SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

Coreless Asphalt Pavement Compaction Assessment: Density Profiling System

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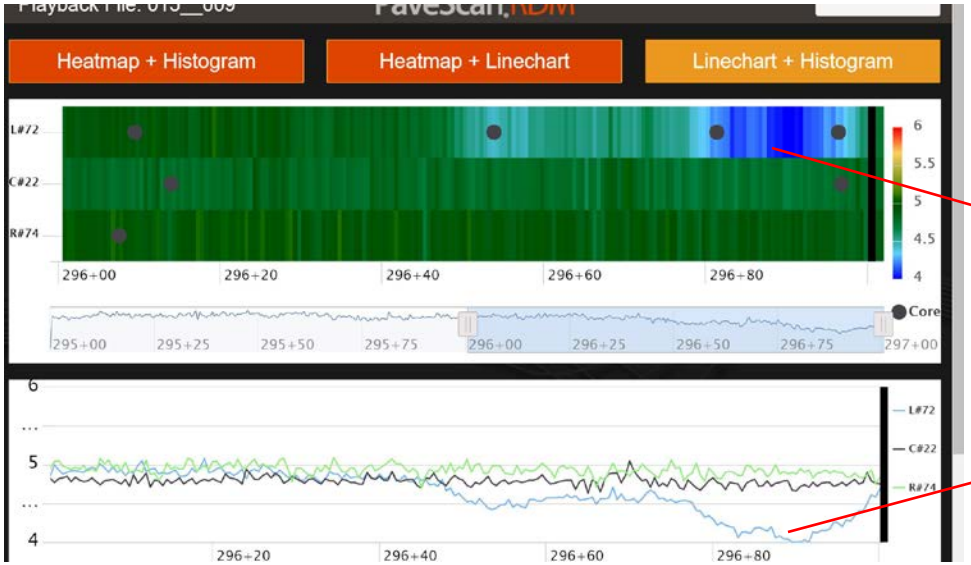
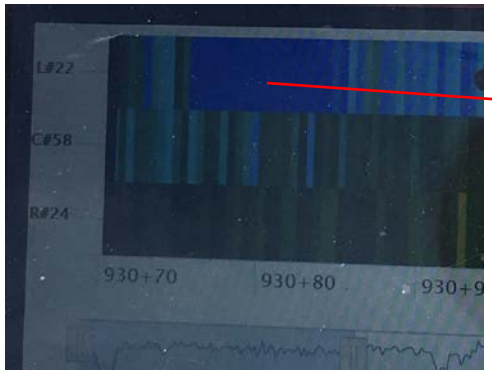
TRB 99th Annual Meeting
Asphalt Pavement Construction
and RehabilitationCommittee

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

DPS: Deficiency Detection





Need for Improved QA

Elephant = 6 tons

- Goals:
  - 100% joint coverage
  - Improve random mat sampling (random cores on steroids)
  - Improve dielectric to density conversion process.
  - Reduce field cores!

Hedgehog < 1 pound

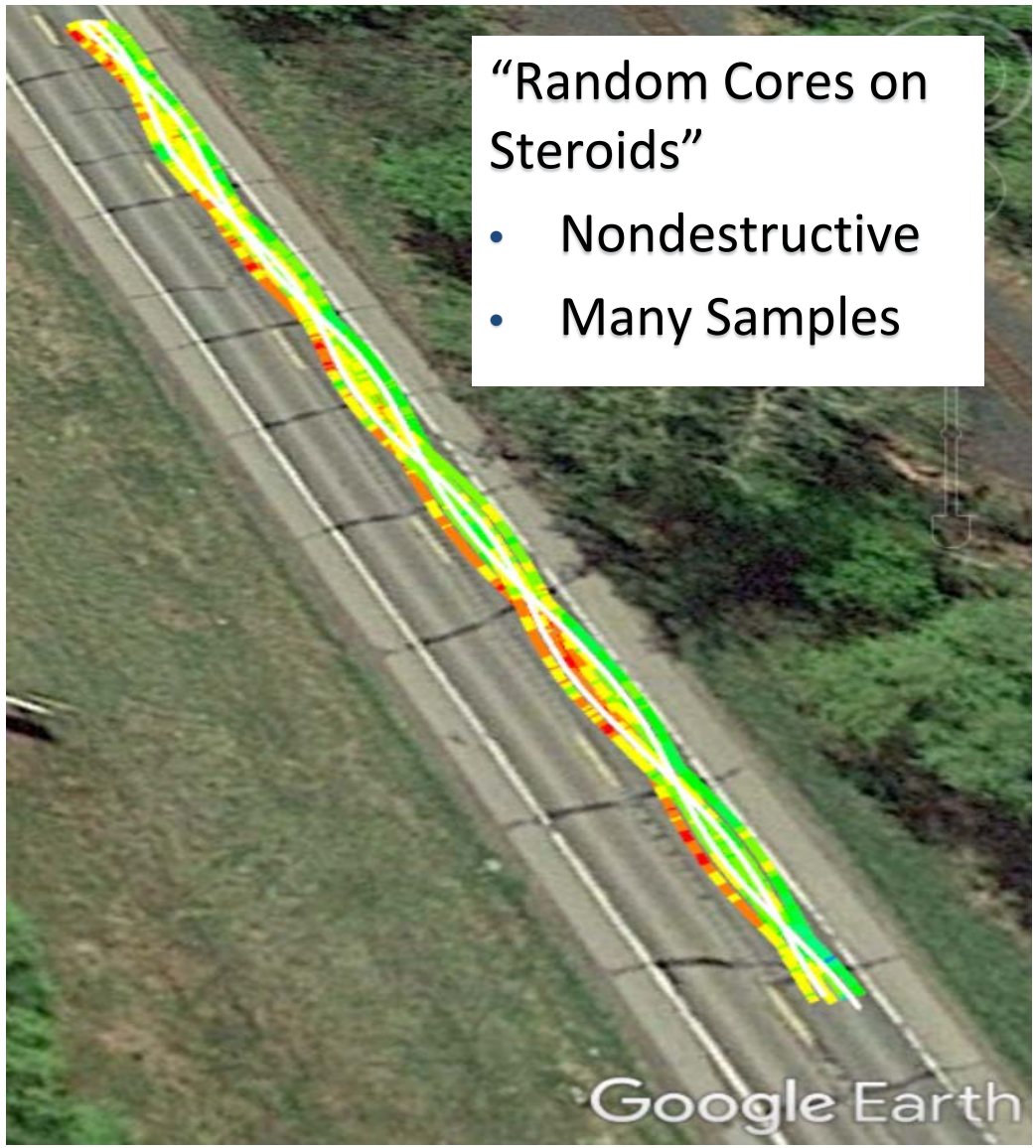
For every 100 elephants of mix, we sample and test two hedgehogs (cores)

THAT'S IT?

Analysis: 100% Joint Coverage

Geospatial Representation

Analysis: Mat Compaction



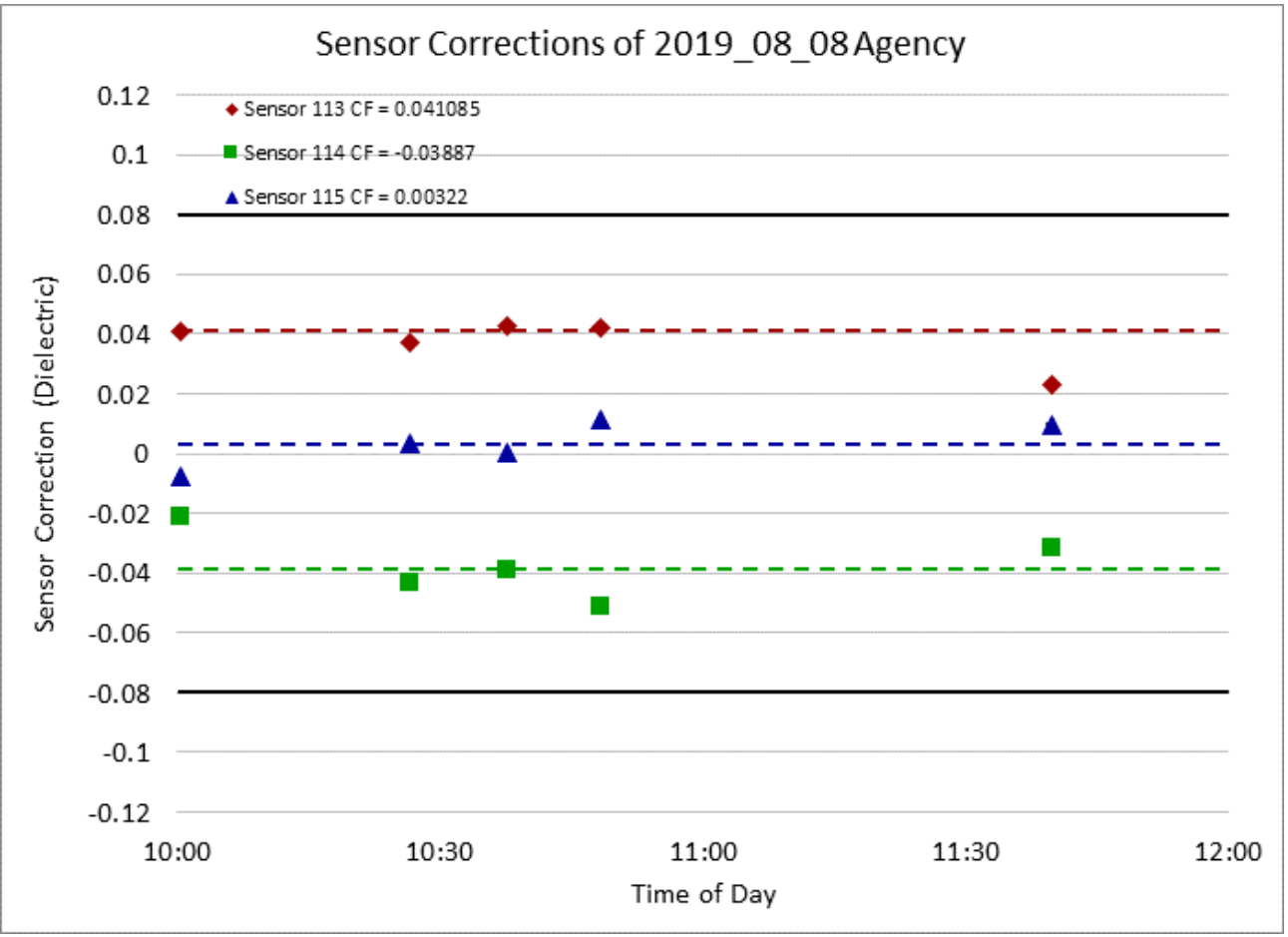
"Random Cores on Steroids"

- Nondestructive
- Many Samples

Swerve Survey

Method Overview: Field Calibration

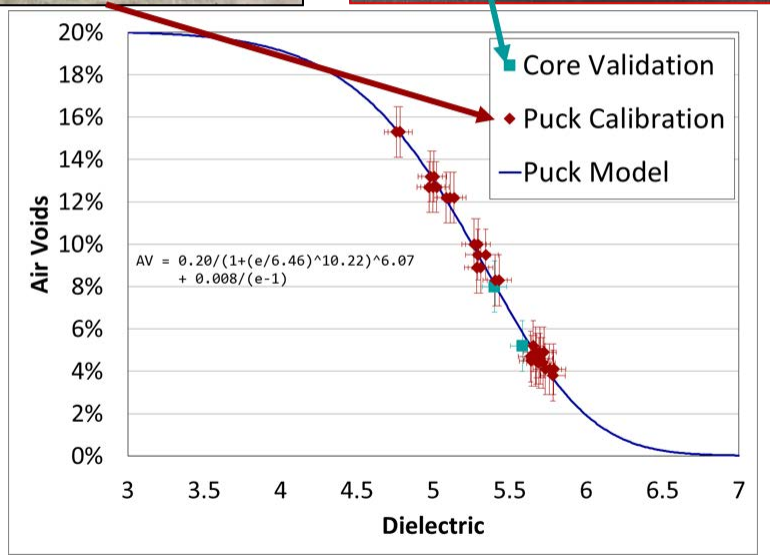
Daily Check



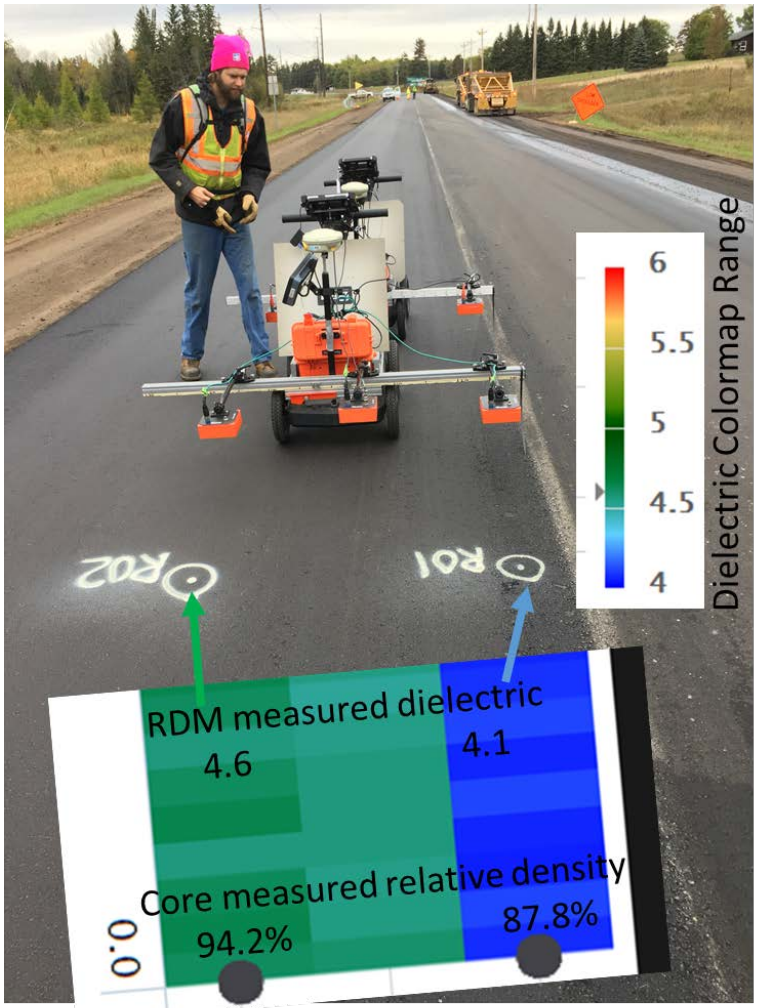
Convert “Moving Nuke Gage” to Moving “Core Machine”

- Create daily dielectric to density conversion
  - Fabricate coreless calibration pucks every day of production
    - Design voids (4%), -250 grams (8-10%), -500 grams (12-15 AV%)
    - Contractor vs Agency: Good agreement 2019 on TH 61
    - Day to day variation of same mix showed very little variation
    - Coreless calibration effective at picking up changes in the mix

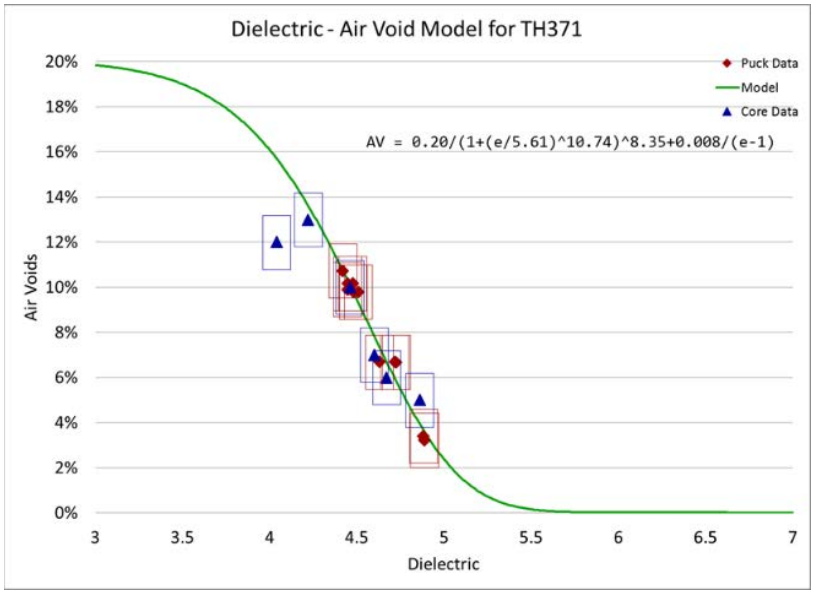
Proactive contractor lab QC

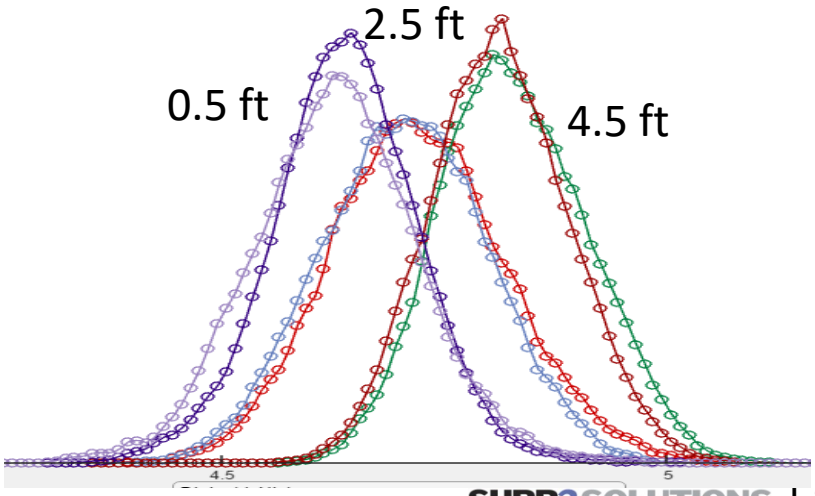


Coreless Calibration Case Study: October 1th - 10th 2018 TH371

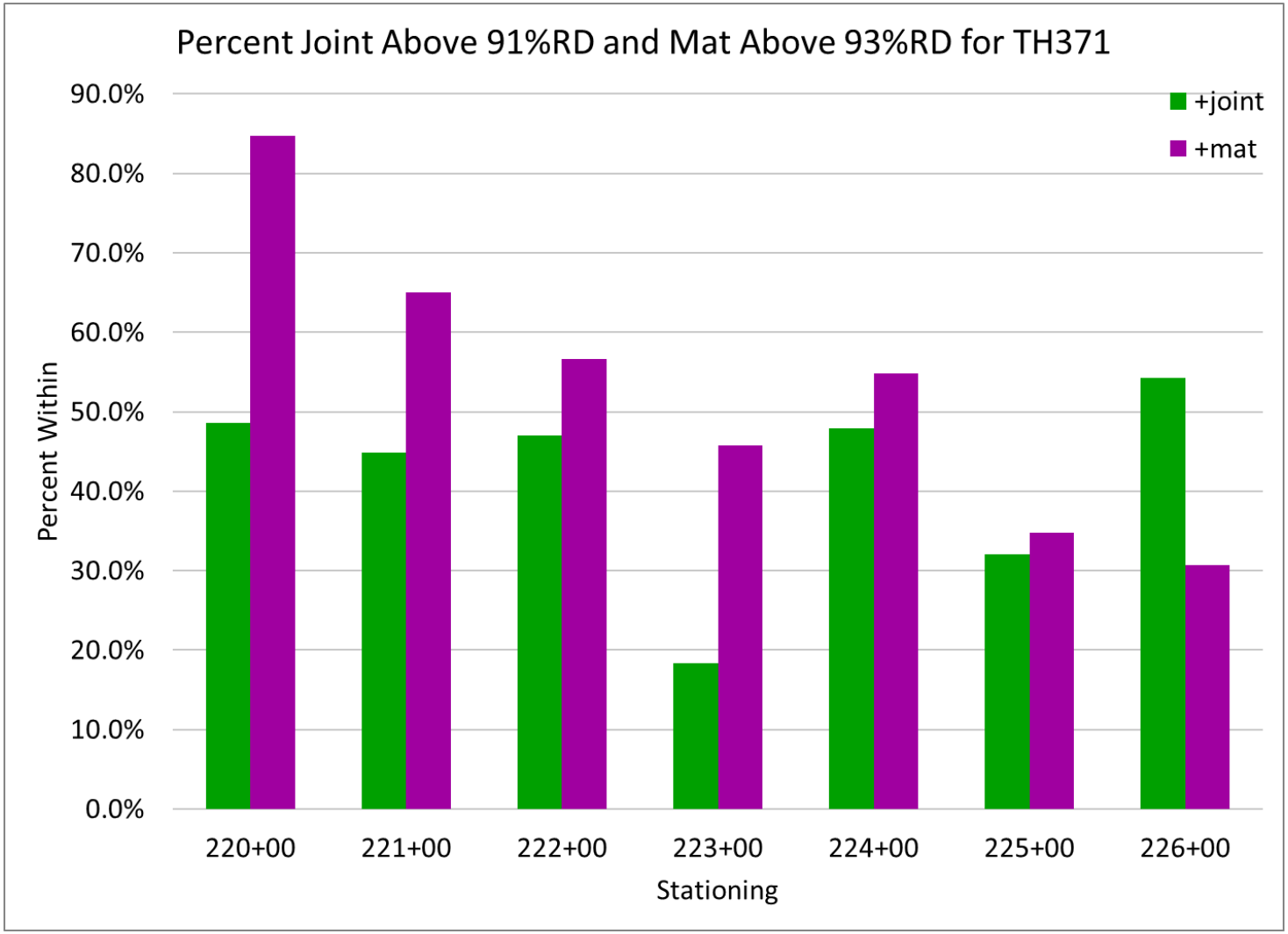


Contractor RDM1 real time display



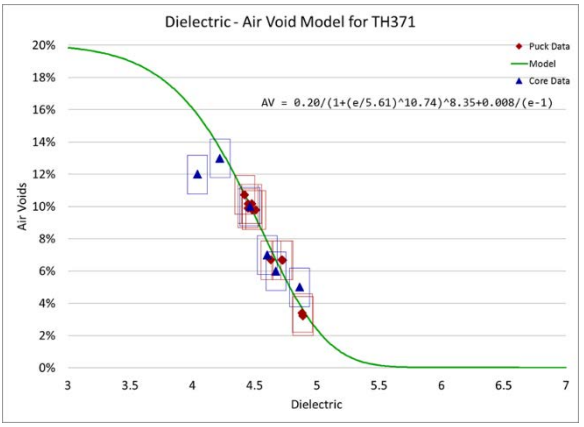


371 Results: Example PAL Variability

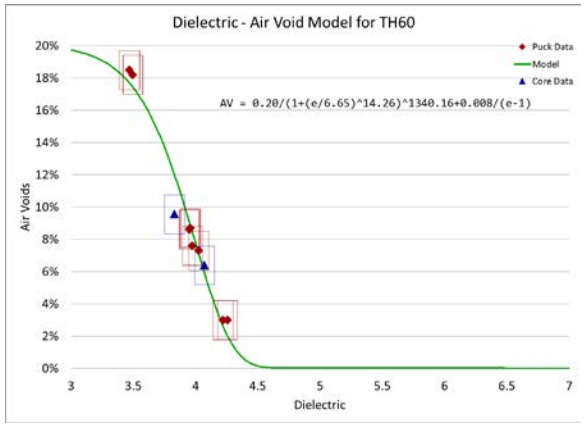


Coreless Dielectric to Air Voids

Gyratory Compacted "Puck" Coreless Calibration



TH 371



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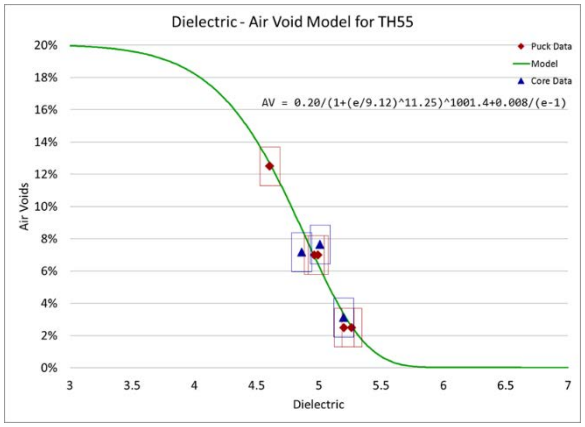
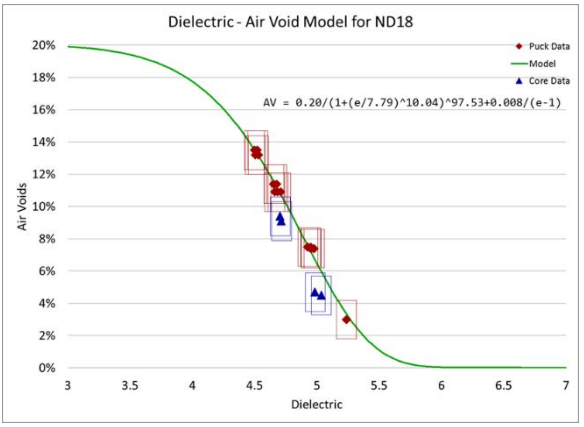
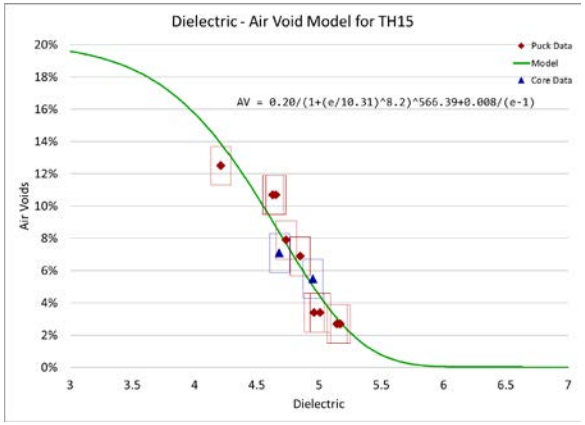


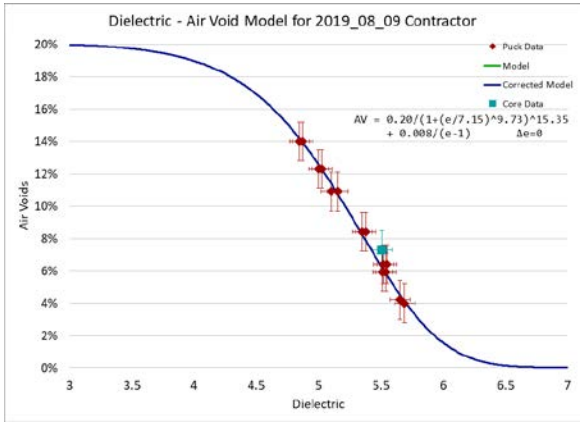
TH 55



ND 18



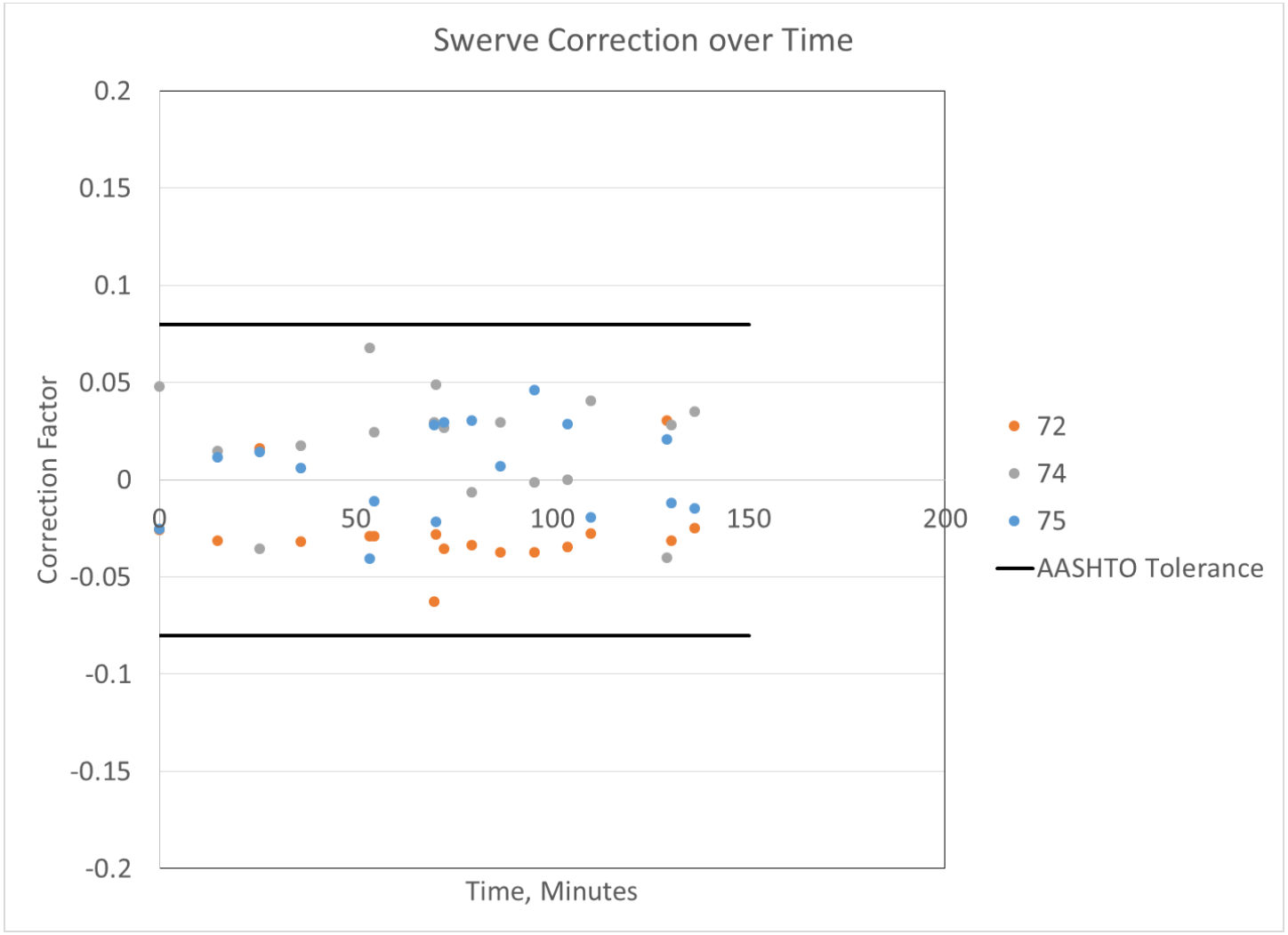
TH 15



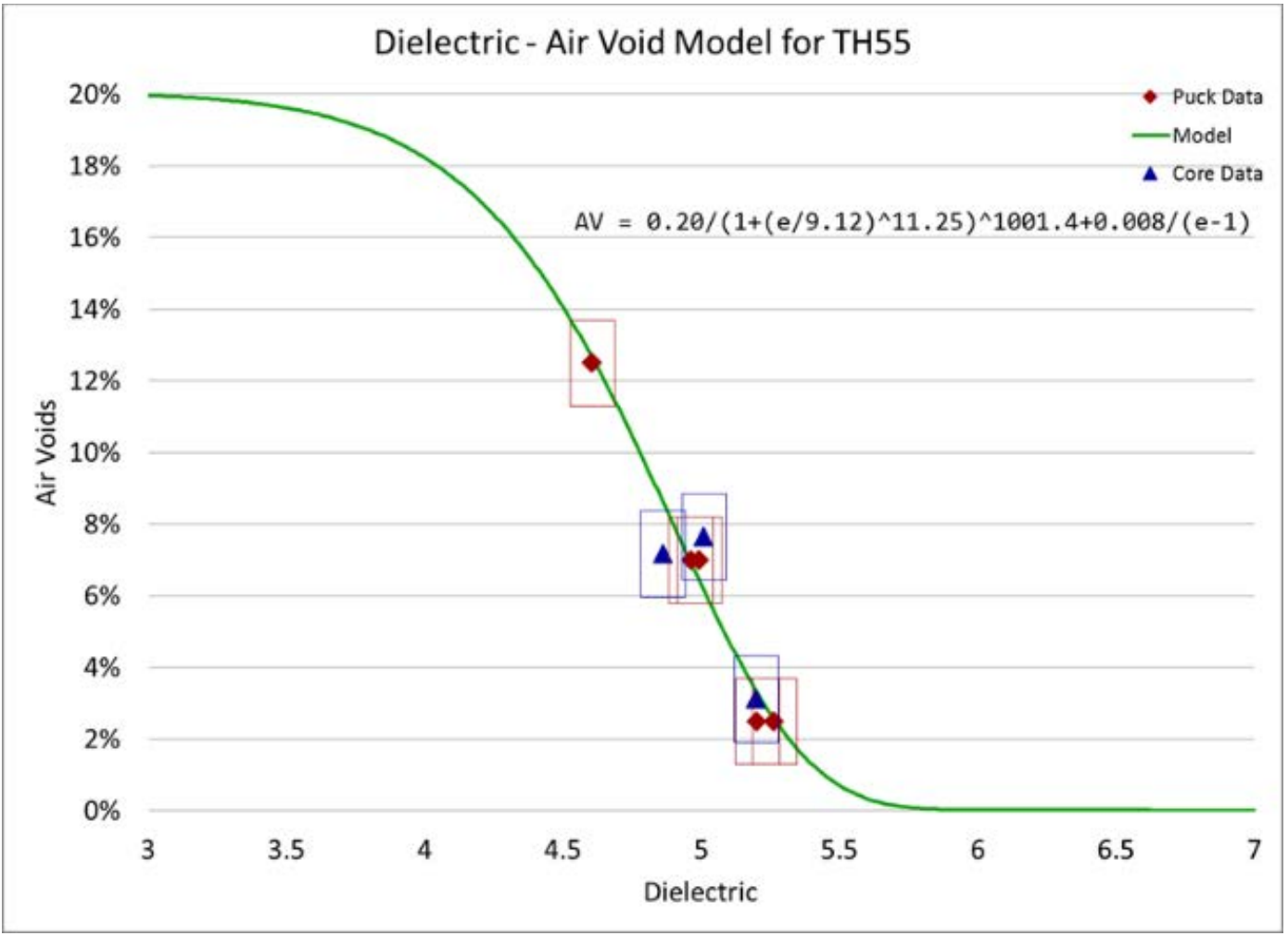
TH 61

Coreless Calibration Case Study: May 20th 2019 TH55 Testing

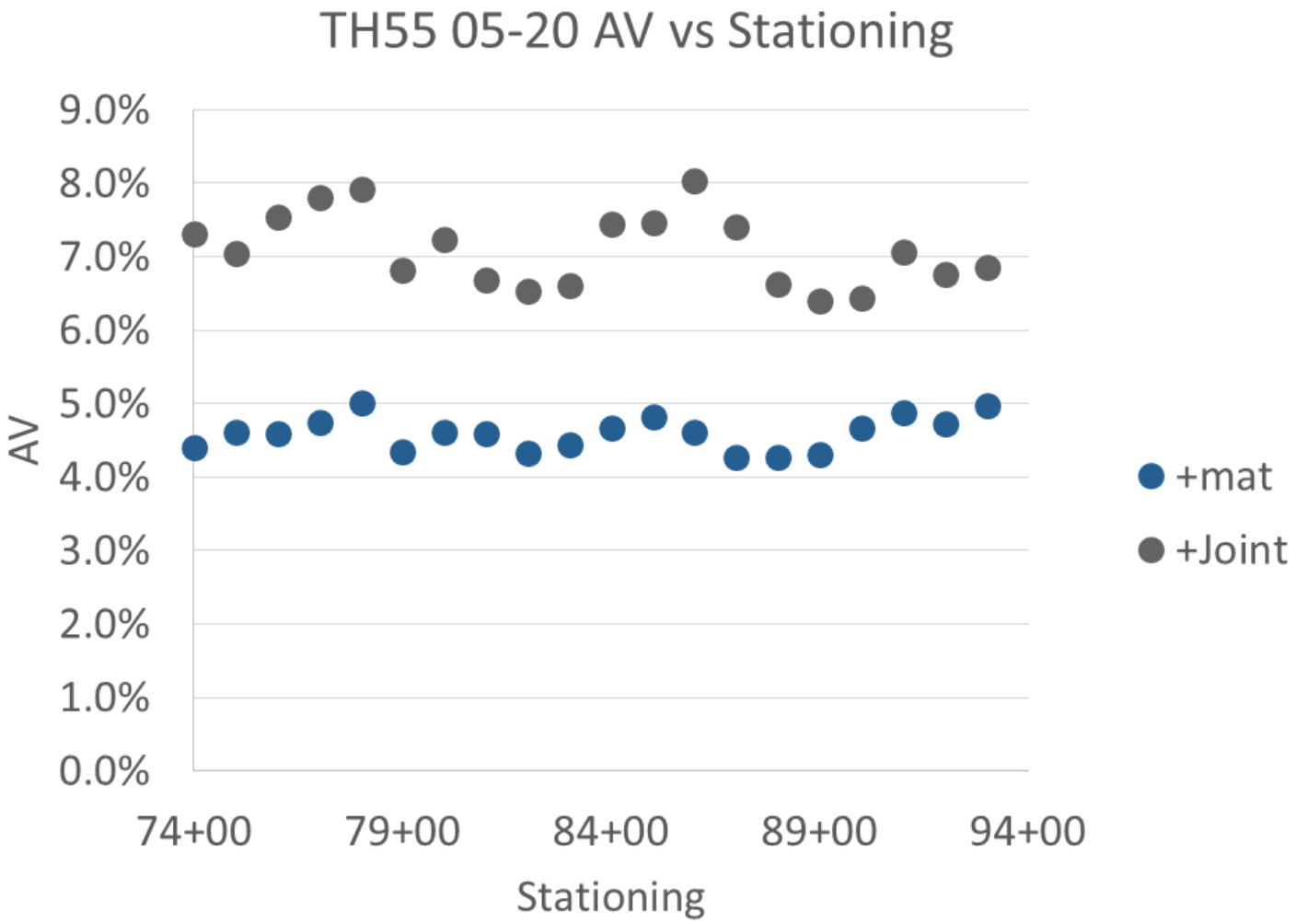
Coreless Calibration Case Study: TH 55 Daily Report



Coreless Calibration Case Study: TH 55 Daily Report



Coreless Calibration Case Study: TH 55 100 ft. Lot Analysis



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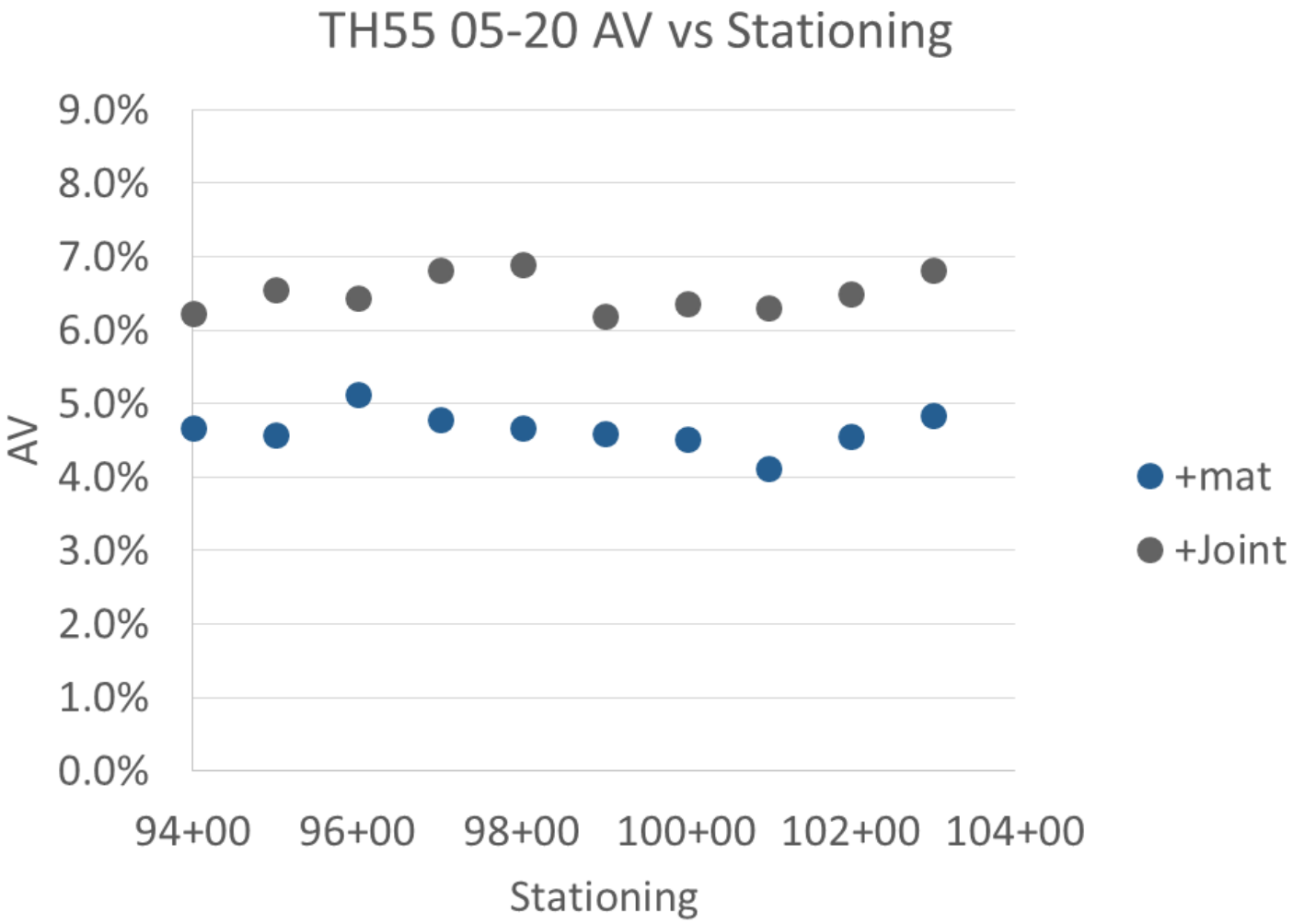

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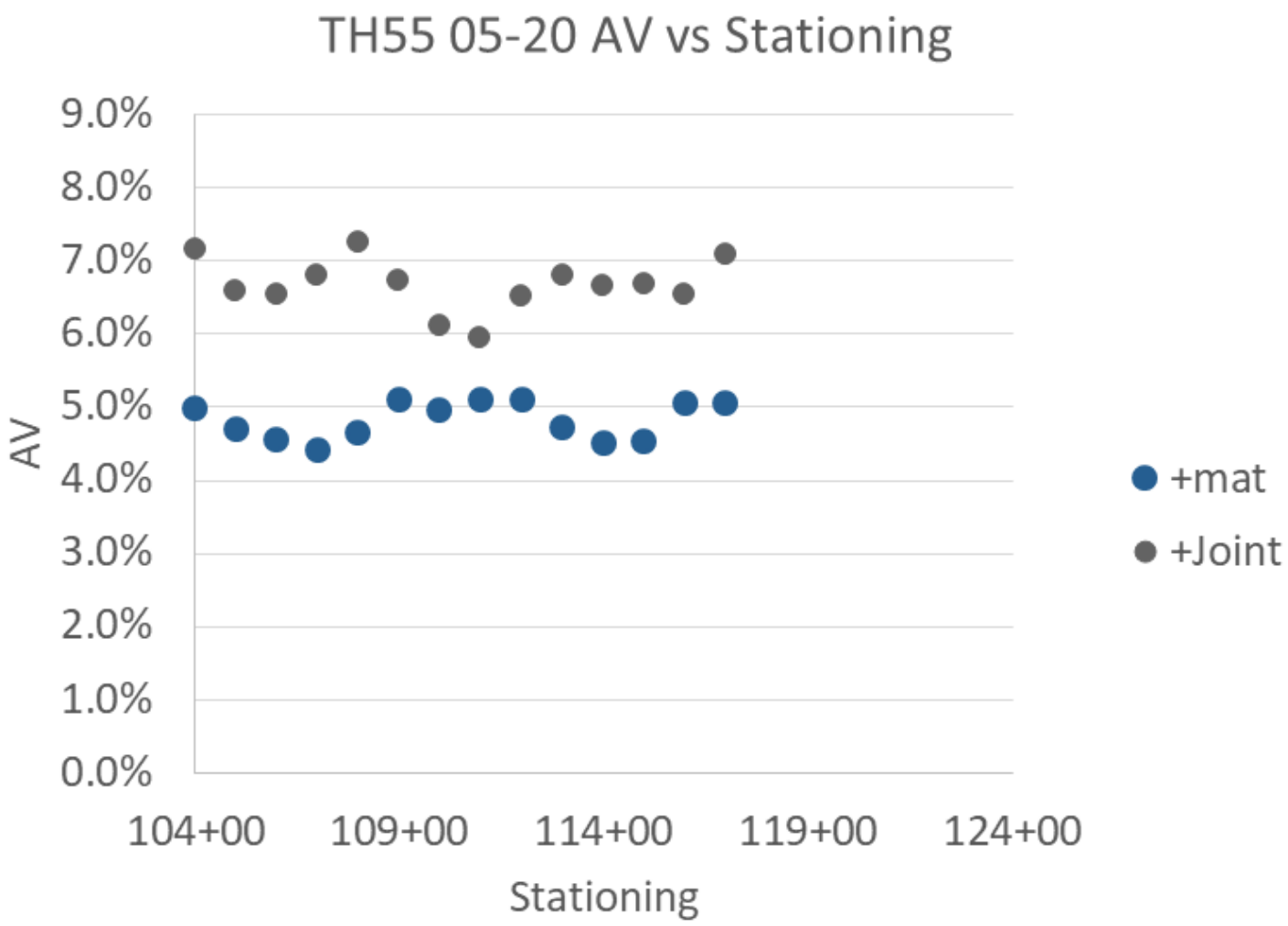

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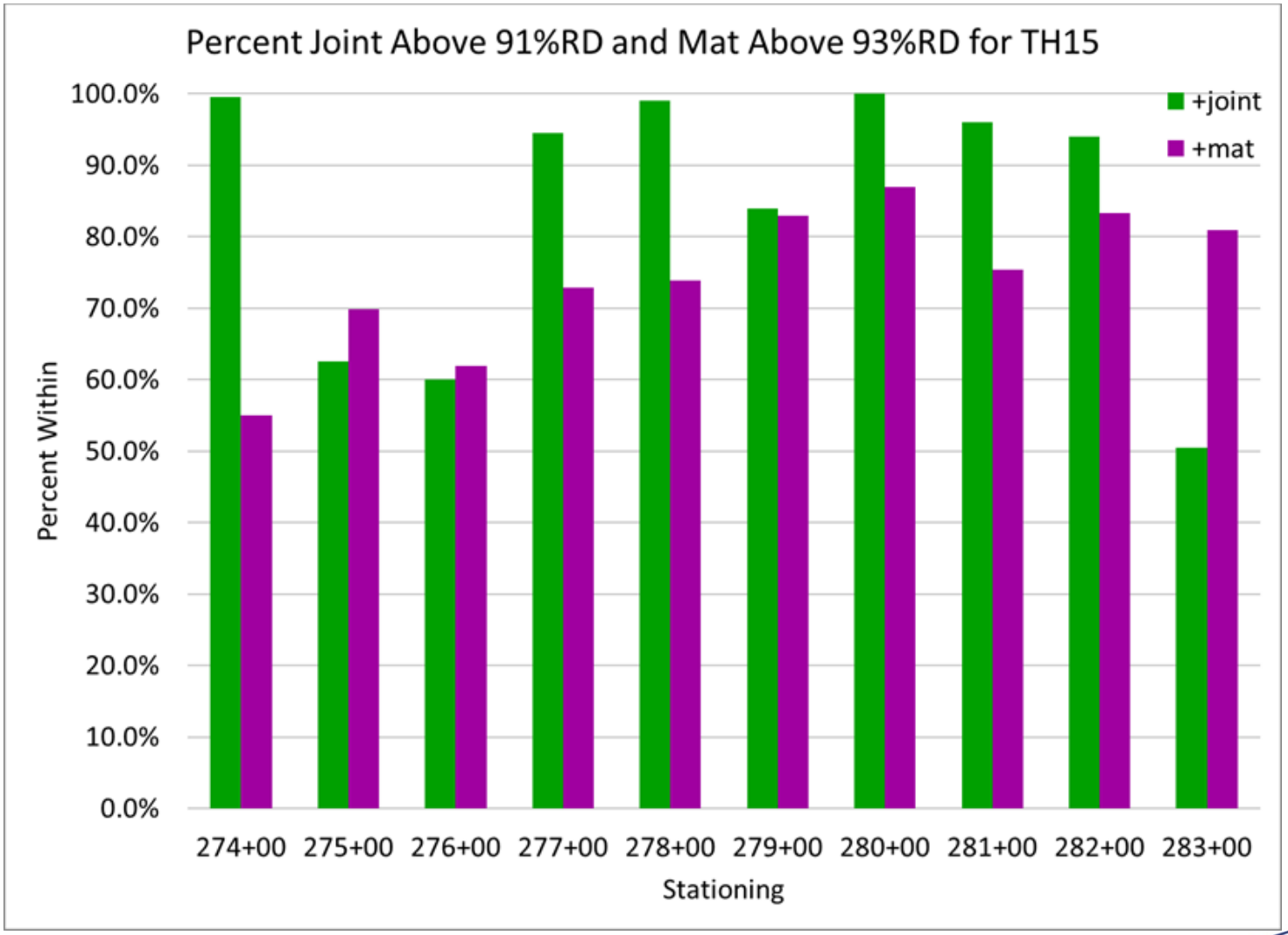
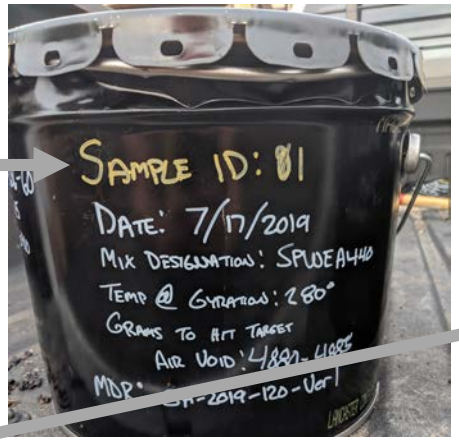
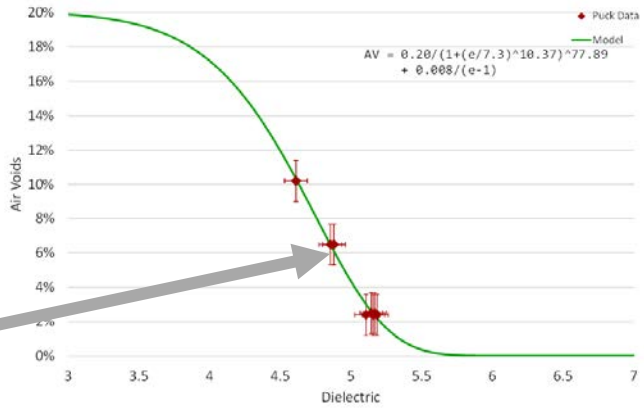


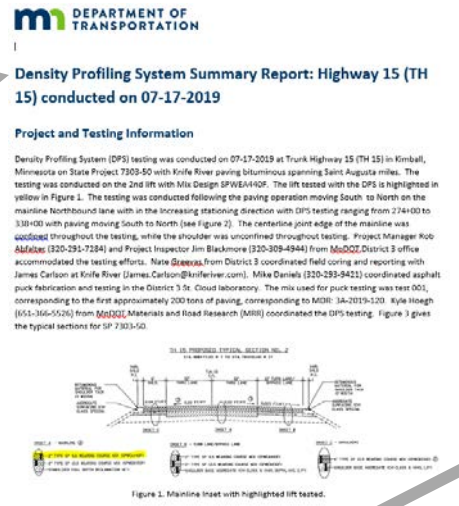
FHWA Visit TH15: July 17th 2019 Demo

FHWA Visit TH15: July 17th 2019 Demo

- Morning
  - Production Mix Collected
  - Field Testing
  - Demonstration
  - Run Gyratory Pucks
- Afternoon
  - Test Pucks for Dielectric
  - Run Analysis on Morning Data
  - Run Auto Report
  - Add results to afternoon presentation for FHWA





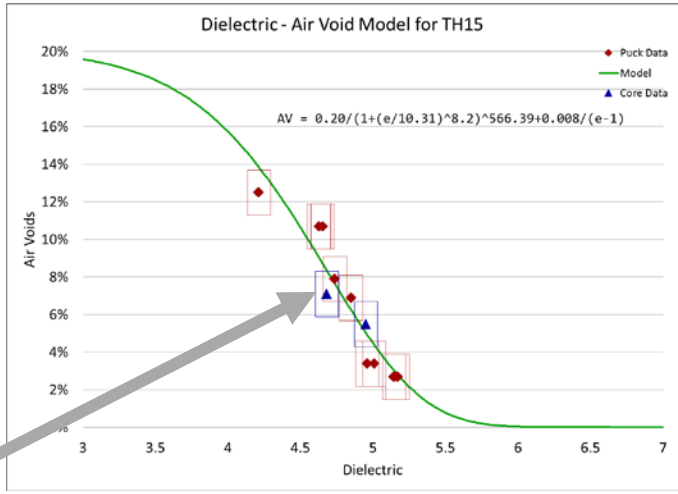

DEPARTMENT OF TRANSPORTATION

Density Profiling System Summary Report: Highway 15 (TH 15) conducted on 07-17-2019

Project and Testing Information

Density Profiling System (DPS) testing was conducted on 07-17-2019 at Trunk Highway 15 (TH 15) in Kimball, Minnesota on State Project 7303-50 with Knife River paving bituminous spanning Saint Augusta miles. The testing was conducted on the 2nd lift with Mix Design SPWEA440F. The lift tested with the DPS is highlighted in yellow in Figure 1. The testing was conducted following the paving operation moving South to North on the mainline Northbound lane with in the increasing stationing direction with DPS testing ranging from 274+00 to 338+00 with paving moving South to North (see Figure 2). The centerline joint edge of the mainline was confined throughout the testing, while the shoulder was unconfined throughout testing. Project Manager Rob Abfalter (320-291-7284) and Project Inspector Jim Blackmore (320-309-4944) from MnDOT District 3 office accommodated the testing efforts. Nate Greeves from District 3 coordinated field coring and reporting with James Carlson at Knife River (James.Carlson@kniferiver.com). Mike Daniels (320-293-9421) coordinated asphalt puck fabrication and testing in the District 3 St. Cloud laboratory. The mix used for puck testing was test 001, corresponding to the first approximately 200 tons of paving, corresponding to MDP: 3A-2019-120. Kyle Hoegh (651-366-5526) from MnDOT Materials and Road Research (MRR) coordinated the DPS testing. Figure 3 gives the typical sections for SP 7303-50.

Figure 1. Mainline inset with highlighted lift tested.



Next Day: Core Validation Results

FHWA Visit TH15: July 17th 2019 Demo

	Input the following information:	Code:		first location:	
2	State Project ID number	dddd		7303-50	Execute
3	Day of week, Month, day, year	aaaa		07-17-2019	
4	City	cccc		Kimball	
5	Testing from starting direction	jjjj		South	
6	Testing moving toward direction	kkkk		North	
7	Stationing direction	llll		Increasing	
8	Starting Station	mmmm		274+00	
9	Ending Station	nnnn		338+00	
10	Lift number testing conducted	hhhh		2nd	
11	Centerline relative to Paving direction	oooo		Left	
12	Shoulder relative to Paving direction	pppp		Right	
13	Location of sensors relative to centerline	aaab		Left-0.5, Middle-2.5, Right-4.5ft	
14	corresponding to x tons of paving	aaad		approximately 200	
15	Lane of testing (Ex. Eastbound)	aaaf		Northbound	
16	Number of swerve tests	aabb		7	
17	Sensor 1 Median correction factor (72)	aaag		-0.04 +/- 0.02	
18	Sensor 2 Median correction factor (74)	aaah		-.05 +/- 0.03	
19	Sensor 3 Median correction factor (75)	aaai		-0.01 +/- 0.03	
20	Sample Dry weight 1	aaaj		4868	
21	Sample Dry weight 2	aaak		4872	
22	Sample Dry weight 3	aaal		4624	
23	Dry weight 1 cooresponding AV%	aaam		2.40%	
24	Dry weight 2 cooresponding AV%	aaan		2.50%	
25	Dry weight 3 cooresponding AV%	aaao		6.50%	
26	Number of locations with lower dielectrics	aaap		1 location was	
27	Number of locations with high dielectrics	aaau		1 location was	
28	Date of Puck testing	aaaz		7/17/2019	
29	Puck sample number	zzzz		001	
30	Contractor	eeee		d	
31	Highway name/number	bbbb		15 (TH 15)	
32	Starting City (spanning multiple)	ffff		Saint Augusta	
33	Ending City (spanning multiple)	gggg		Kimball	
34	Mix Design code	iiii		SPWEA440F	
35	Mix used for puck testing	aaac		test 001	
36	Info about centerline joint	qqqq		confined throughout the testing	
37	Info about shoulder	bbba		unconfined throughout testing	
38	Project Manager Contact info	rrrr		Rob Abfalter (320-291-7284)	
39	Project Chief Inspector	ssss		Jim Blackmore	
40	Project Inspector Phone	tttt		(320-309-4944)	

Density Profiling System Summary Report: Highway 15 (TH 15) conducted on 07-17-2019

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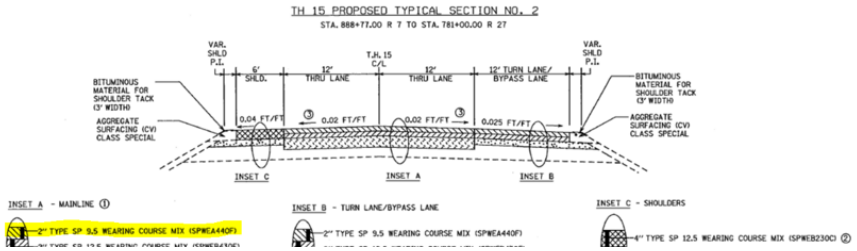


FHWA Visit TH15: July 17th 2019 Demo

Figure 2. Google Earth image of DPS tested areas (link to .kml file for viewing).

- Sensor 72
  - In specification 100% of the time (7/7)
  - Median Correction Factor: -0.04 +/- 0.02
- Sensor 22
  - In specification 100% of the time (7/7)
  - Median Correction Factor: -.05 +/- 0.03
- Sensor 74
  - In specification 100% of the time (7/7)
  - Median Correction Factor: -0.01 +/- 0.03

The AASHTO 0.08 dielectric tolerance was monitored throughout the day, validating the quality of the data for use in assessing compaction. The Median correction factors given in the bullets above were applied to ensure the different sensors are measuring uniformly, and used for results presented herein.

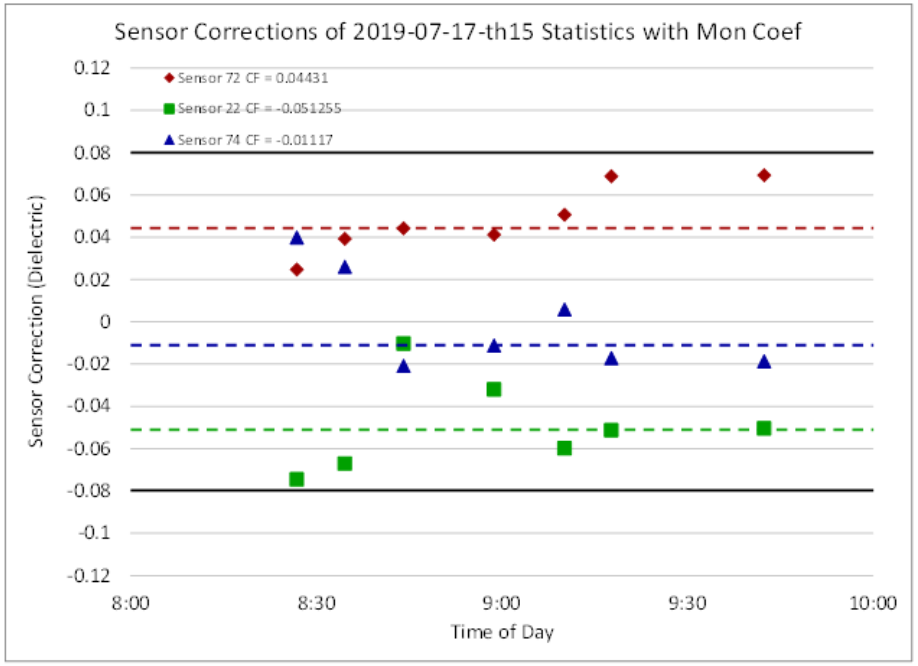


Figure 6. Swerve correction factor results versus time of day.

FHWA Visit TH15: July 17th 2019 Demo

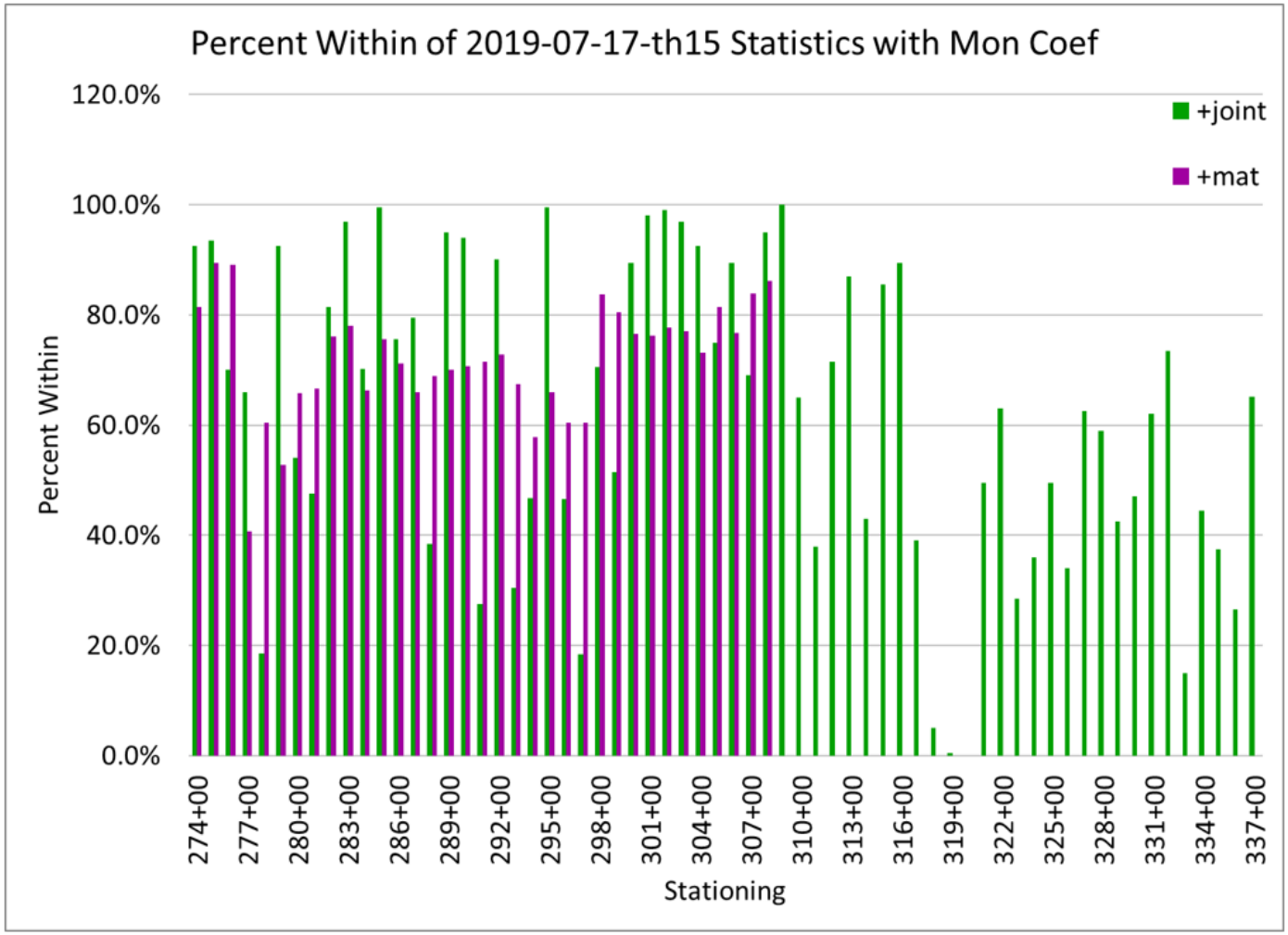
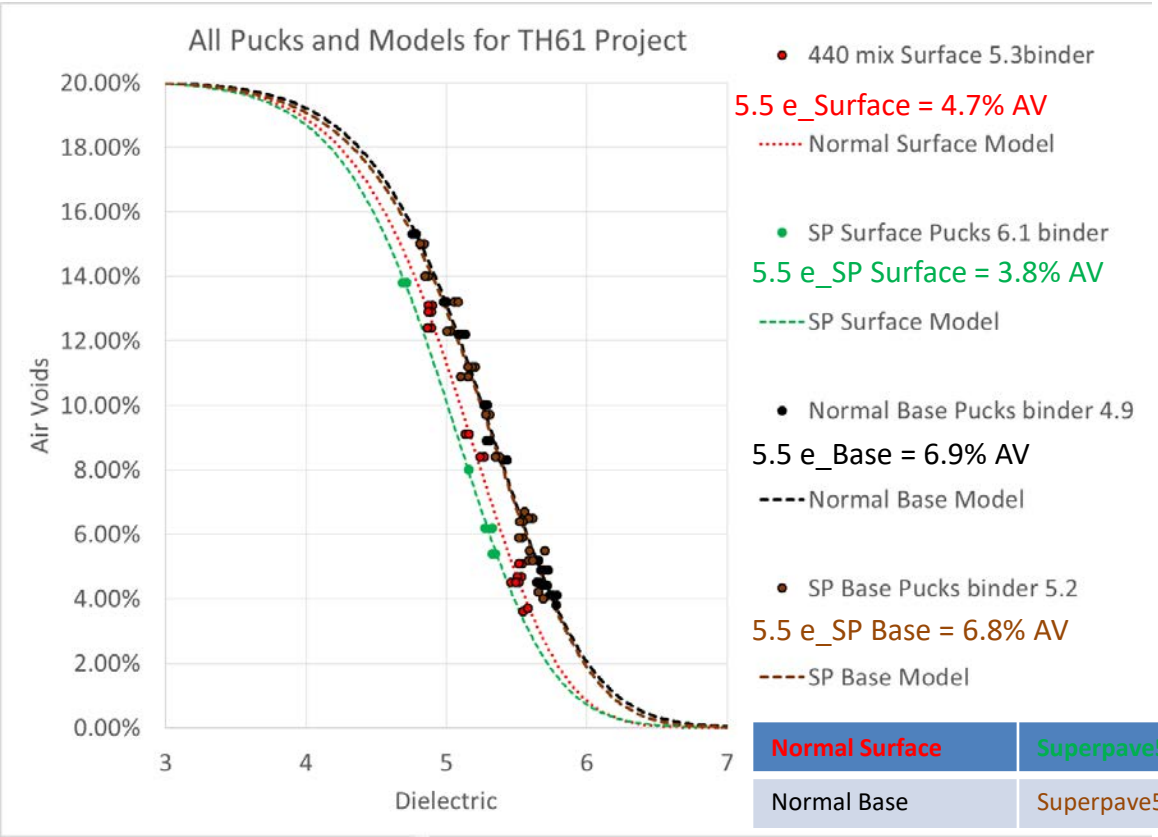


Figure 11. PWL throughout project (91 for joint, 93 for mat). First plot has data on joint and in mat.

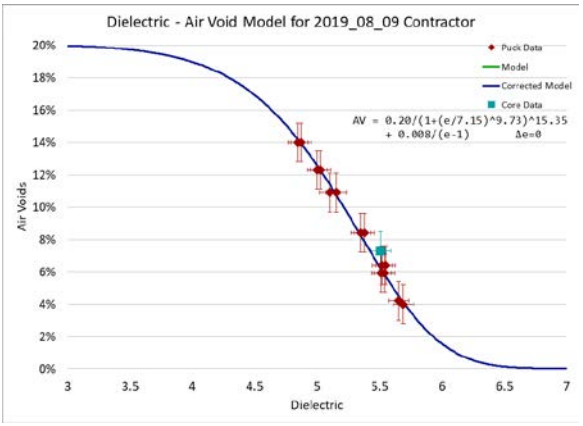
Goals Required for Use as QA Tool

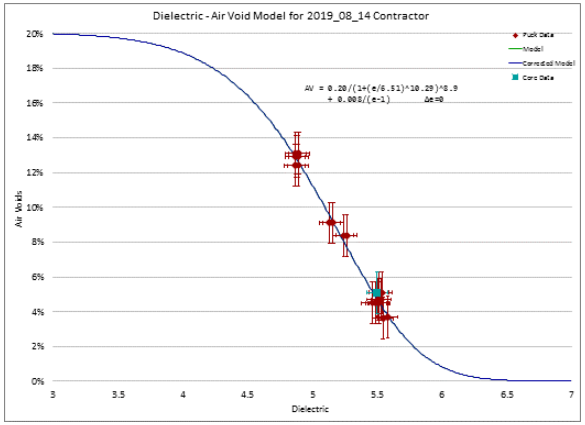
- Create daily dielectric to density conversion
  - Fabricate coreless calibration pucks every day of production
    - Design voids (4%), -250 grams (8-10%), -500 grams (12-15 AV%)
    - Contractor vs Agency: Good agreement 2019 on TH 61
    - Day to day variation of same mix showed very little variation
    - Coreless calibration effective at picking up changes in the mix

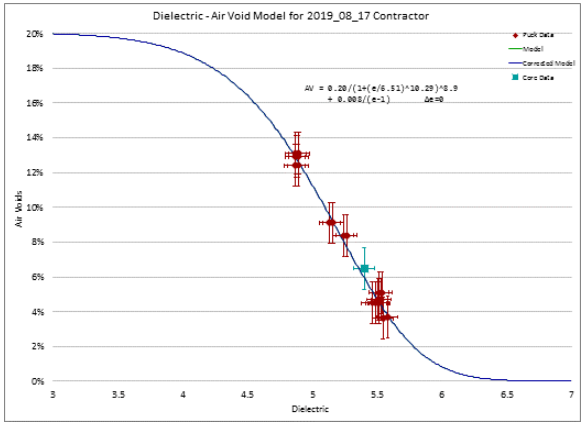


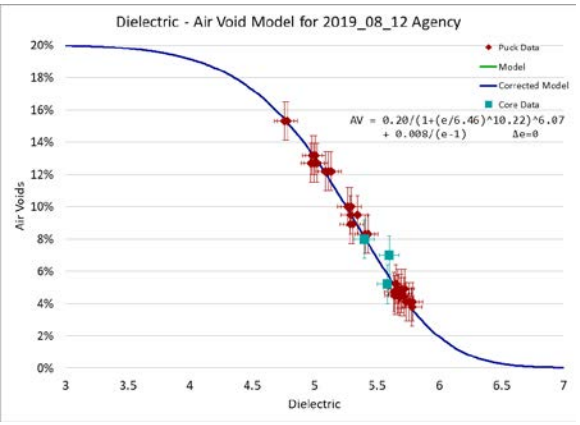
Proactive contractor lab QC

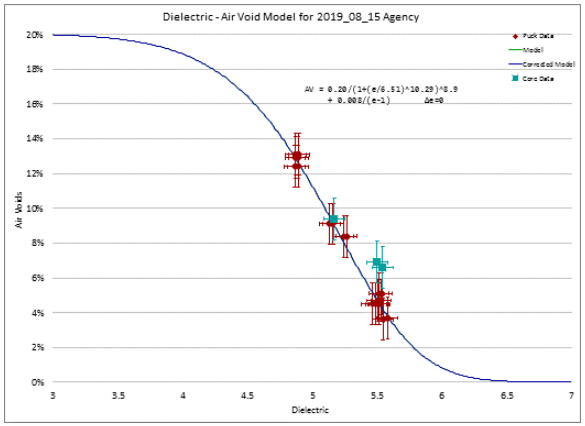
TH 61 Case Study: Puck Vs Cores

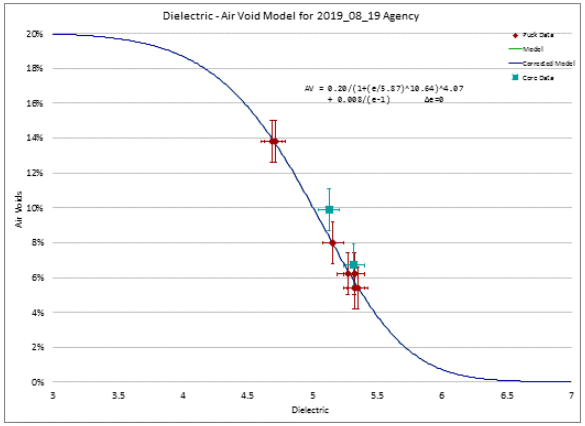






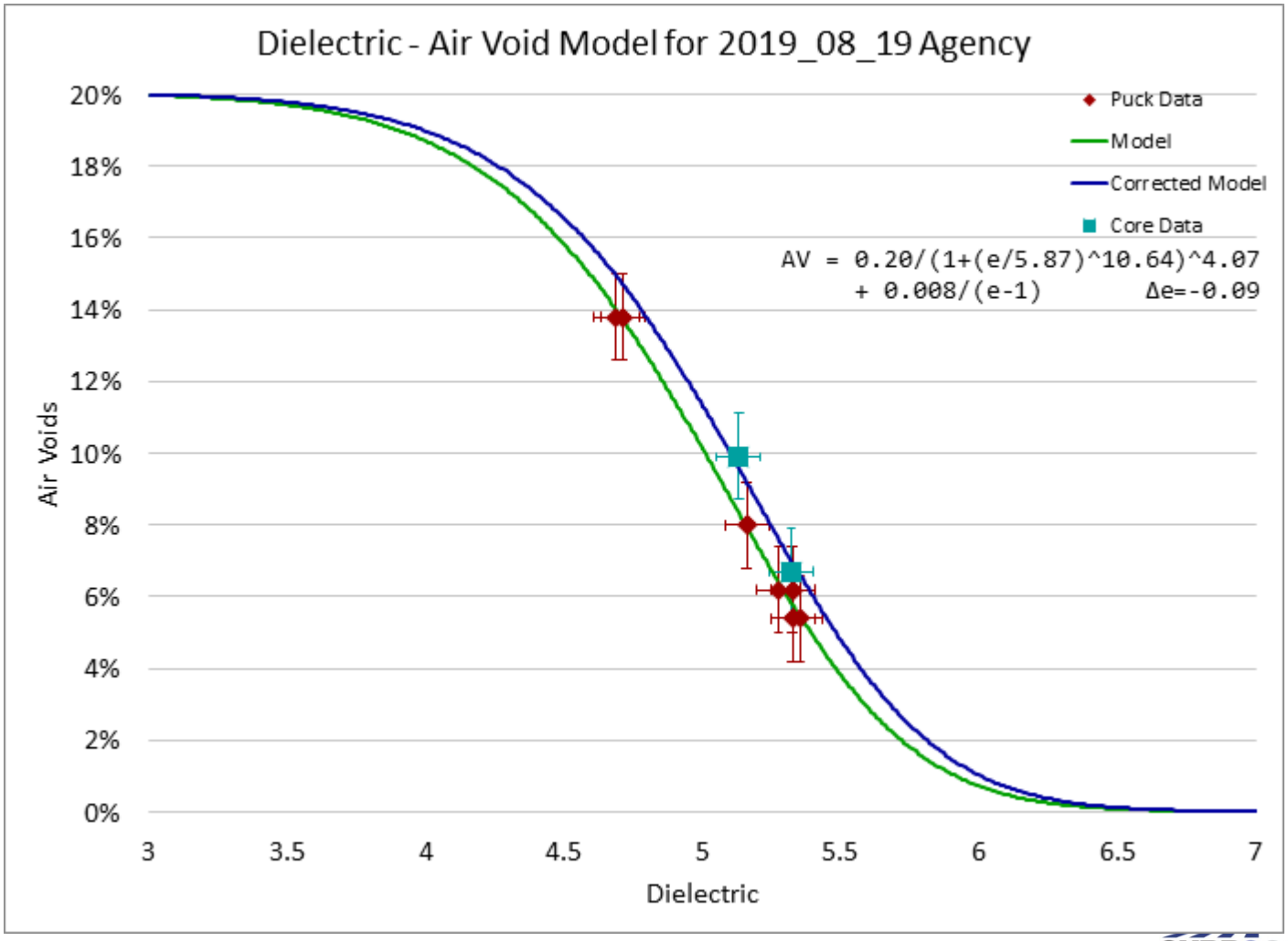






Coreless Calibration Case Study: Puck Vs Cores

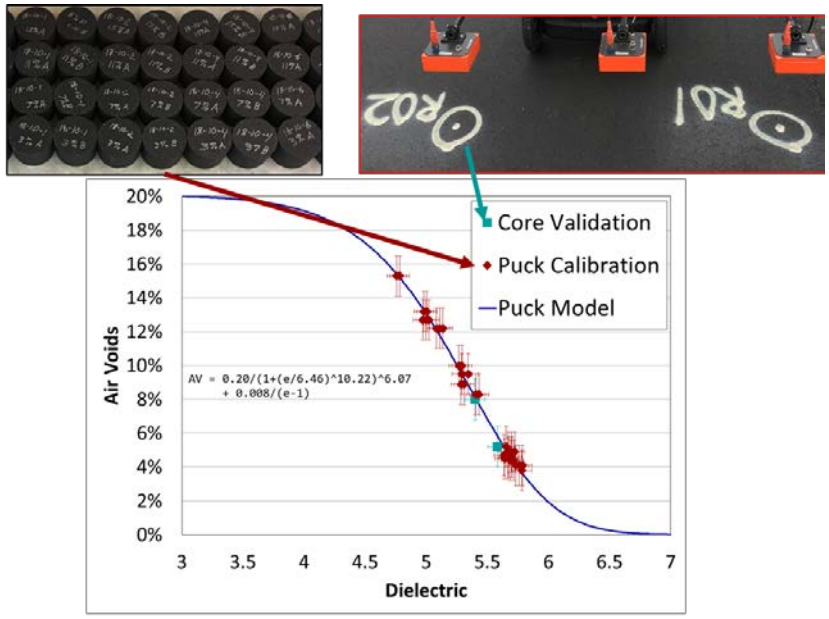
Core Correction Factor



Goals Required for Use as QA Tool

- Conduct Daily Validation of Coreless Calibration Prediction

Last Season: Marked one high and one low dielectric location each day



2020: No additional cores, just use QA randomly selected locations

- Selected/marked after final roller but within traffic control
- **Proactive on-site inspector**
- Test with DPS during routine data collection throughout the day

Goals Required for Use as QA Tool

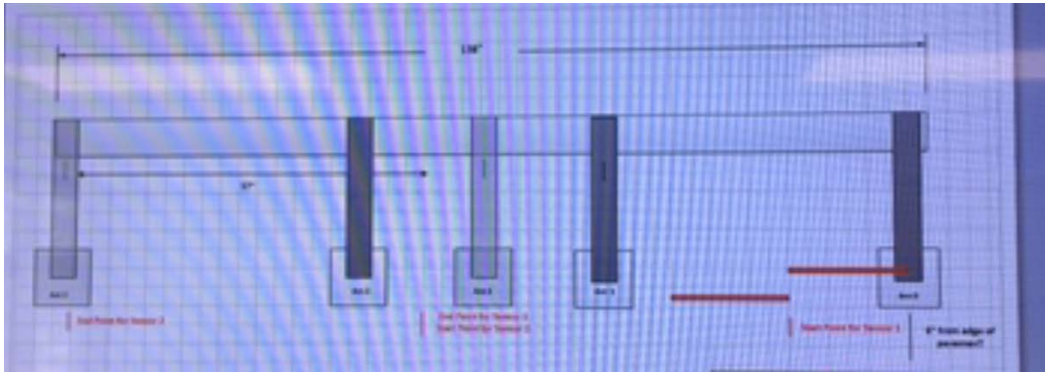
- Routine collection that is accurate and not too labor intensive

Proactive contractor field collection

Robot Collection

Manual Collection

Single Pass: Programmable moving bracket collection (Gator)



Thanks! Questions? Challenges?

NRRA National Road Research Alliance

presents

2020 NRRA PAVEMENT WORKSHOP

May 19-21, 2020 | Shoreview, Minnesota

Visit our booth #548 or online:
mndot.gov/mnroad/nrra/pavement-workshop

Meeting @ TRB: Jan. 15 | 6:30-8pm | Chinatown (M3) Marriot Marquis