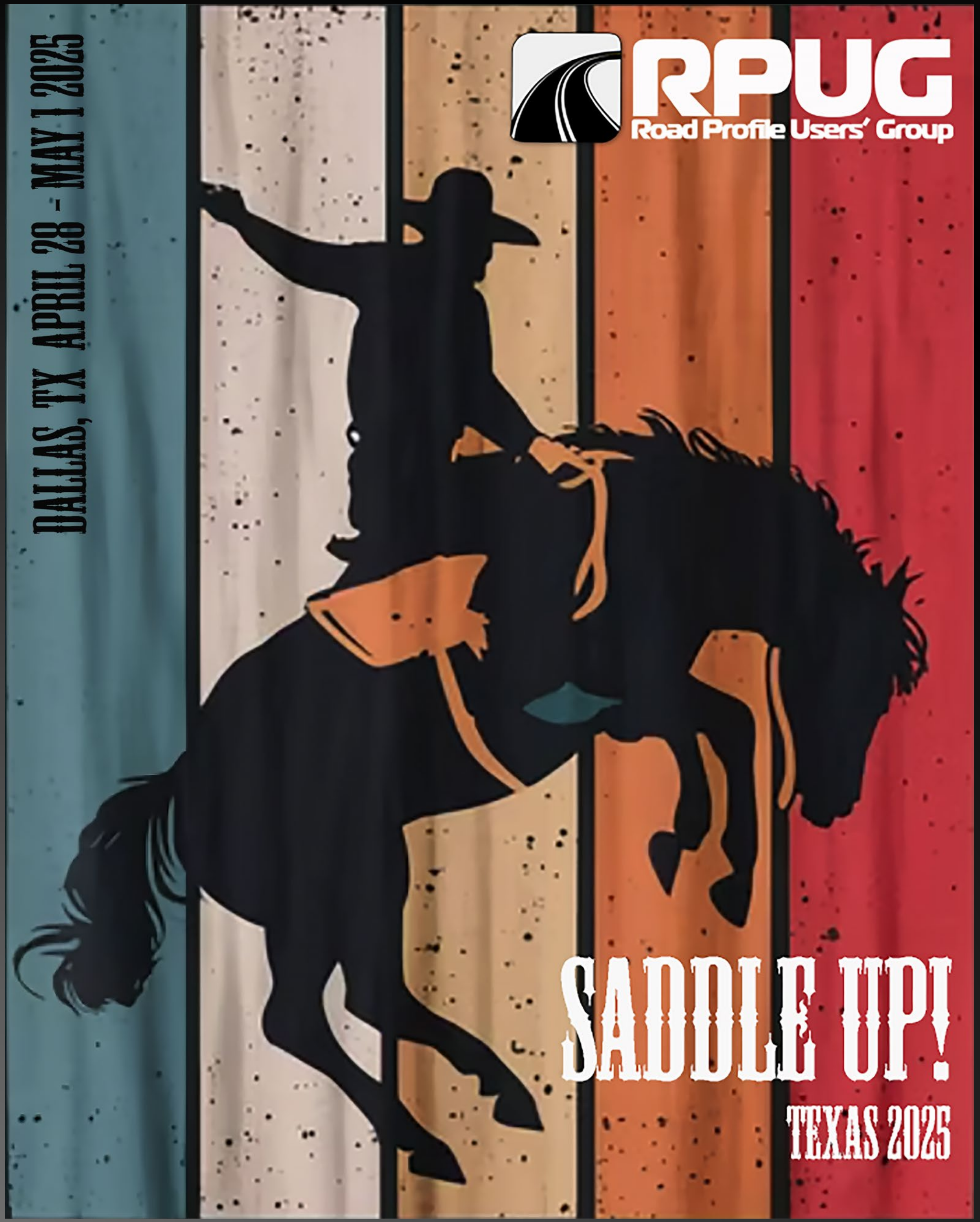

ESTABLISHING FRICTION AND MACROTEXTURE INVESTIGATORY THRESHOLDS

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RPUG
Road Profile Users' Group

OUTLINE

- Acknowledgements
- Research Background
- Data
- Friction and Macrotexture Performance
- Safety Performance
- Conclusions

ACKNOWLEDGEMENTS

- NCSU
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  - Dr. Cassie Castorena – Professor
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  - Shawn Troy, STU
  - Matt Hildebran, M&T
  - Andrew Wargo, M&T
  - Matthew York, Hydraulics

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<u>DISCLAIMER</u>

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

RESEARCH BACKGROUND

- Internal studies on targeted sites (2017-current)
- RP2017-02 - Evaluation of Methods for Pavement Surface Friction, Testing on Non-tangent Roadways and Segments (Completed, VT)
- RP2020-11 - Evolution of Pavement Friction and Macrotexture after Asphalt Overlay (Completed)
- RP2022-05 - Development of Friction Performance Models (Completed)
- RP2024-12 - Evaluation of Macrotexture and Friction of Alternative Asphalt Surface Course Material (Completed)
- Network Data Collection (2022, 2023, 2024)
- RP2025-18 - Updating Friction/Texture Demand Categories for Improved Pavement Design Guidance (Ongoing)

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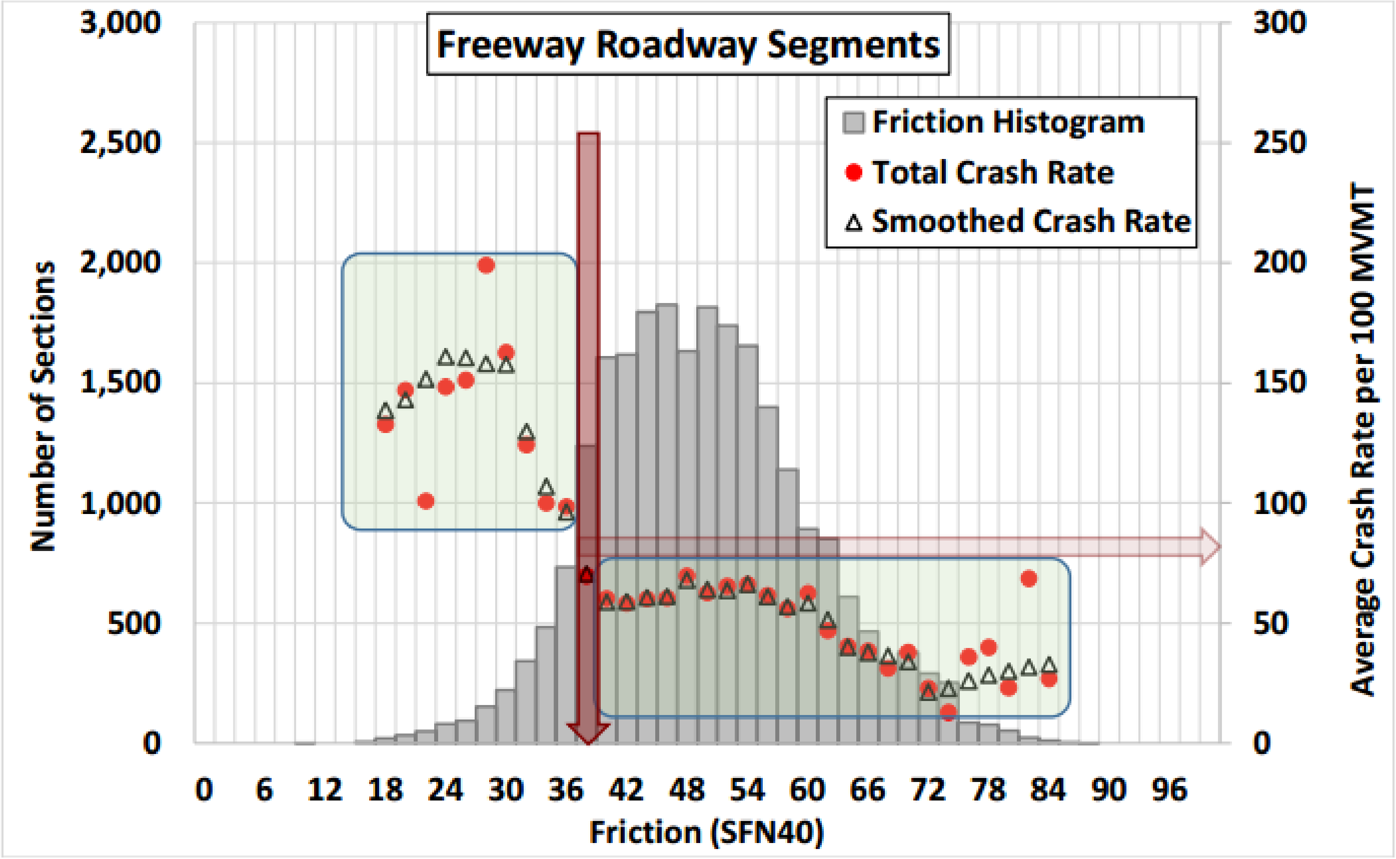
RESEARCH BACKGROUND

SKID RESISTANCE RELATIONSHIP WITH HIGHWAY SAFETY

Hydroplaning, noise, and splash

Braking distance, ride, and cornering

Road geometry, skid resistance demand



Source: FHWA

The lower the skid resistance, the higher the crash risk.

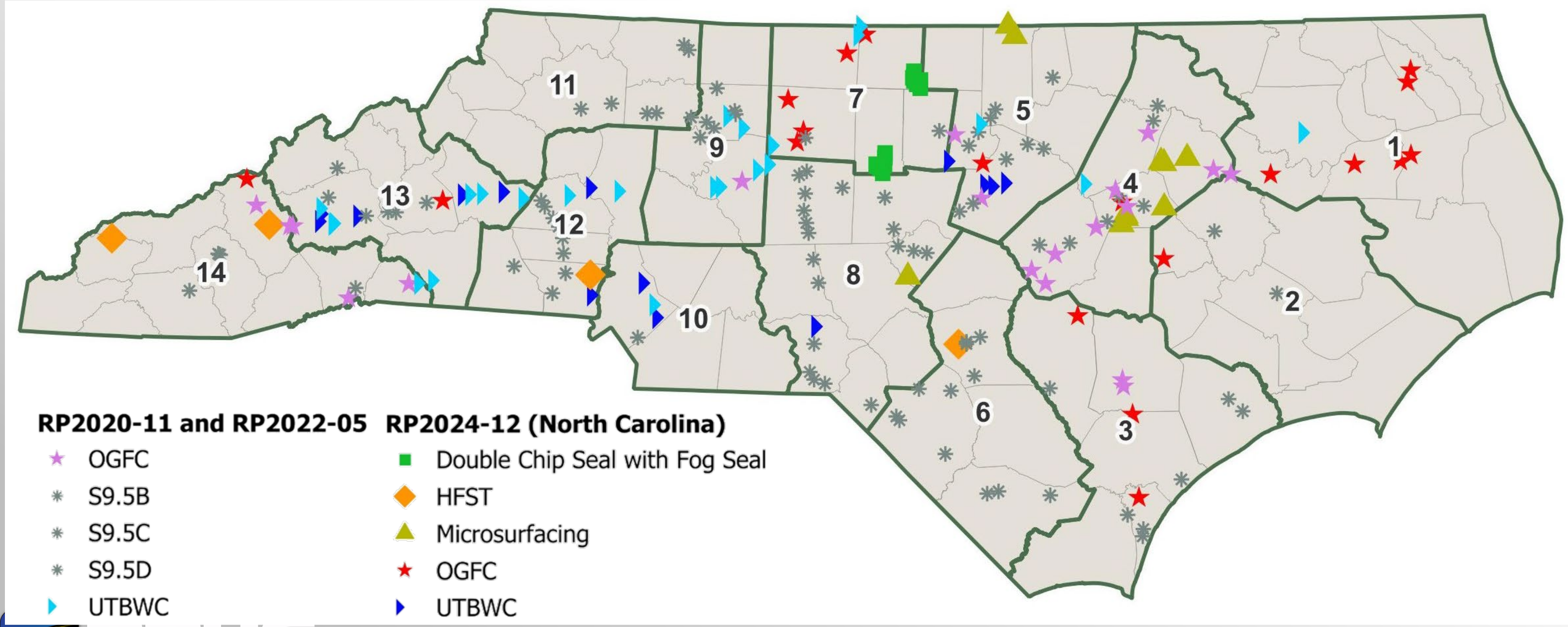
RESEARCH BACKGROUND

OBJECTIVES

- Characterize the typical range of friction and macrotexture observed in North Carolina by pavement type and traffic levels.
- Characterize friction and macrotexture performance models.
- Develop friction and macrotexture performance investigatory thresholds.

DATA

- Core Acquisition and Lab Measurements
- Continuous Friction Measurement Equipment
- High-Speed Laser Profiler
- Lane Departure, Wet-Crashes



- Group 1 sites for short term monitoring
- Group 2 sites for long-term monitoring
- Group 3 sites for special surface
- Group 4 sites from Network data collection

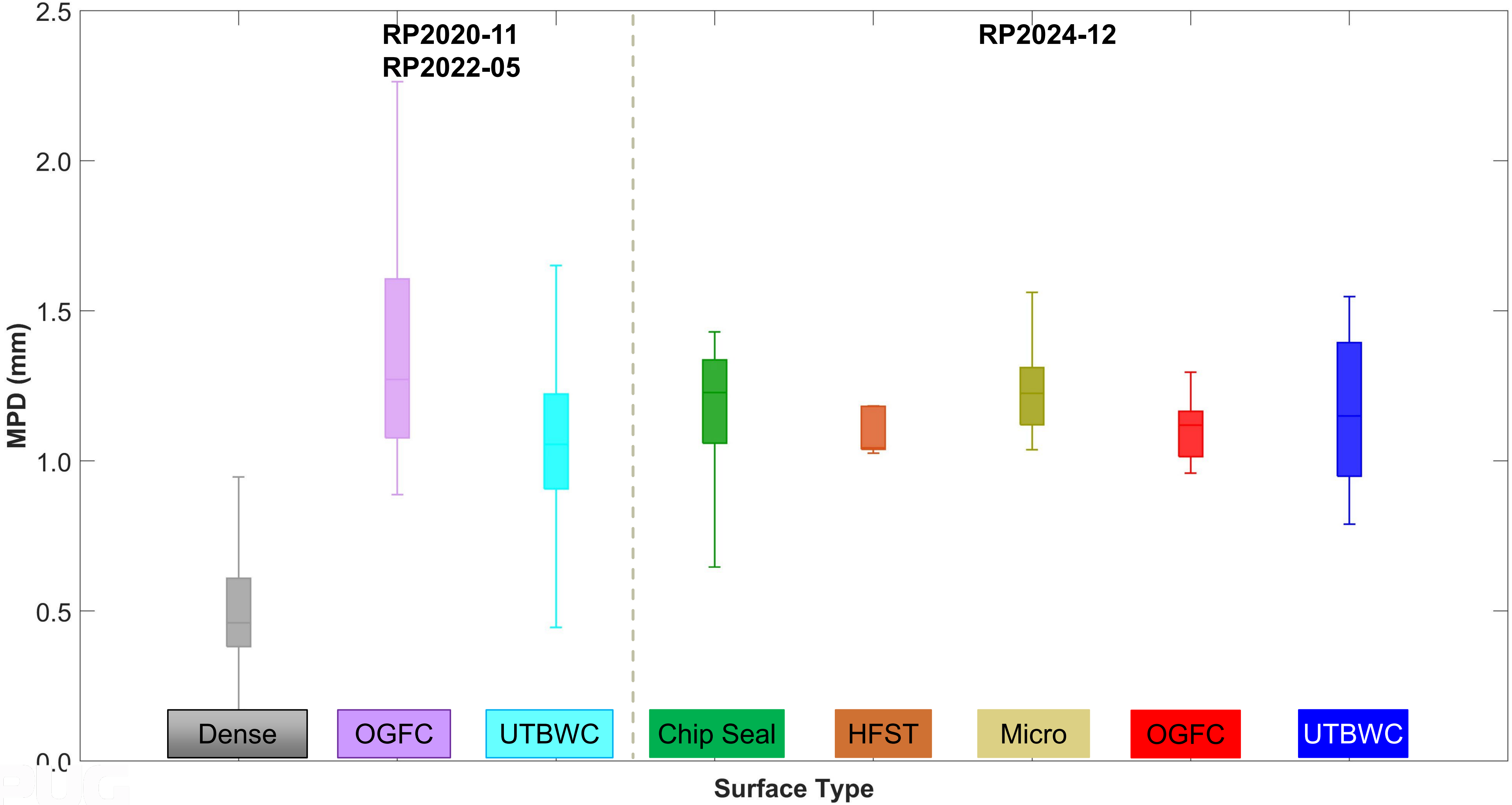
DATA

FRICTION AND MACROTEXTURE MEASUREMENT DEVICES

Device	 BV-11	 AMES AccuTexture 100
Speed	60-mph (96 km/h)	Posted speed limit
Location	• RWP • Center of the lane	• RWP • Center of the lane
Frequency	3 m (10 ft)	3 m (10 ft)

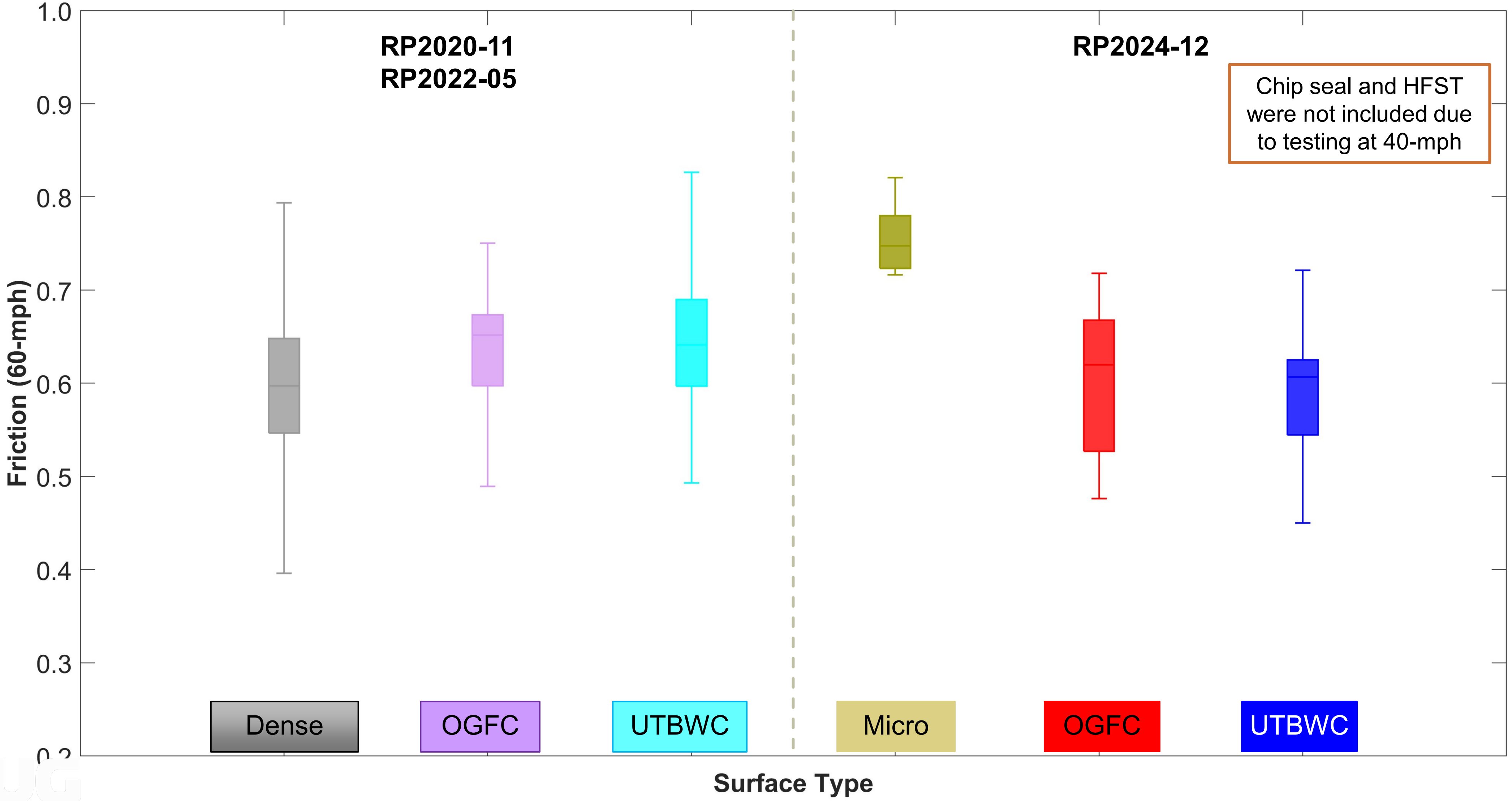
DATA

OBSERVED MACROTEXTURE VALUES



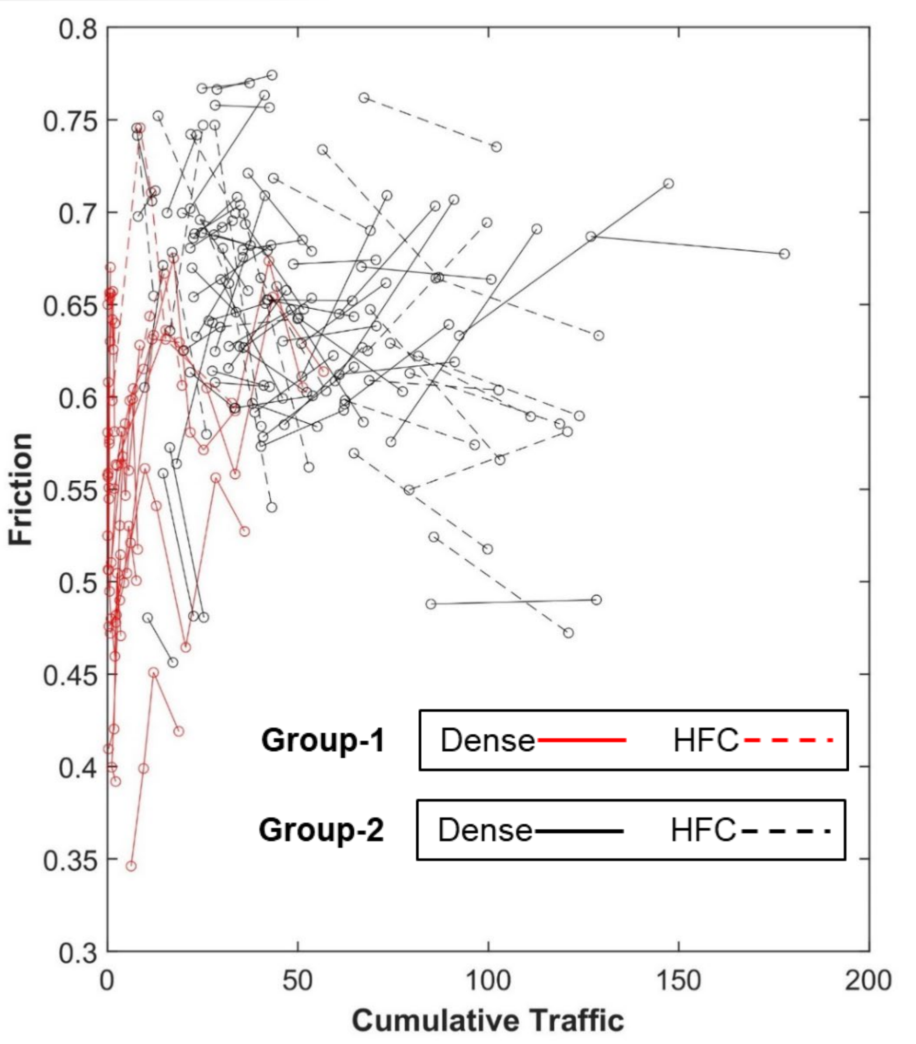
DATA

OBSERVED BV-11 FRICTION VALUES

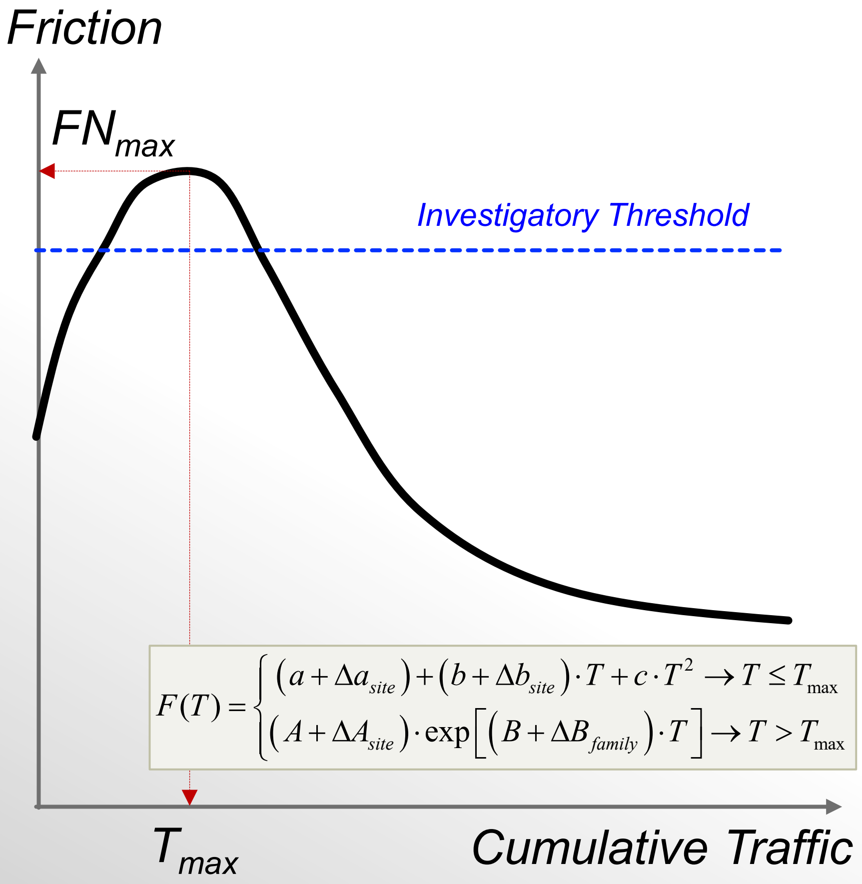


FRICTION AND MACROTEXTURE PERFORMANCE

FRICTION MODELS



Seasonal effects were modeled separately and are not shown in the schematic. Seasonality was removed from the data.



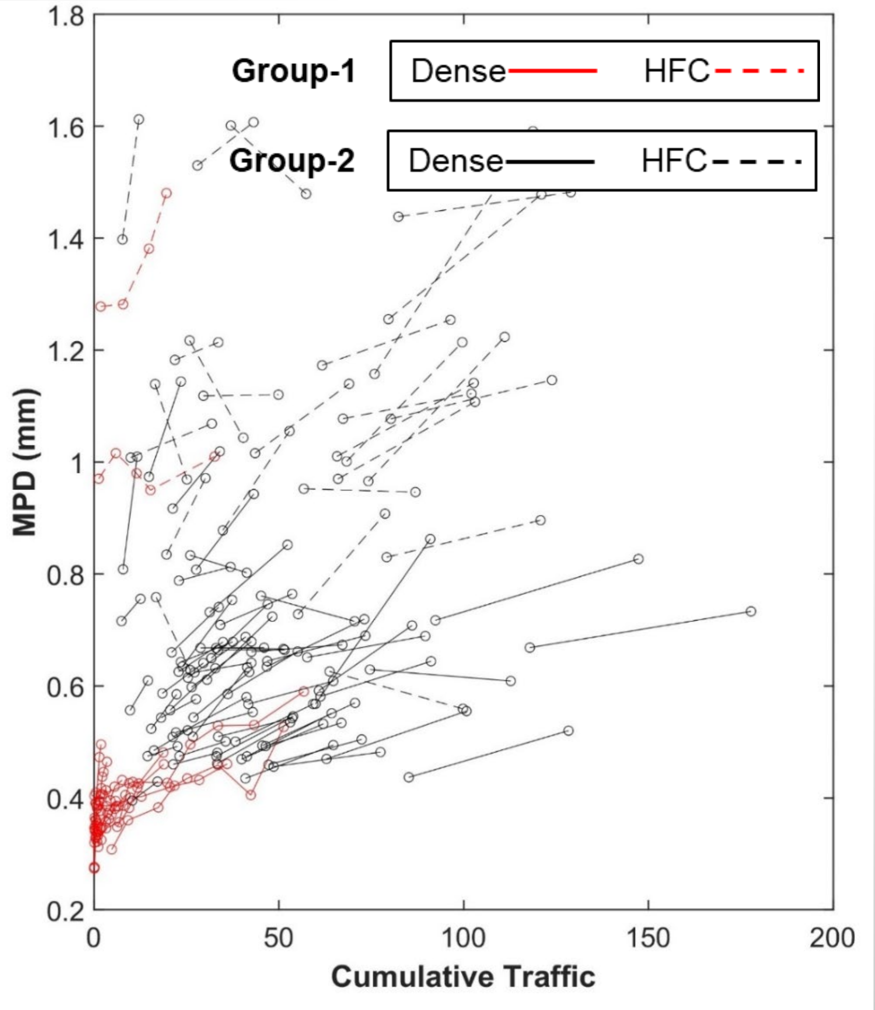
$$F(T)=\begin{cases}(a+\Delta a_{site})+(b+\Delta b_{site})\cdot T+c\cdot T^2 \rightarrow T\le T_{\max}\\(A+\Delta A_{site})\cdot \exp\left[\left(B+\Delta B_{family}\right)\cdot T\right]\rightarrow T>T_{\max}\end{cases}$$

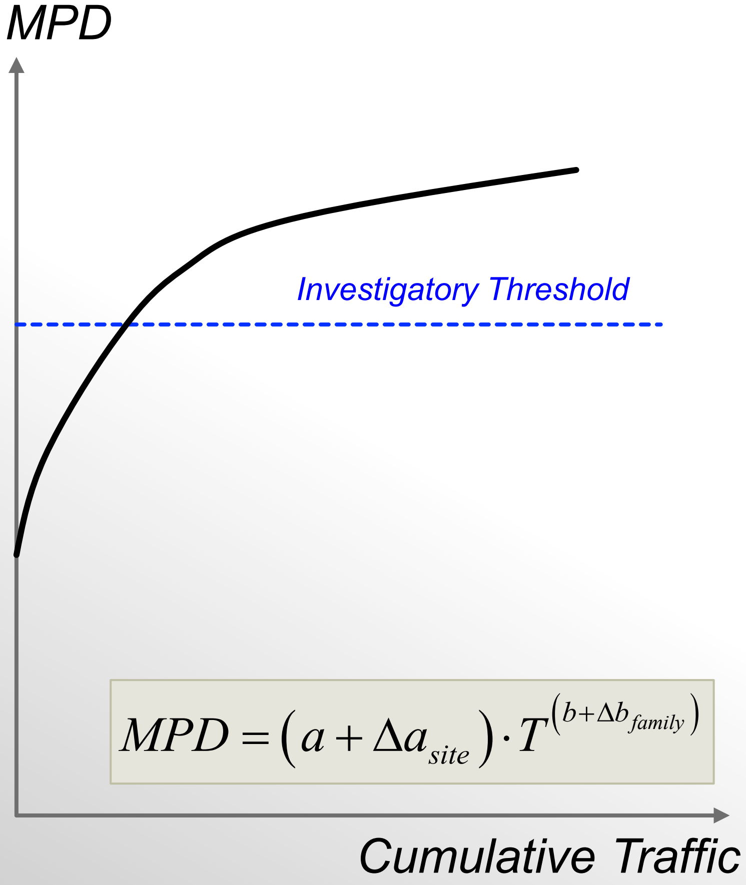
With these parameters, the model indicates that:

- *Average traffic needed to reach FN_{max} is 34.9 million repetitions.*
- *Average FN_{max} is 0.63*
- *Regional differences were not evident in RP2020-11 and RP2022-5 .*

FRICTION AND MACROTEXTURE PERFORMANCE

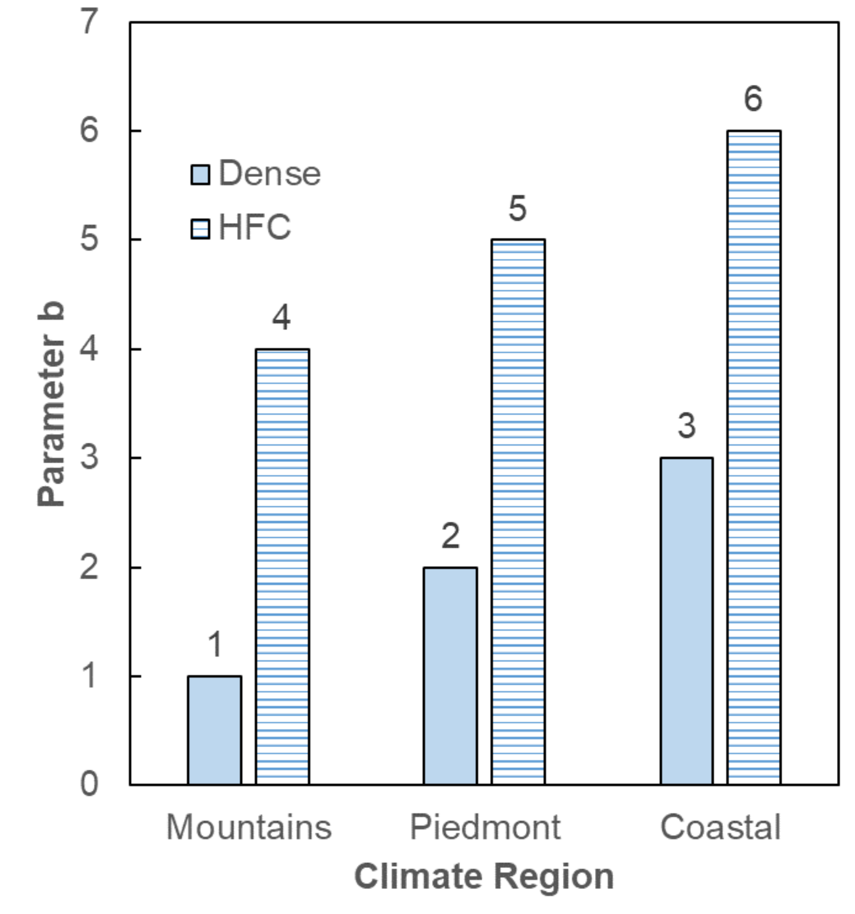
MACROTEXTURE MODELS





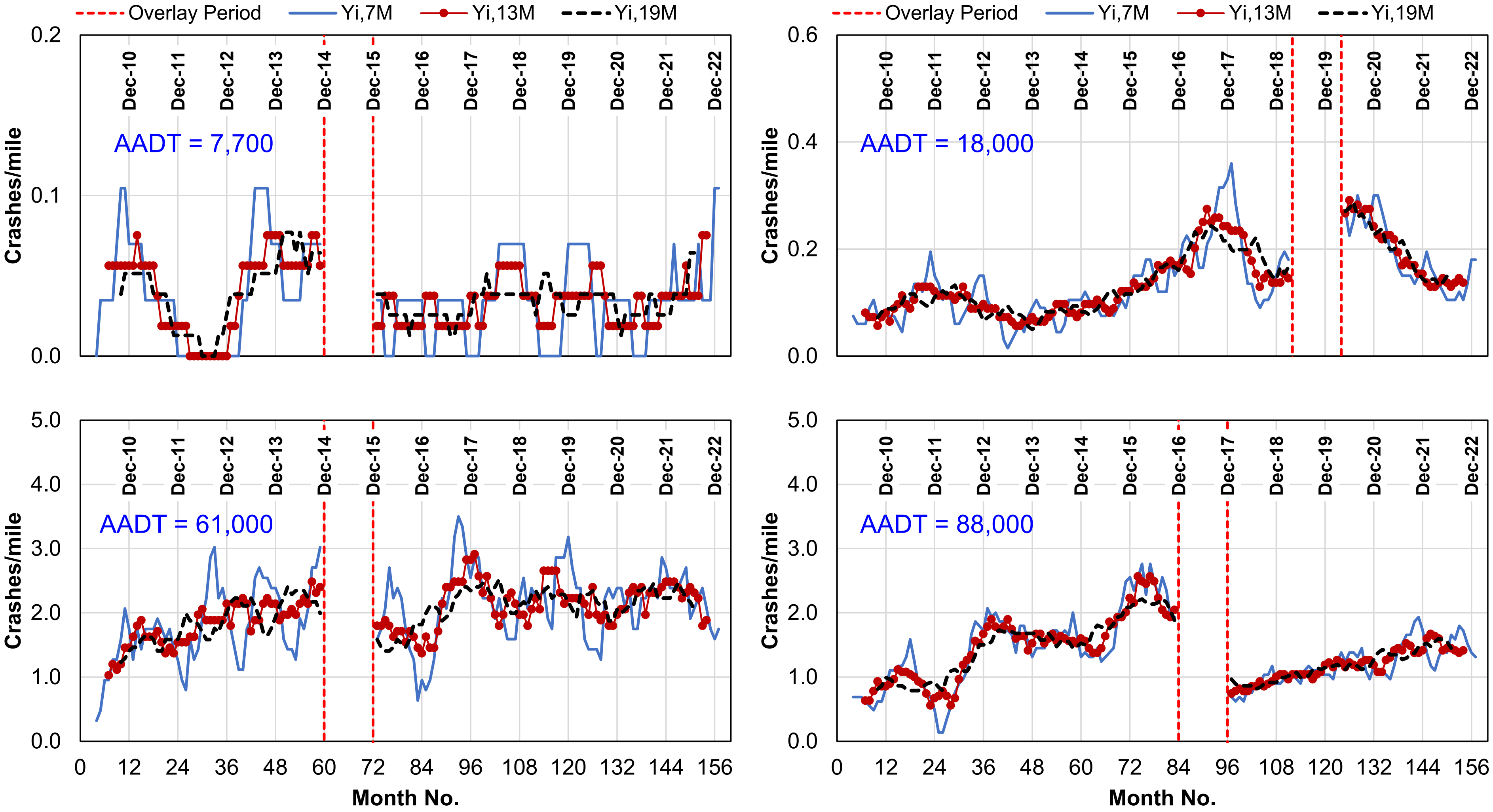
$$MPD = \left(a + \Delta a_{site}\right) \cdot T^{\left(b + \Delta b_{family}\right)}$$

Rate of Change



SAFETY PERFORMANCE

METRICS – TOTAL CRASHES

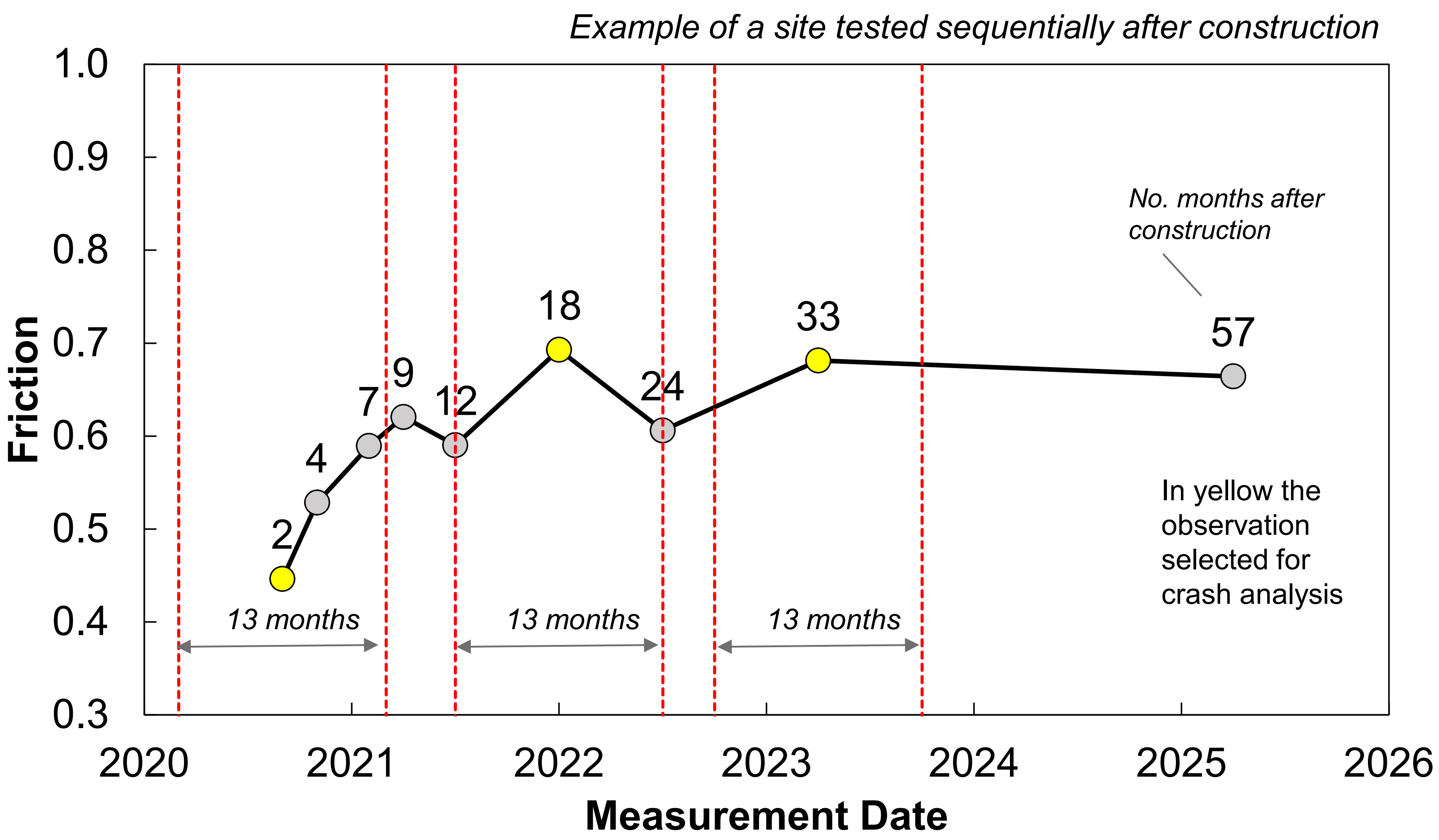


- ❑Crashes/mile moving average for three different time windows.
- ❑The 13-month and 19-month windows, on average, produce similar standard deviations.
- ❑A 13-moving window was selected.

SAFETY PERFORMANCE

METRIC CALCULATION

- Crashes were computed in a 13-month window centered around the measurement date.
- For sites tested at their late service life, performance models were used to ‘back-cast’ friction and macrotexture values to increase the sample size.

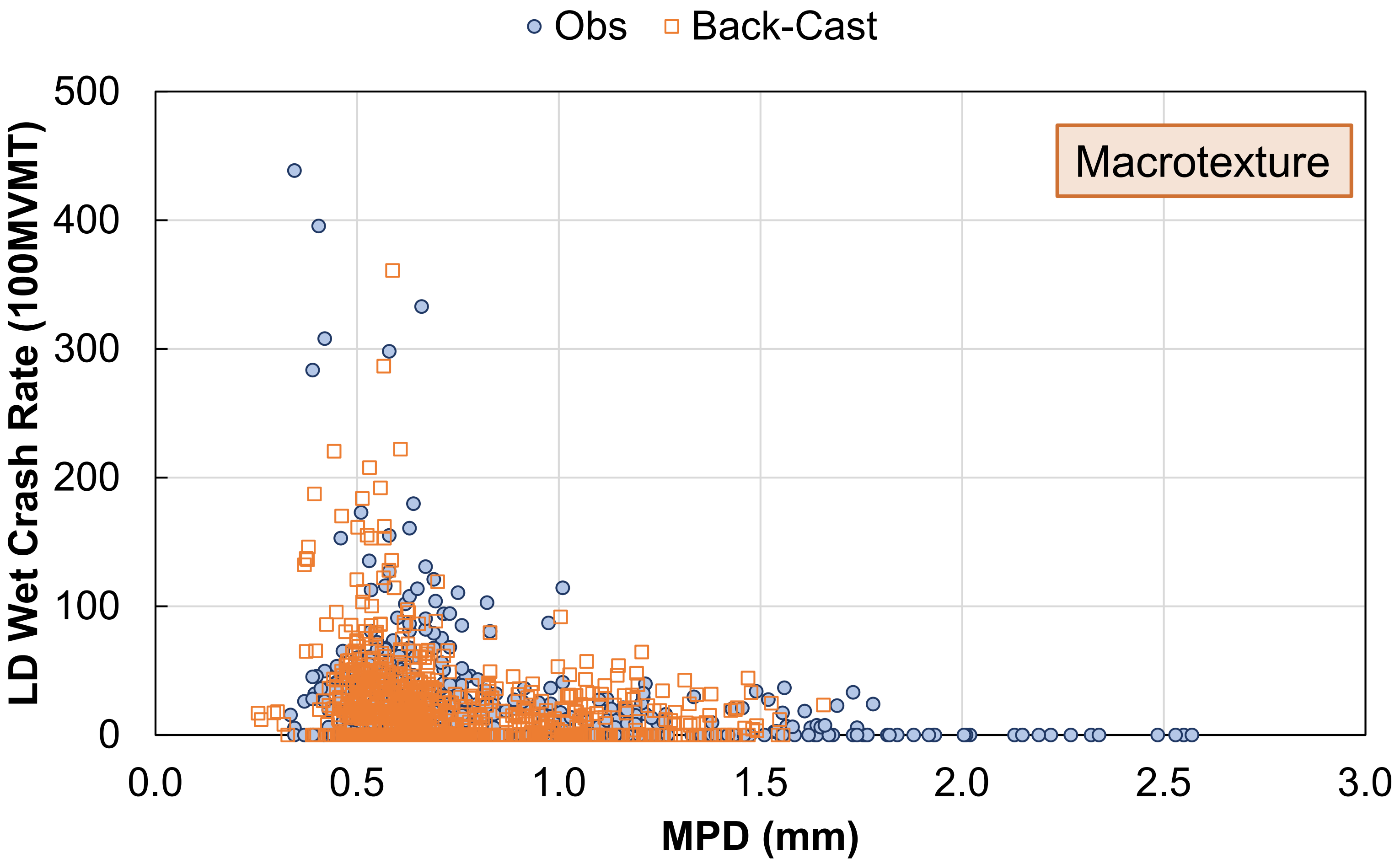


SAFETY PERFORMANCE

METRICS – LANE WET DEPARTURE CRASHES

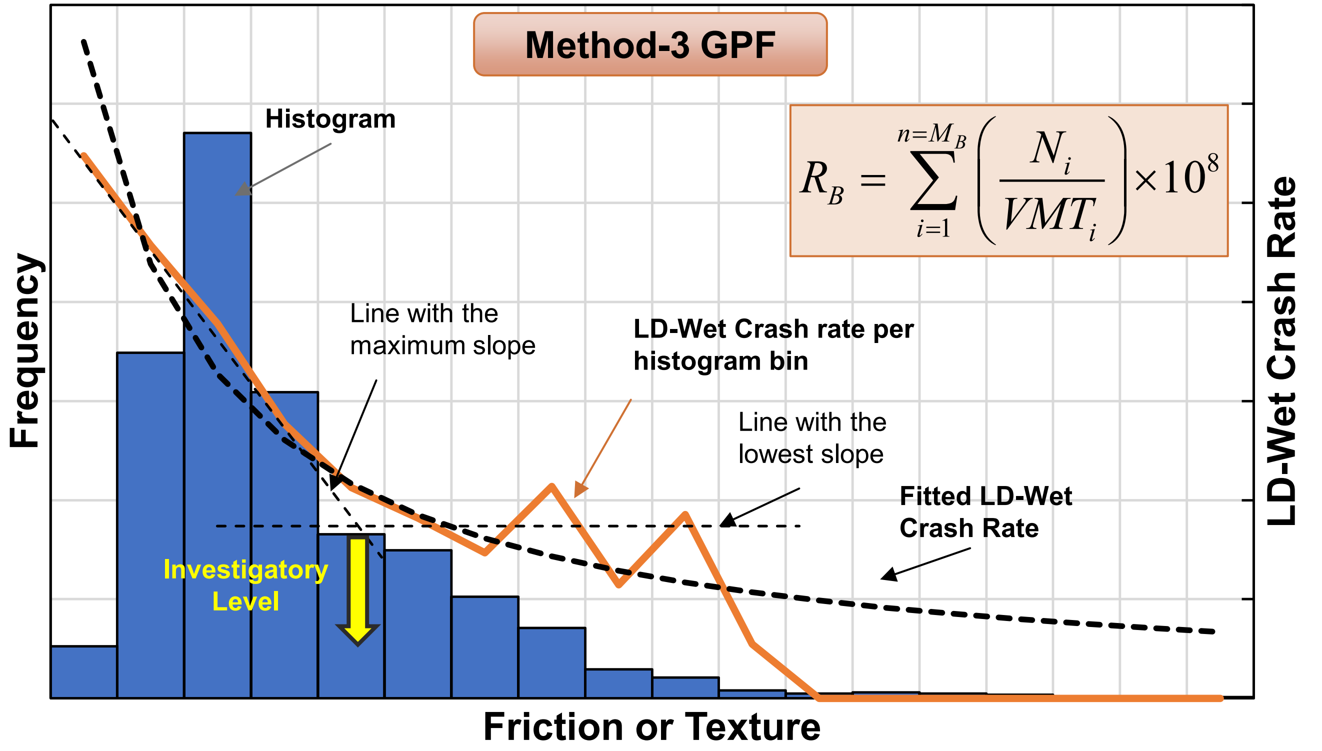
- Once the crashes were paired with their respective friction and macrotexture value, crash rates were computed.

- For the analysis, lane wet departure crashes were used.



SAFETY PERFORMANCE

APPLICATION TO REFINE PERFORMANCE THRESHOLDS – HIGH SPEED FACILITIES



Final Proposed Friction Thresholds

Variable	Non-Interchanges	Interchanges
FN_{INV}	0.57	0.65
FN_{INT}	0.43	0.49

Note: $FN_{INT} = 0.75*FN_{INV}$

Final Proposed Texture Thresholds

Variable	Non-Interchanges	Interchanges
MPD_{INV}	0.80	0.80
MPD_{INT}	0.60	0.60

Note: $MPD_{INT} = 0.75*MPD_{INV}$

Abbreviation	Meaning
FN_{INV}	Investigatory friction threshold
FN_{INT}	Intervention friction threshold
MPD_{INV}	Investigatory *MPD* threshold
MPD_{INT}	Intervention *MPD* threshold

- Crashes, traffic, and length were aggregated using the histogram bins.
- R_B was computed for each bin.

CONCLUSIONS

- Friction exhibits a two-step variation. On average, the transition between these two phases occurs at 34.6 million traffic repetitions.
  - Dense-graded surfaces have slightly lower friction than OGFCs and UTBWCs.
  - The OGFCs and UTBWCs have similar initial friction, but the friction of UTBCs decays faster.
- Macrotexture increases with respect to traffic repetitions.
  - Dense-graded surfaces have the lowest macrotexture.
  - UTBWCs have higher MPD values than OGFCs; however, the MPD of OGFC increases faster.
- For non-interchanges, investigatory thresholds of 0.57 and 0.80 mm are proposed for friction and macrotexture, respectively.

THANK YOU

Link to Folder Containing Project Reports

Road Profile Users' Group