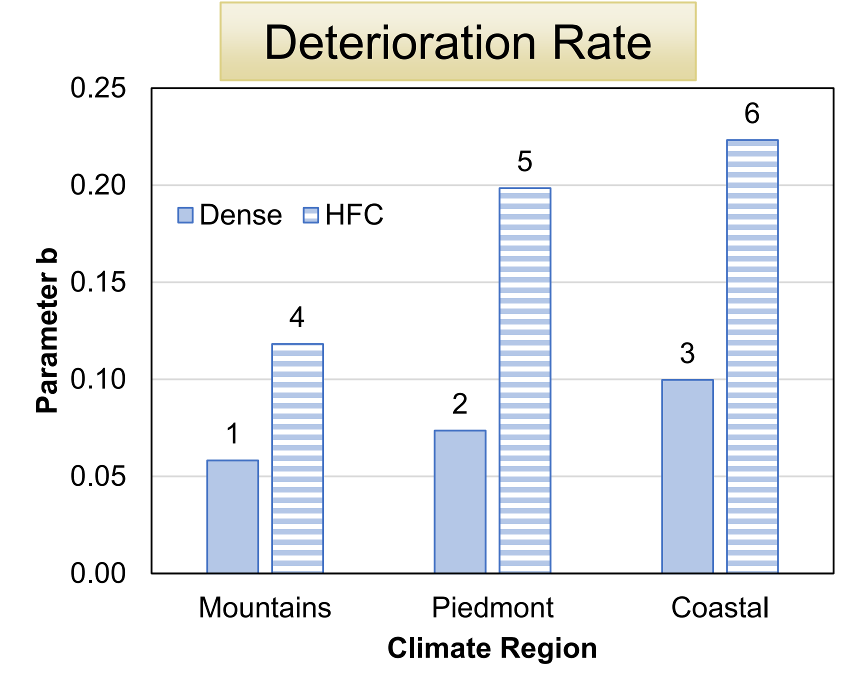
Random Effect in the initial texture



PERFORMANCE CURVE



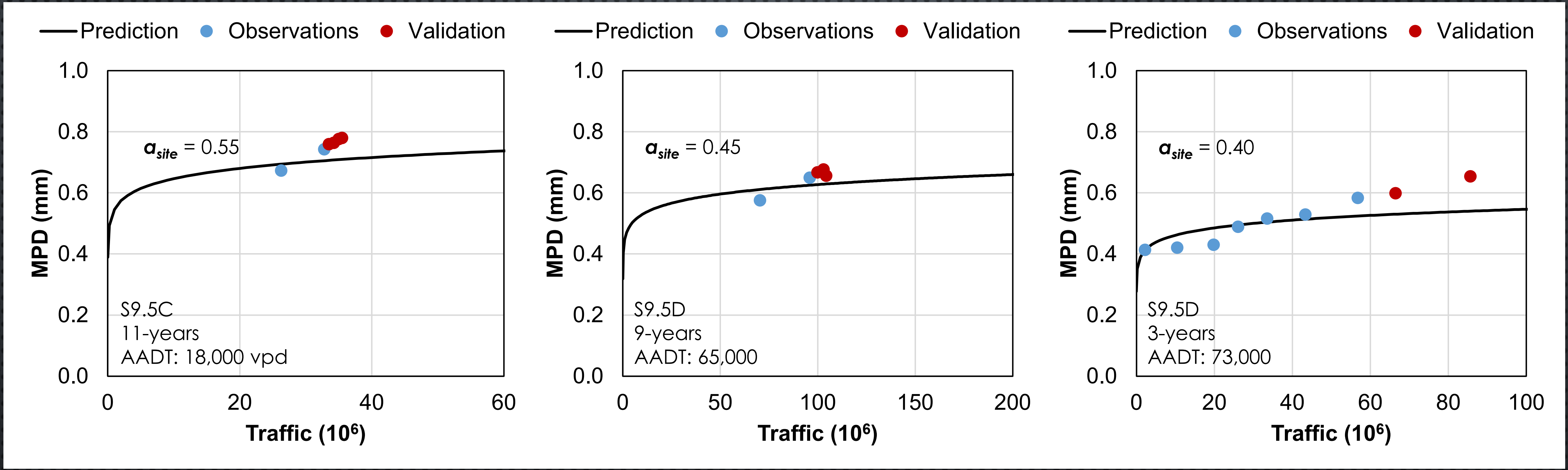
Family 1: Dense – Mountains
Family 2: Dense – Piedmont
Family 3: Dense – Coastal
Family 4: HFC – Mountains
Family 5: HFC – Piedmont
Family 6: HFC – Coastal



Exp(-0.74) = **0.48**

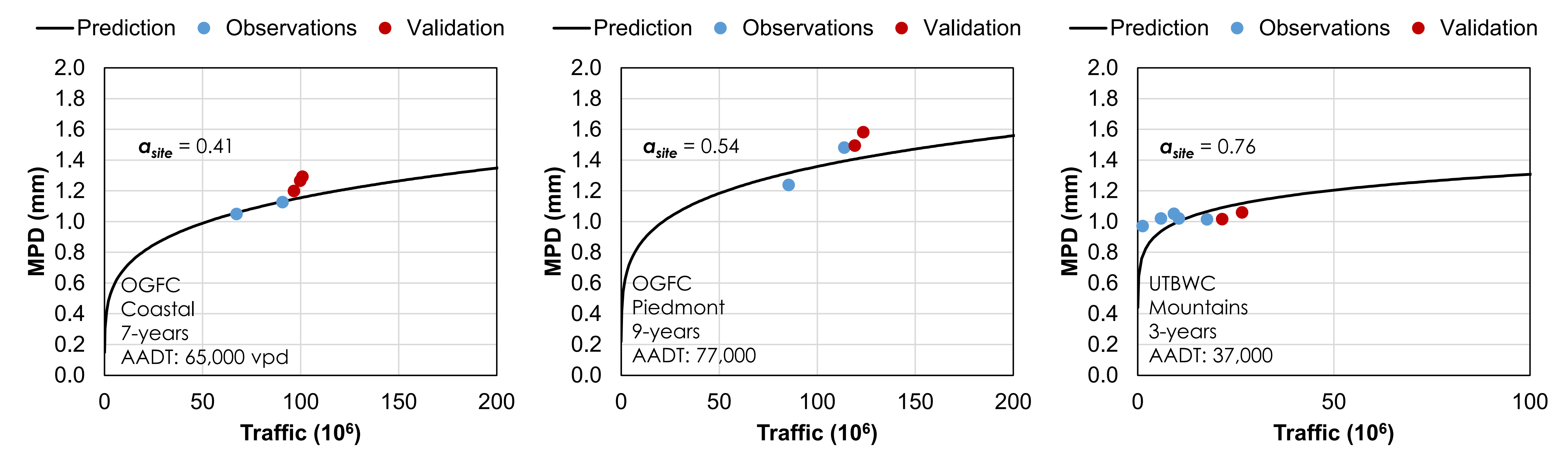
Parameter	Estimate	SE	t-statistic	DF	p-Value	Lower*	Upper*	Std Δa_{site}	Std Δb_{family}
a	-0.74	0.04	-20.6	264	0.0	-0.81	-0.67	0.24	0.06
b	0.13	0.03	4.7	264	0.0	0.08	0.18		

MODEL VALIDATION (PREDICTIONS)



- ❑ All these sites are in the piedmont area, i.e., they belong to Family 2.
- ❑ Mean values of the performance curve: $\boldsymbol{a}$ = 0.48 and $\boldsymbol{b}$ = 0.13.
- ❑ b_{family} = 0.074.

MODEL VALIDATION (PREDICTIONS)



- These sites are in different climate regions and have an HFC. Therefore, they belong to Family 6, 5, and 4.
- Mean values of the performance curve: ***a*** = 0.48 and ***b*** = 0.13.
- b_{costal} = 0.223; $b_{piedmont}$ = 0.199; $b_{mountain}$ = 0.118.

MODEL VALIDATION (PREDICTIONS)

Calibration Set

$$MPD = a_{site}(T)^{b_{family}}$$

New Sites

$$MPD_0 = 1.22 - 0.009 \times VFA + 0.087 \times Cc - 0.046 \times (AC\% \cdot Dense)$$

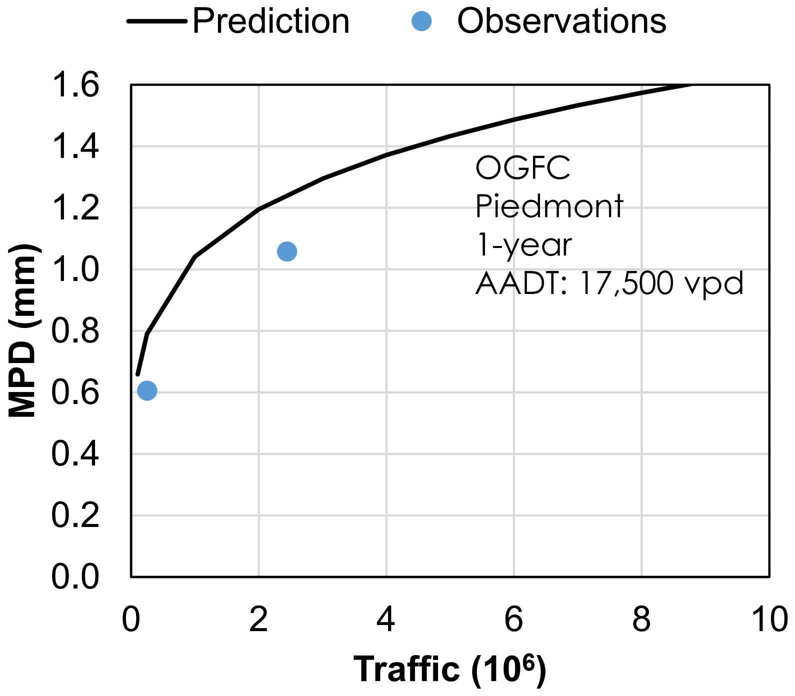
MPD_0 = Mean texture depth, approximately 30-days after construction, in mm,
VFA = Voids filled with asphalt, %,
Cc = Gradation Coefficient of Curvature,
AC% = Total binder content, in %, and
Dense = Binary variable, 1 = Dense mix, 0 = UTBWC or OGFC.

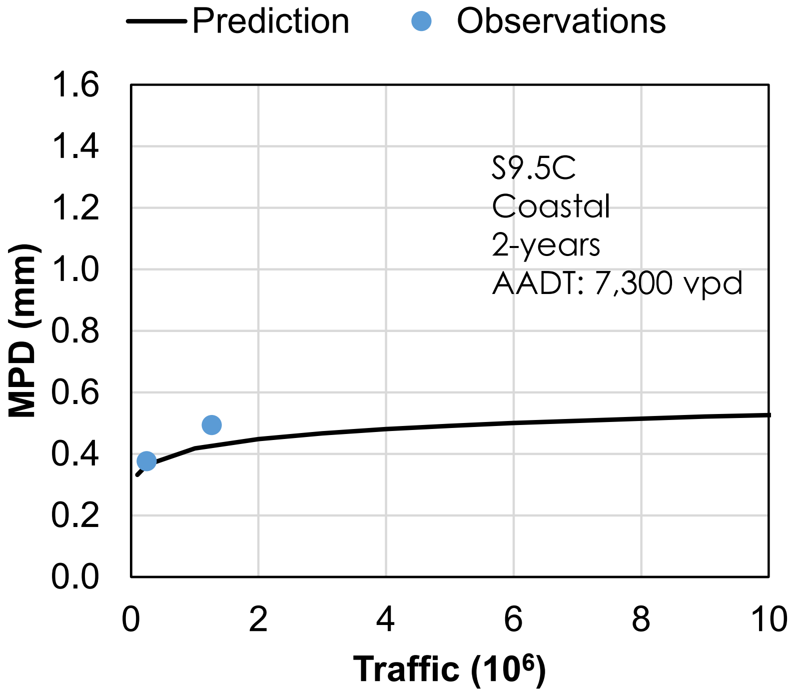
$$Cc = \frac{D_{30}^2}{D_{10} \times D_{60}}$$

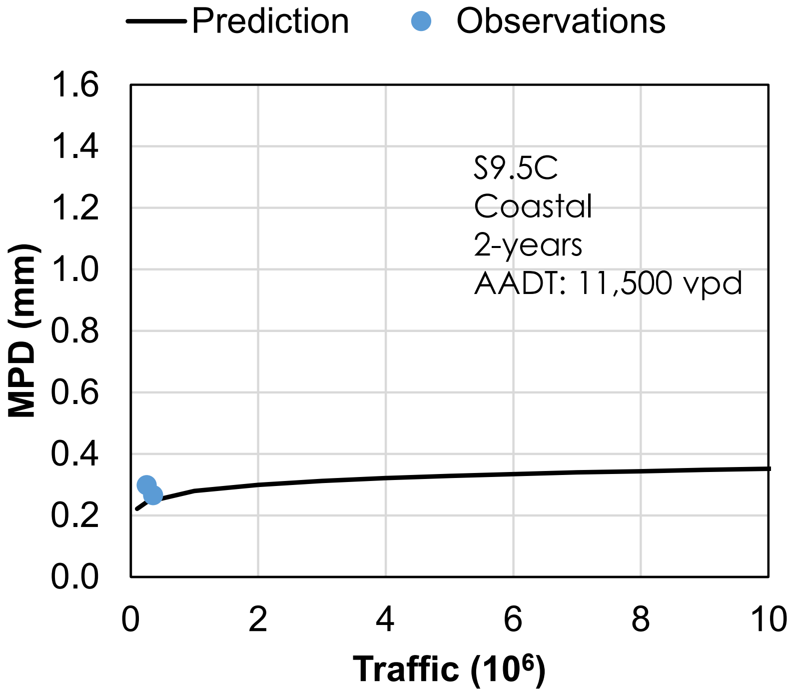
$$MPD = a_{site}(T)^{b_{family}}$$

$$a_{site} = \frac{MPD_0}{(T_{1-month})^{b_{family}}}$$

MODEL VALIDATION (NEW SITES)





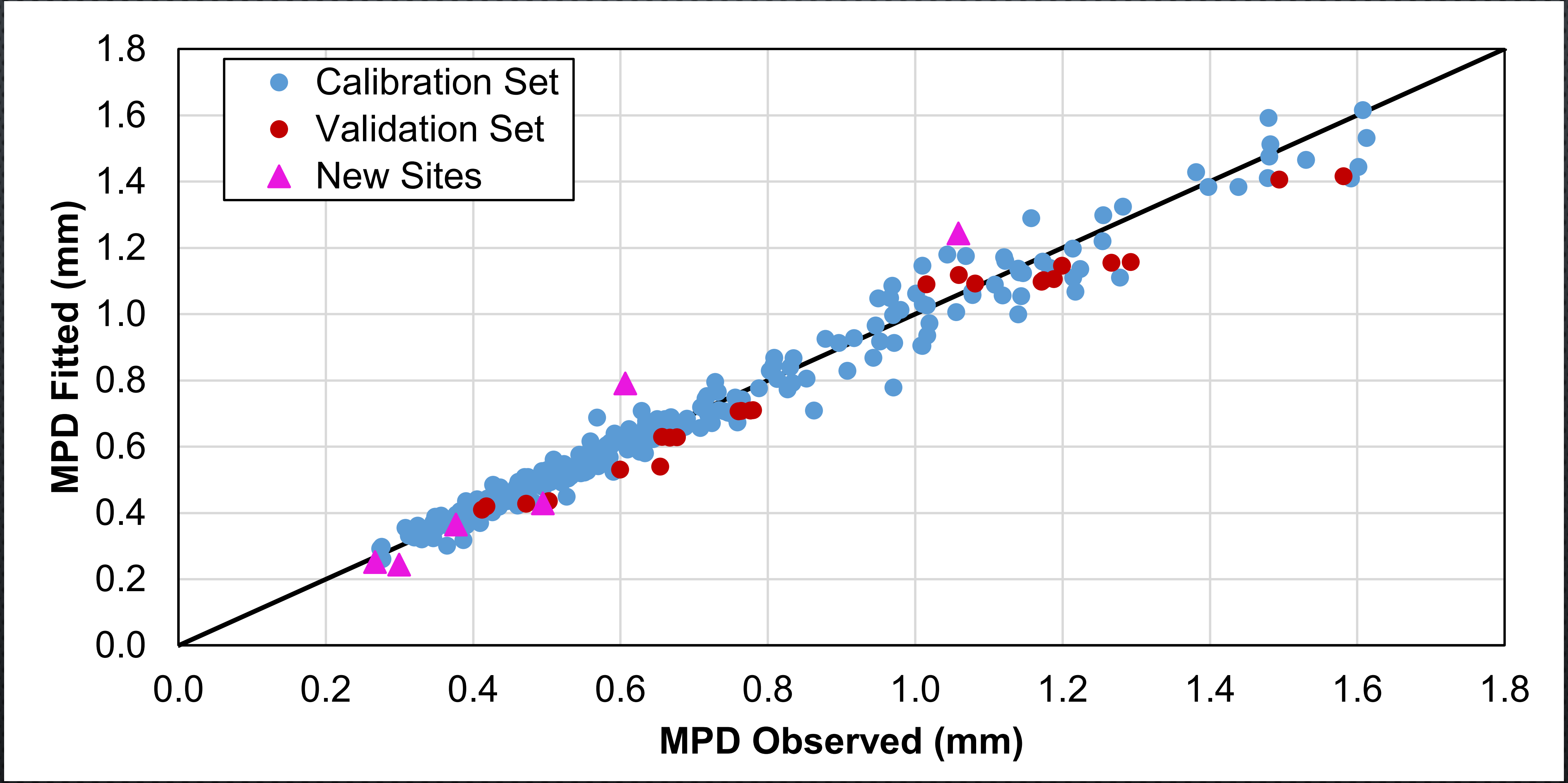


Cc	1.23
Binder (%)	6.2
VFA (%)	39.7
Dense	0
MPD_0 (mm)	0.97
a_{site}	1.04
b_{family}	0.199

Cc	0.67
Binder (%)	5.4
VFA (%)	74.5
Dense	1
MPD_0 (mm)	0.36
a_{site}	0.42
b_{family}	0.10

Cc	0.48
Binder (%)	6.9
VFA (%)	77.0
Dense	1
MPD_0 (mm)	0.25
a_{site}	0.28
b_{family}	0.10

MODEL VALIDATION



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CONCLUSIONS

- To accurately represent texture performance, it is necessary to account for the heterogeneity in the deterioration process.

- Based on the results, it is recommended to include at least three or four observations per section to get reliable estimates of the deterioration curve.

- Clustering the pavements by climate region and surface type reduced the number of coefficients in the model. Other clustering criterions, based on mixture composition, could be used to improve the accuracy of deterioration rates.

THANK YOU!!!

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