Texas A&M Transportation Institute

Qualify High Frequency GPR for Asphalt Mixture Construction

Product 0-6874-P6

Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS

in cooperation with the
Federal Highway Administration and the
Texas Department of Transportation
http://tti.tamu.edu/documents/0-6874-P6.pdf

Qualify High Frequency GPR for Asphalt Mixture Construction

TxDOT Project 0-6874 Develop Nondestructive Rapid Pavement Quality Assurance/Quality Control Evaluation Test Methods and Supporting Technology

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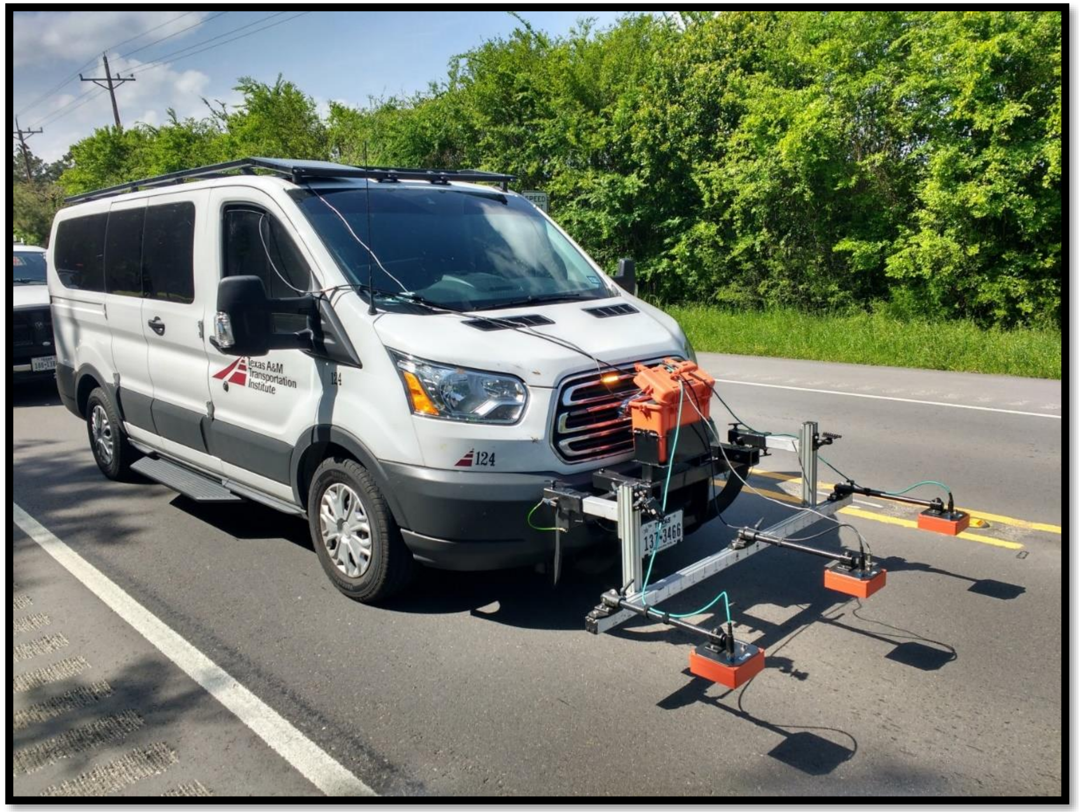
Goals



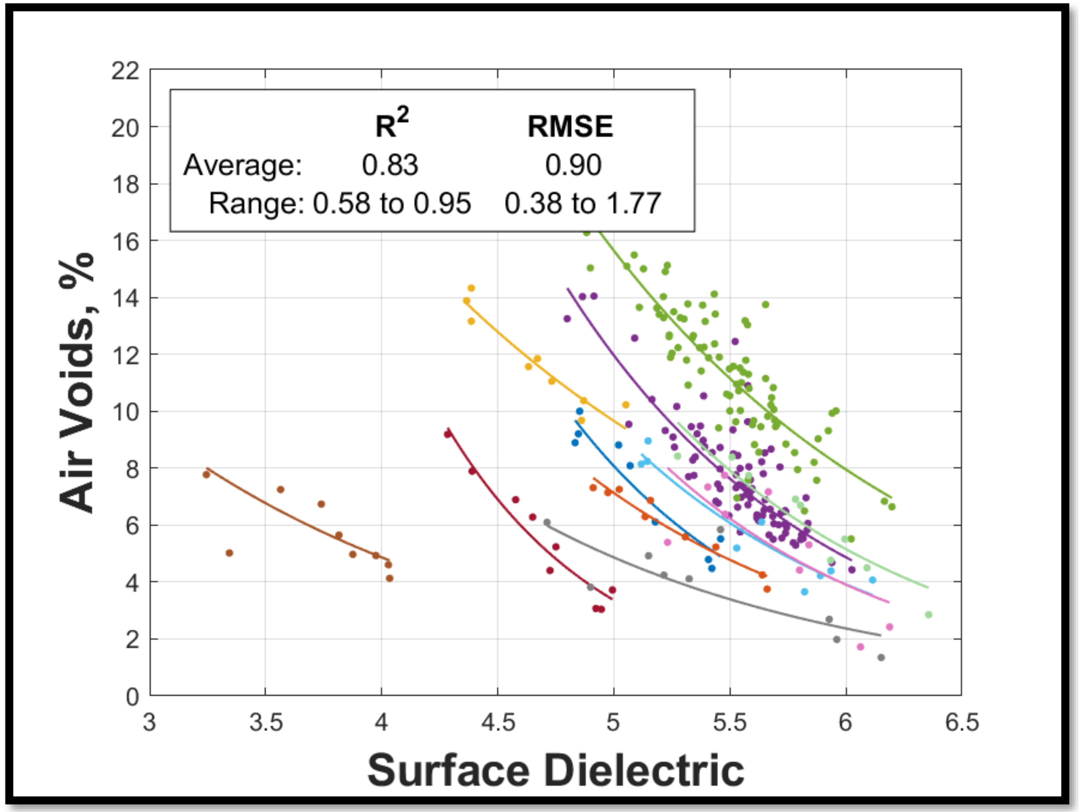
- Demonstrate shadow QA on projects
- Perform lab sensitivity analysis
- Explore forensic applications
- Develop test procedure

Key Activities Completed

- Deployed to 12 projects representing different common mixes
- Deployed to 3 forensic applications
- Defined expected influence on measurements from changes in mixture properties
- Test procedure

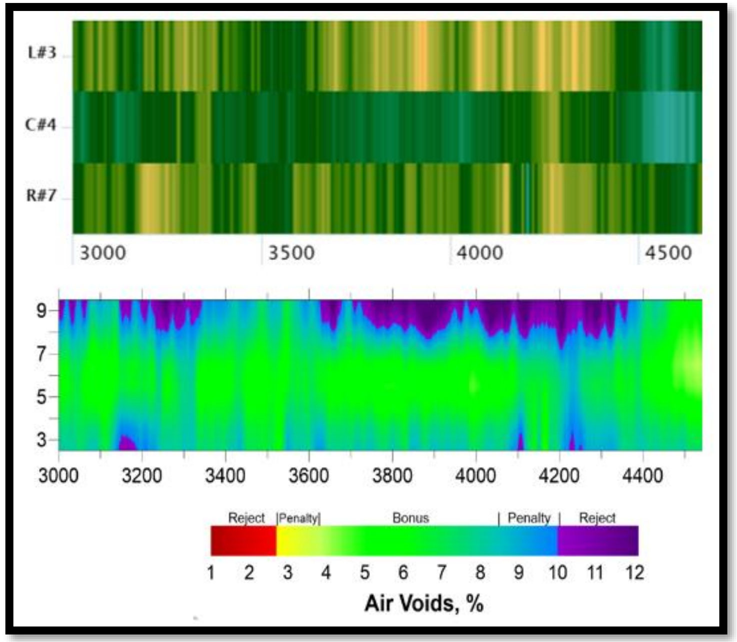
	Year	Location	Mix Type
Construction	2017	SH 6-Valley Mills (WAC)	DG-D
		SH 6-Waco (WAC)	TOM-C
		SH 30-College St. (BRY)	SMA-C
		RELLIS Campus (BRY)	DG-D
			TOM-F
	2018	US 287-Groveton (LFK)	SP-C
		SL 79-Del Rio (LRD)	DG-B
		SH 149-Beckville (ATL)	SP-C
		IH 45-Huntsville (BRY)	SMA-D
	2019	FM 158-Bryan (BRY)	SP-D
		US 59-Texarkana (ATL)	SMA-D
		SH 40-College St. (BRY)	SP-C
Forensic	2018	US 287-Groveton (LFK)	SP-C
	2019	SS 248-Tyler (TYL)	DG-C
		SH 36-Gustine (BWD)	SP-D

All Calibrations – Construction Projects

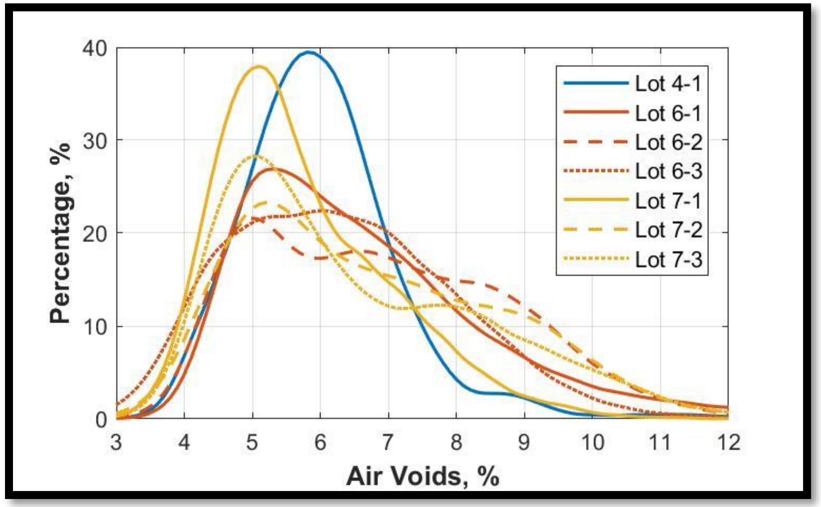


Example Output Formats

Spatial



Histogram

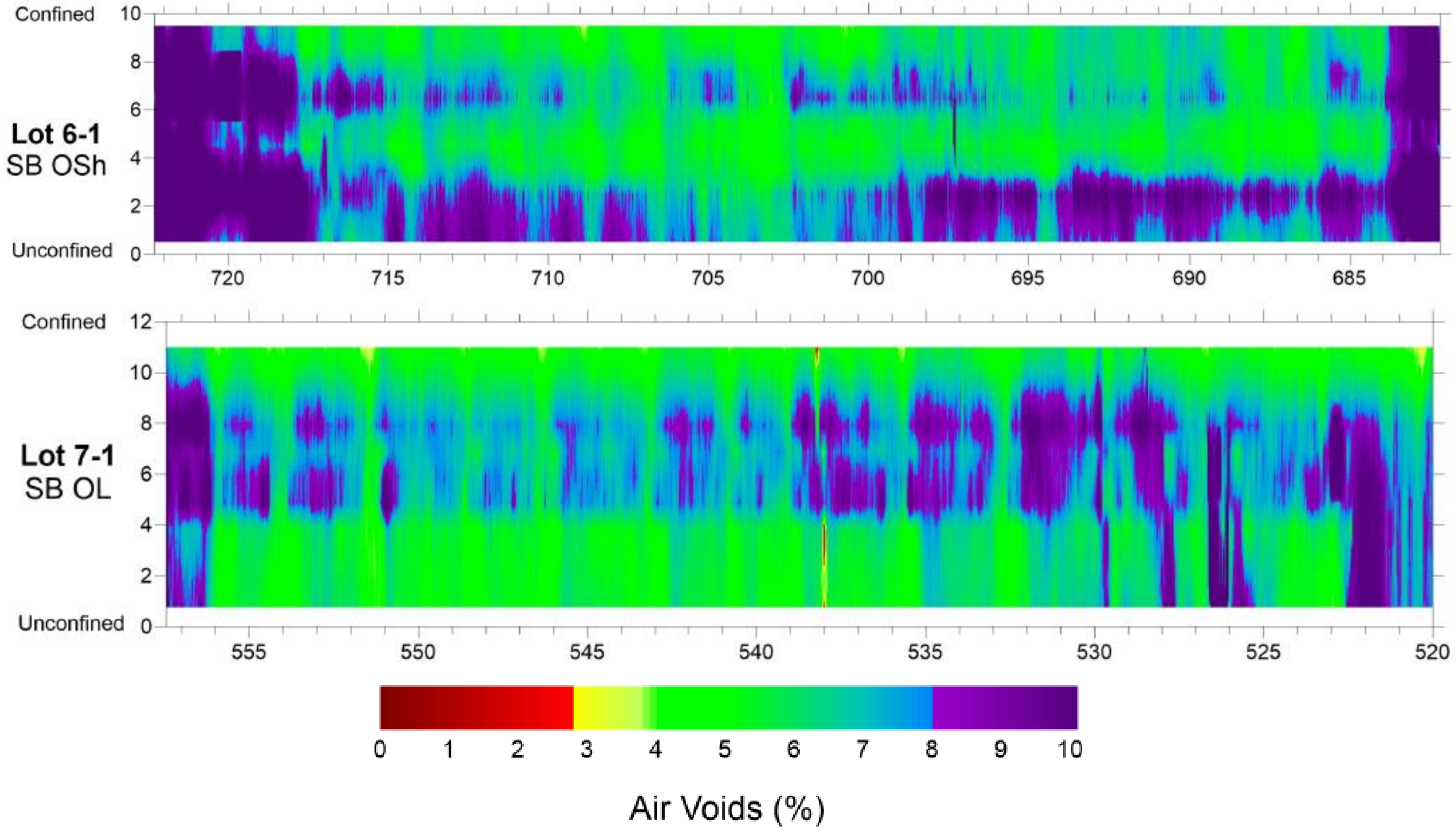


Tabular

Lot	Sublot	Predicted Air Voids (%)				
		Avg.	St Dev	Med	5th Perc.	95th Perc.
4	1	6.0	1.2	5.9	4.4	7.9
6	1	6.8	3.3	6.3	4.5	10.6
	2	6.9	1.9	6.7	4.4	10.2
	3	6.3	1.9	6.2	3.9	9.1
7	1	5.8	1.3	5.5	4.1	8.2
	2	6.8	1.9	6.4	4.2	10.1
	3	6.5	1.9	6.0	4.2	10.1

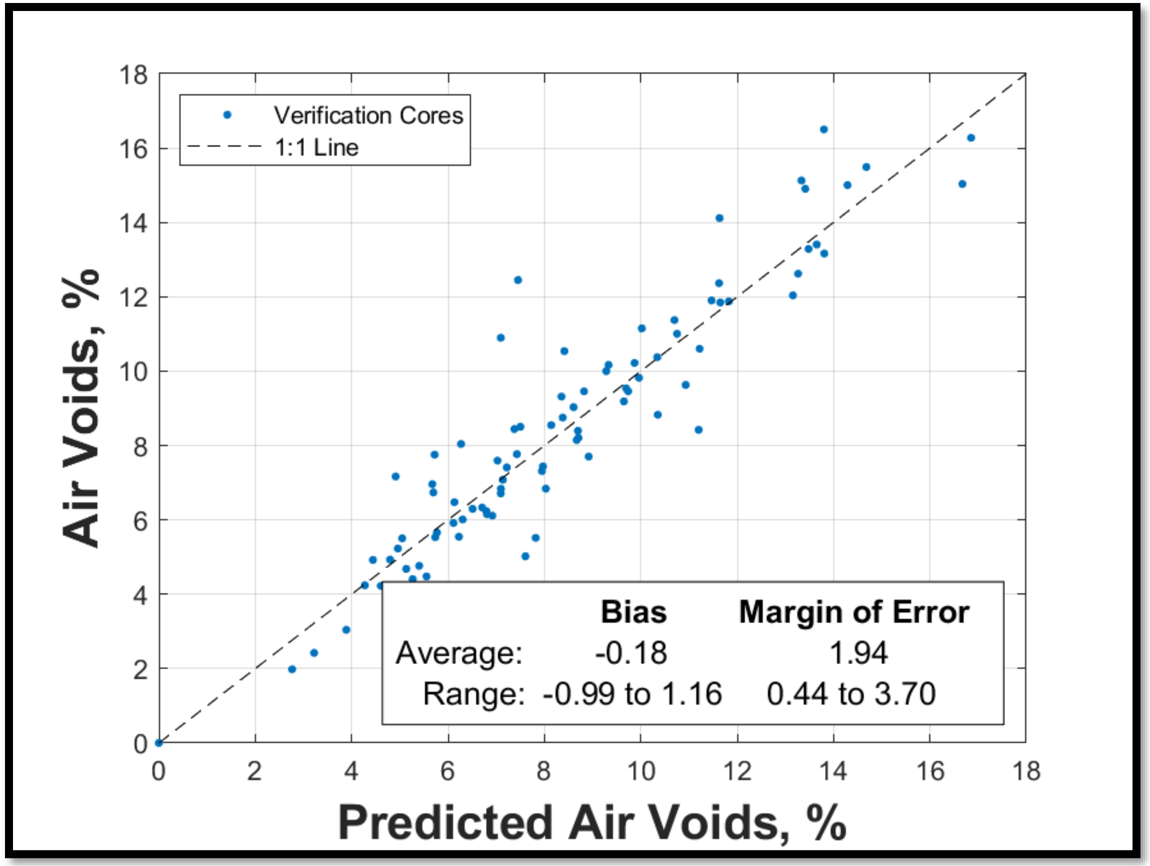
Also can calculate percent conforming

Example Result - IH 45



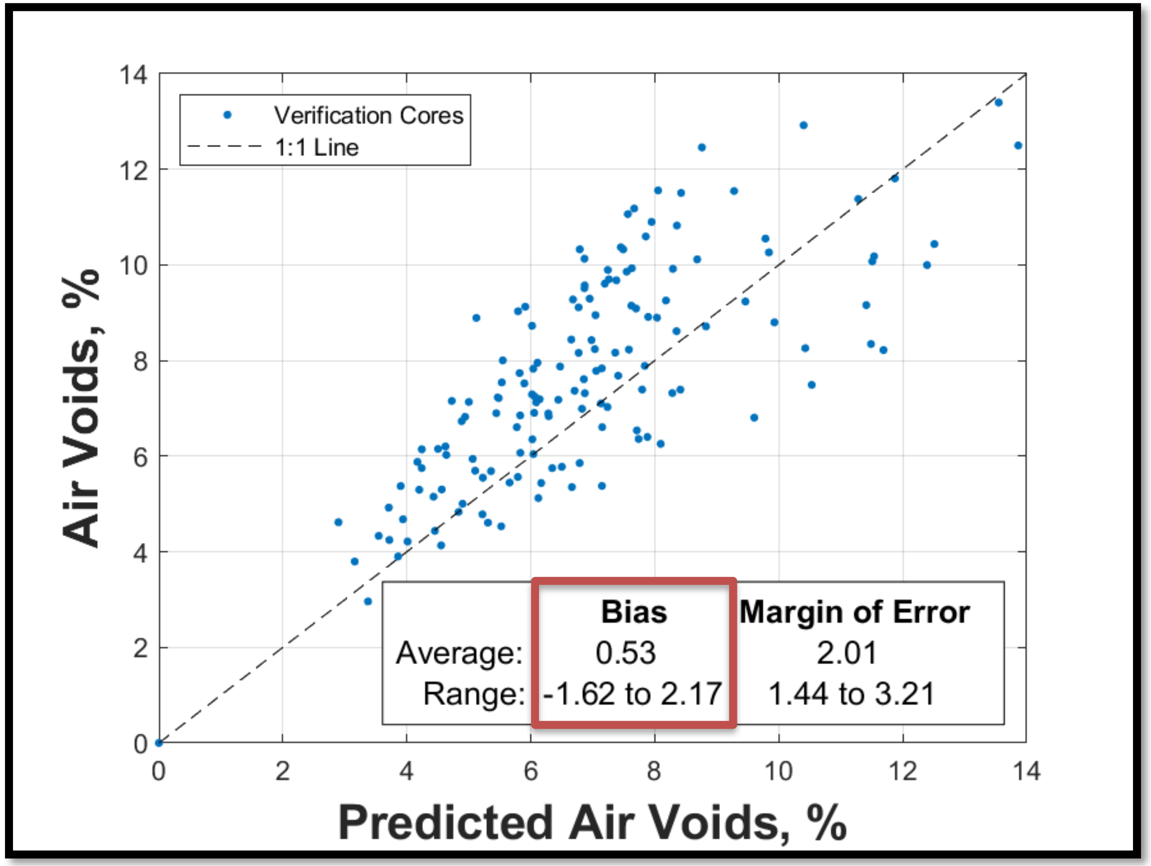
Verification Results – Construction Projects

Same Lot as Calibration



	Bias	Margin of Error
Average:	-0.18	1.94
Range:	-0.99 to 1.16	0.44 to 3.70

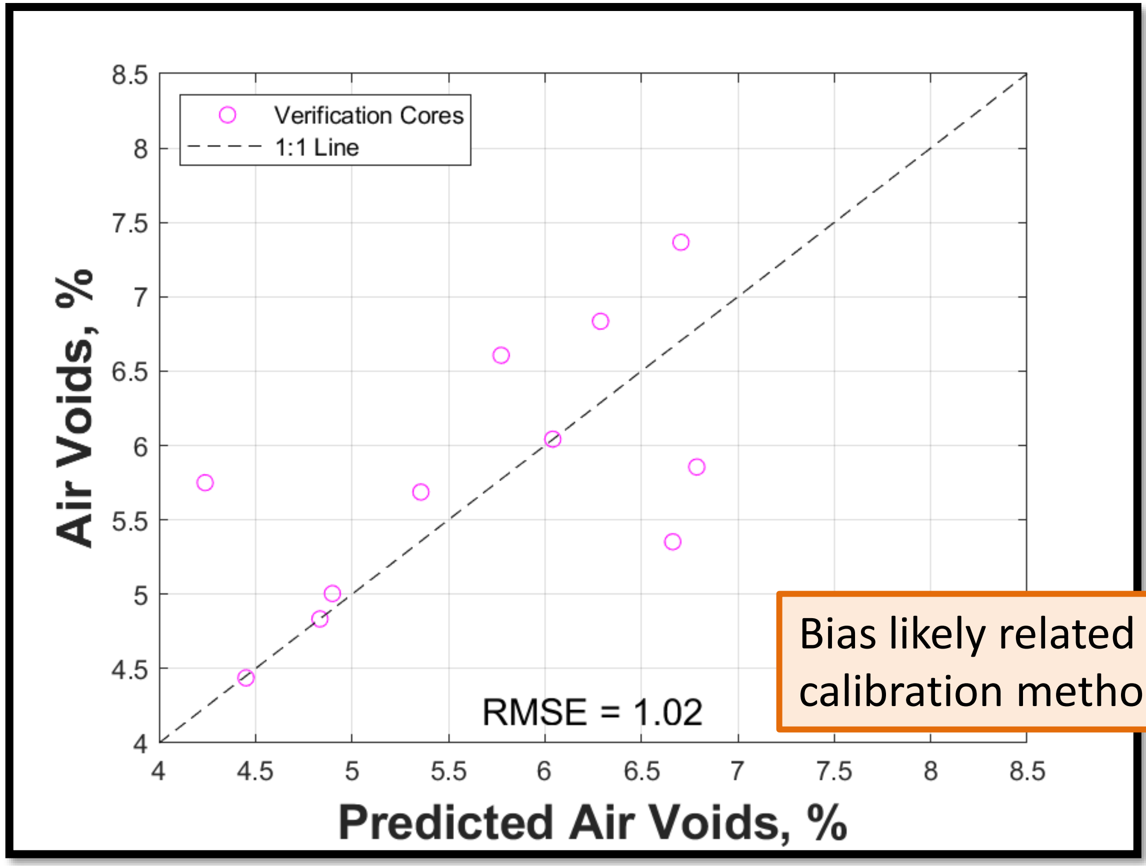
Different Lots than Calibration



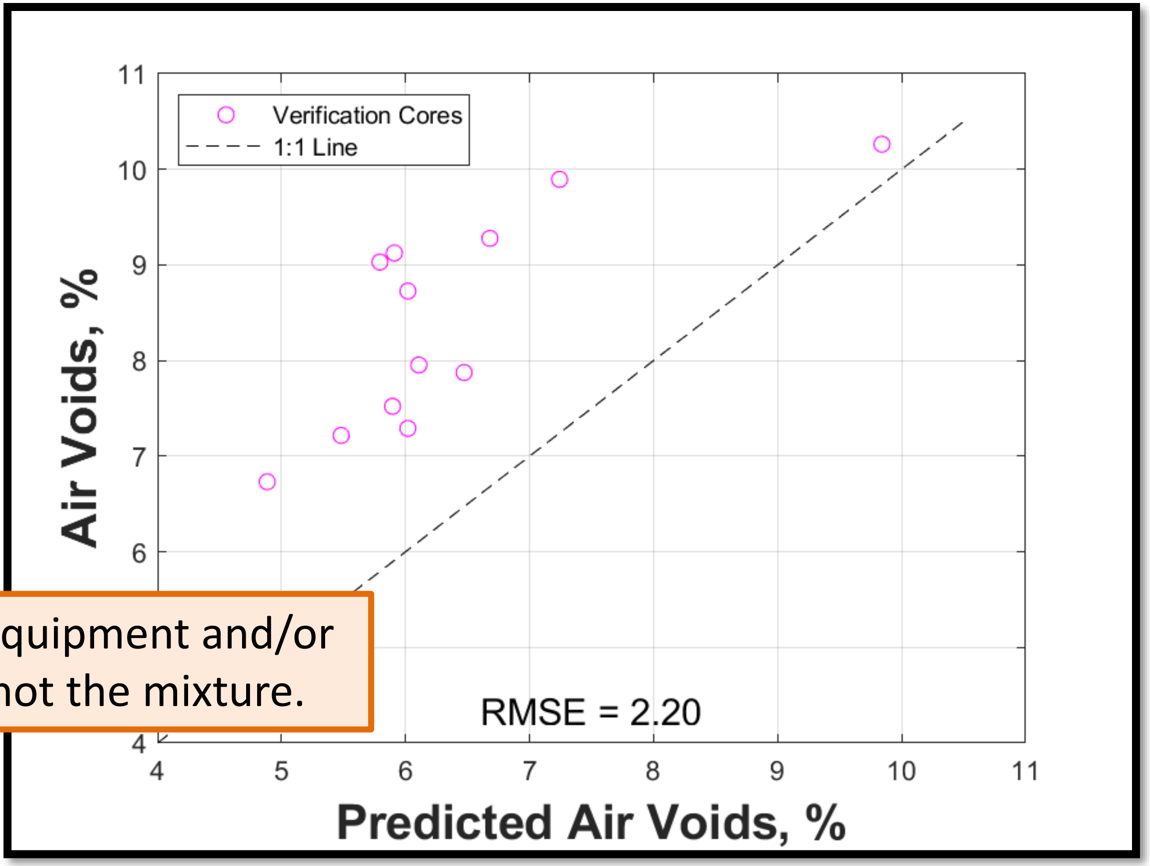
	Bias	Margin of Error
Average:	0.53	2.01
Range:	-1.62 to 2.17	1.44 to 3.21

Verification, Construction Project Examples

No Bias
(SH 149-Beckville)



With Bias
(FM 158-Bryan)



Bias likely related to equipment and/or calibration methods, not the mixture.

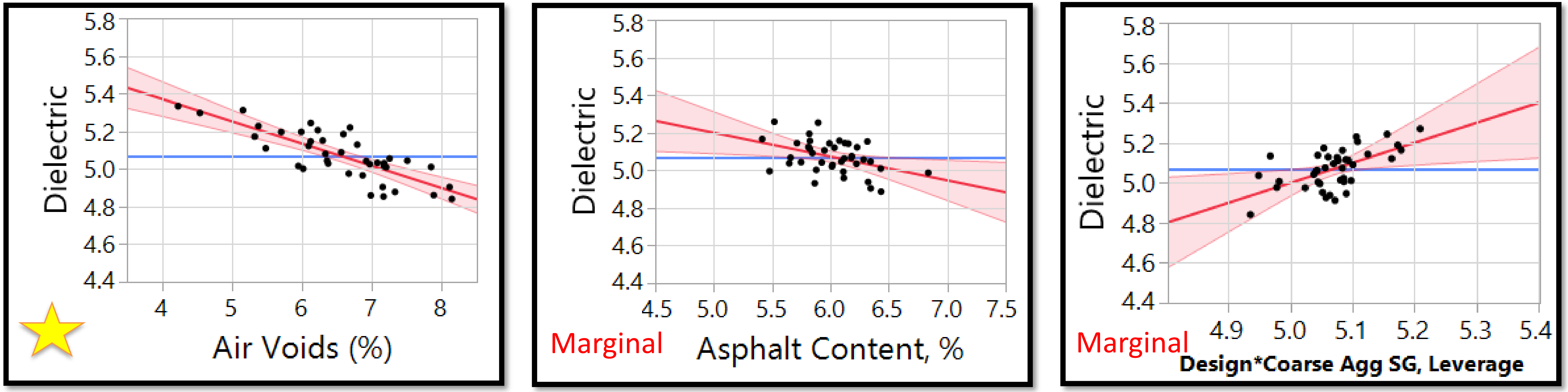
Dielectric Sensitivity Analysis

- 5 unique HMA designs
  - Gradations
  - Aggregate types
  - Asphalt contents
- 8 variations from design

Asphalt Content	Coarse Agg. Substitution	Air Voids
Design	None	3
Design	None	8
Low	None	5
High	None	5
Design	Reduce	5
Design	Increase	5
Low	Increase	3
High	Reduce	8

Results - Dielectric Sensitivity Analysis

Leverage Plots



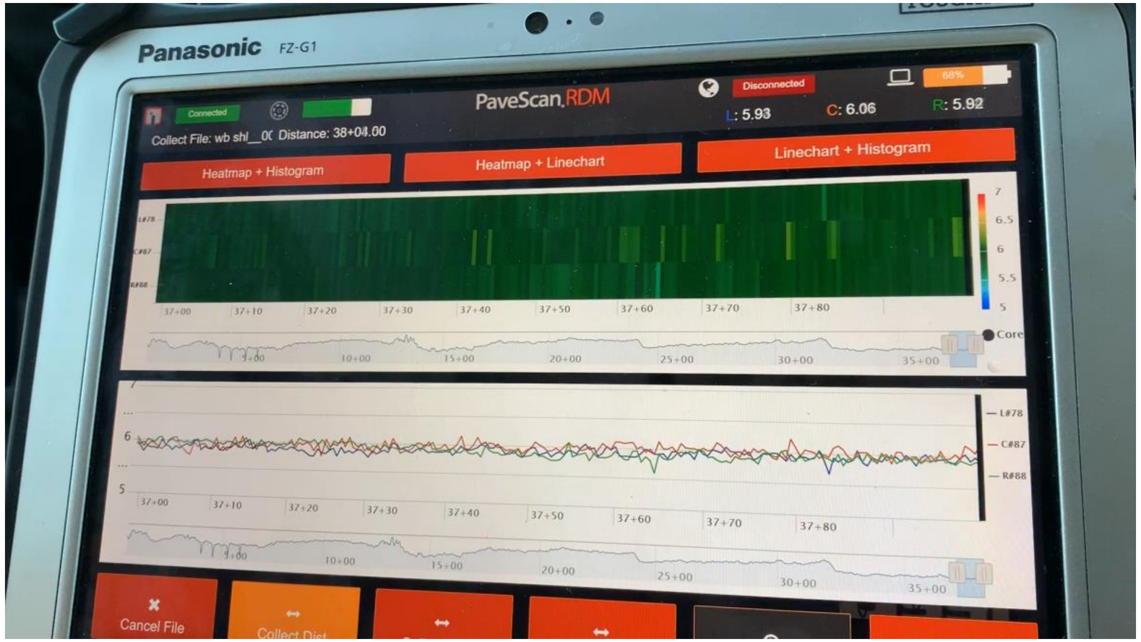
Source	LogWorth	PValue	
Voids_Perc	6.996	0.00000	
Project*CoarseAgg_SG	1.907	0.01240	
AC_Perc	1.693	0.02025	
CoarseAgg_SG	1.650	0.02241	^
Mix Design	1.449	0.03557	^

Results – Dielectric Sensitivity

Changing Property	Maximum Expected Change of Property Within a Project		Estimated Change in Dielectric
Avg. Air Voids (%)	±2.6		±0.31
Asphalt Content (%)	±0.5		±0.07
Coarse Agg. SG	In practice:	Likely only with mix design change.	NA
	In lab study:	±0.019 with ±12% substitution	±0.08 to ±0.04*

* Effective change in SG will depend on the original and substitute aggregate.

Example Forensic Deployment – SH 36



Typical Sequence

Survey with GPR

Coring for calibration

Cores for laboratory analysis

Summary – Task 3

- Empirical approach works. Active national efforts to move toward implementation in several states
- More work needed to identify and eliminate sources of error when recalibrating equipment
- Meaningful application in forensic settings
- Data suggest strong candidate for implementation
  - Draft test procedure submitted in 0-6874-P5

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