Superpave5

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- Indiana JTRP SPR-3624
  - “Optimizing Laboratory Mixture Design as it Relates to Field Compaction to Improve Asphalt Mixture Durability”
  - Ali Hekmatfar, Rebecca McDaniel, Ayesha Shah, John Haddock
- Indiana JTRP SPR-4211
  - “Implementing the Superpave5 Asphalt Mixture Design Method in Indiana”
  - John Haddock, Reyhaneh Rahbar-Rastegar, Pouranian, Montoya, Patel
- AAPT Paper – 2019 – SuperPave5: Relationship of In-Place Air Voids and Asphalt Binder Aging
  - Huber, Wielinski, Campbell, Padgett, Rowe, Beeson, Cho

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Superpave5 Concept

- Higher Density = More Durability
- Why do we make density difficult to achieve?

- We need to design mixtures to be more compactible
  - Without compromising rutting resistance

Original Superpave

- Rutting had been a problem
- High Gyratory effort chosen
- Design set at 4% Air Voids
- “Happy” with 7-8% AV in field (92-93% Density)

- Why do we do this to ourselves?

Superpave5 Concept

- What if we designed a mix that would be compacted to the design air void levels in the field?
- 5.0% Design Air Voids
- 5.0% Field Air Voids

- To achieve this, we lowered gyration levels

Does it Change Asphalt Content?

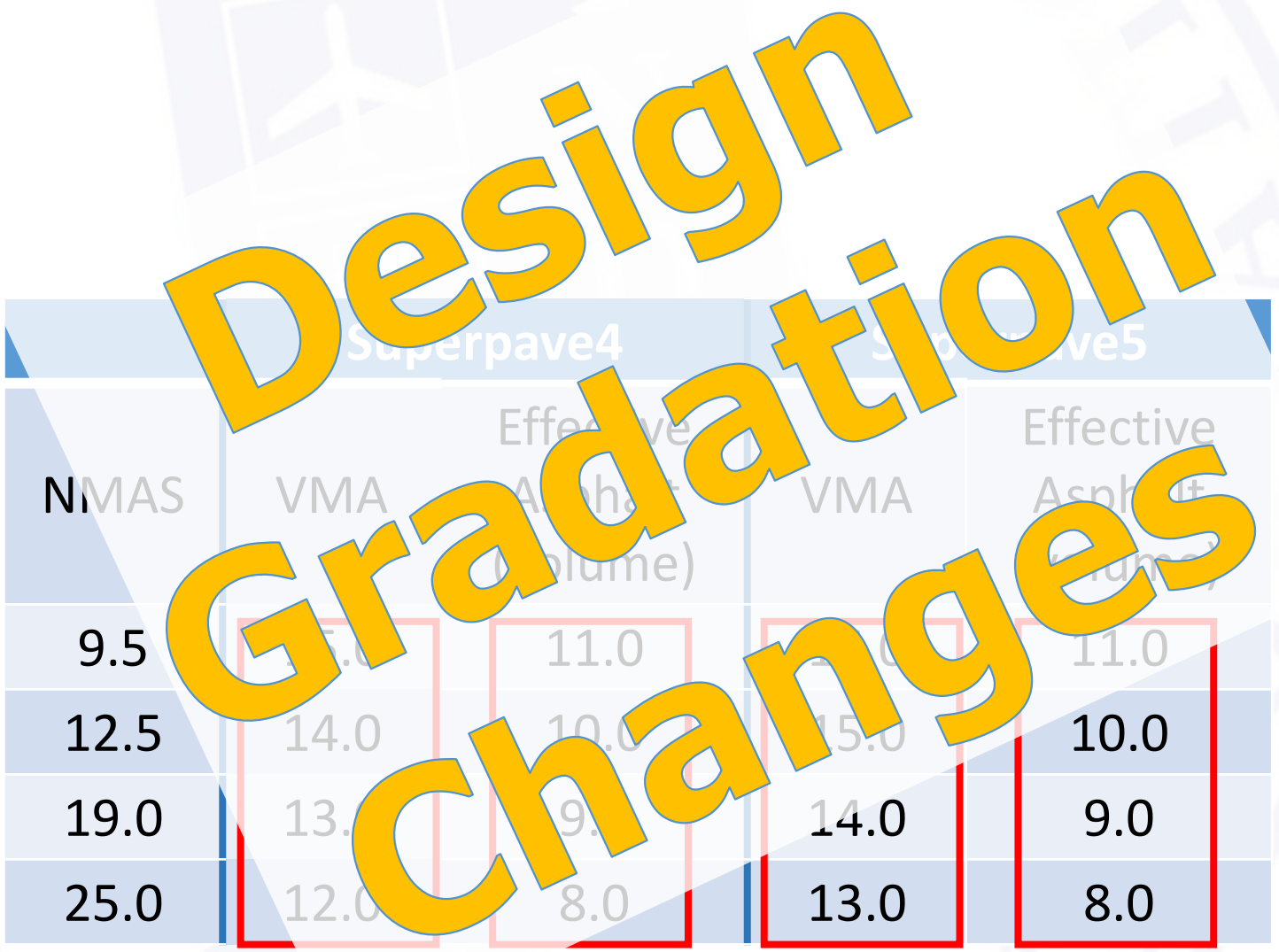
- Doesn’t lowering gyrations increase asphalt content?

	Superpave4	
NMAS	VMA	Effective Asphalt (volume)
9.5	15.0	11.0
12.5	14.0	10.0
19.0	13.0	9.0
25.0	12.0	8.0

Does it Change Asphalt Content?

Asphalt Content Stays Same

Asphalt Content



NMAS	Superpave4 VMA	Superpave4 Effective Asphalt (Volume)	Superpave5 VMA	Superpave5 Effective Asphalt (Volume)
9.5	[illegible]	11.0	[illegible]	11.0
12.5	14.0	10.0	15.0	10.0
19.0	13.0	9.0	14.0	9.0
25.0	12.0	8.0	13.0	8.0

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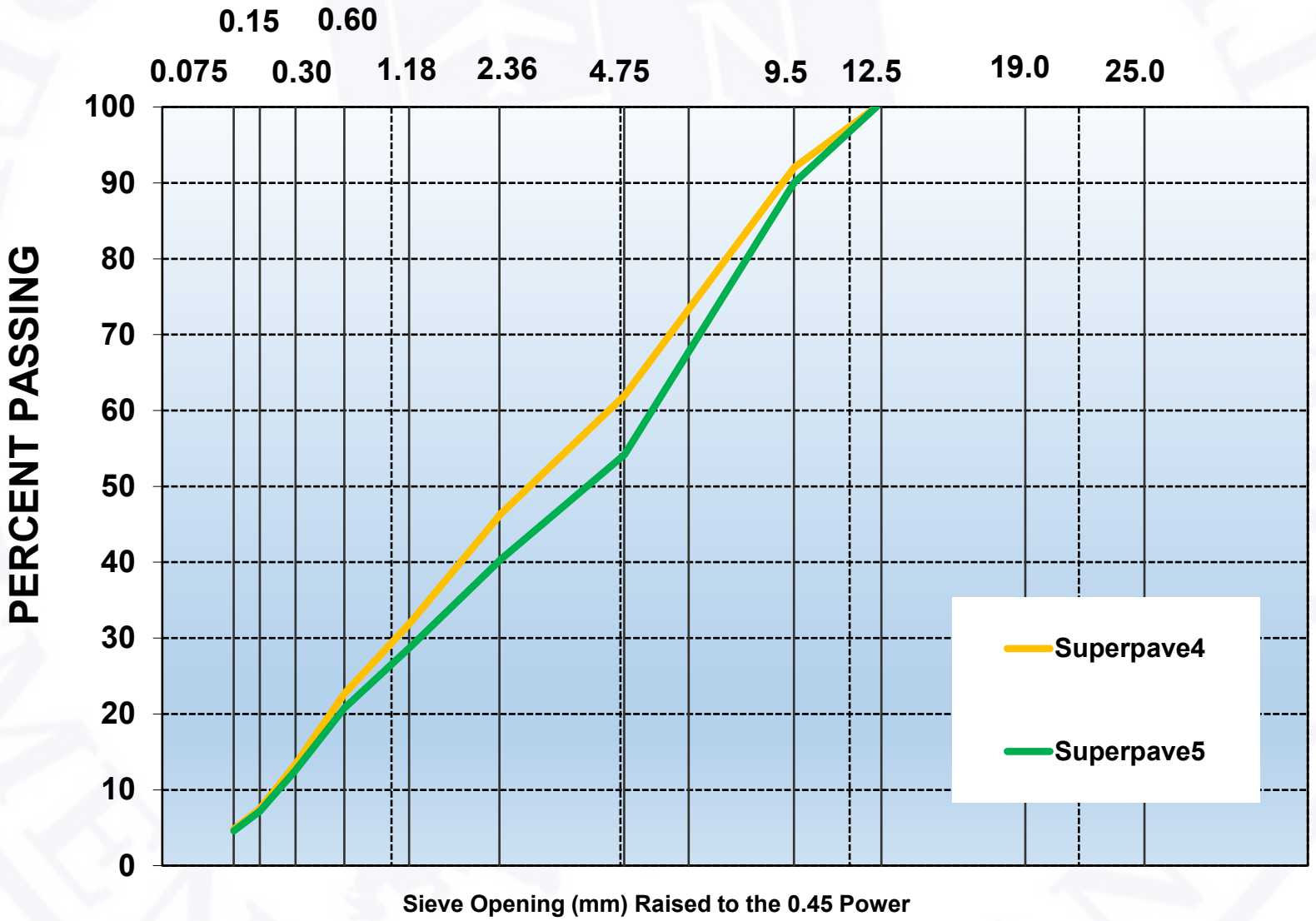
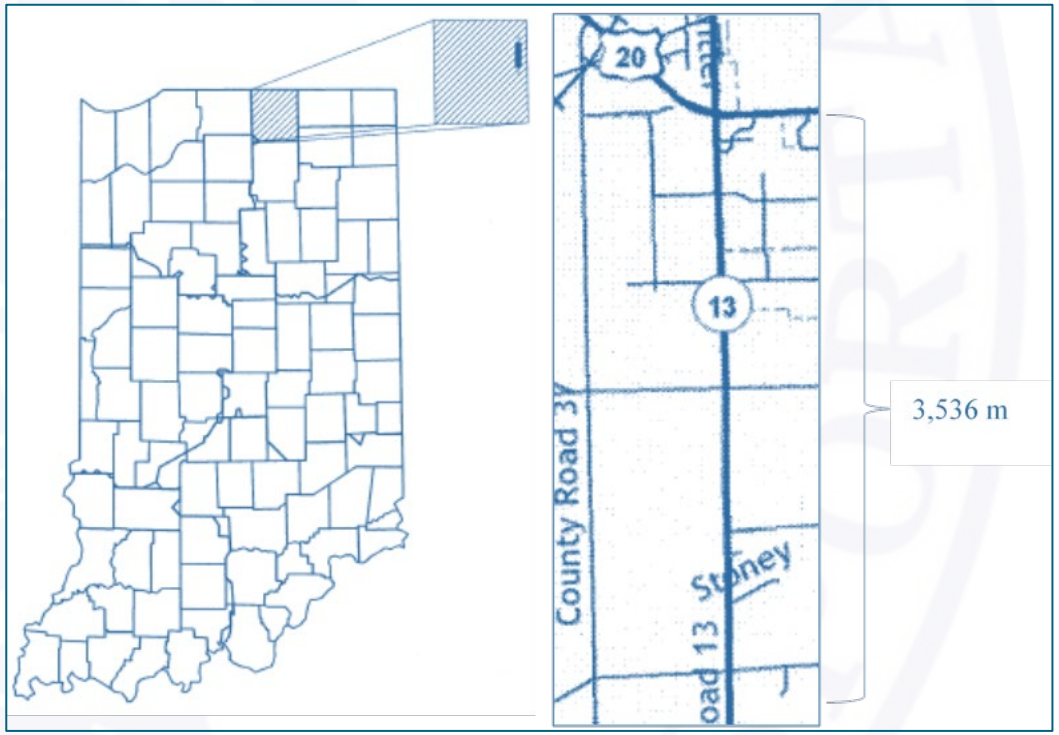
Design Gradation Changes



SR 13, Middlebury, Indiana

- 2013 Trial Project
  - 13,400 AADT
  - 19% heavy trucks
- Same materials
  - Same aggs
  - PG 70-22 binder
  - 7% RAS




Same Rolling Train
Superpave5 Compaction

Mix Construction Properties

	Superpave4			Superpave5		
	Design	QC	QA	Design	QC	QA
Asphalt, %	5.1	5.2	5.2	5.4	5.5	5.2
Air Voids, %	4.0	2.4	2.9	5.0	4.5	4.0
Density, %Gmm	-	-	91.6	-	94.7	96.9

vel

2018 Follow up

- Cores from 6 locations
  - 3 Superpave4
  - 3 Superpave5

- Testing performed
  - Air voids
  - Binder Content
  - PG grading
  - Permeability


Six Cores At Each Location

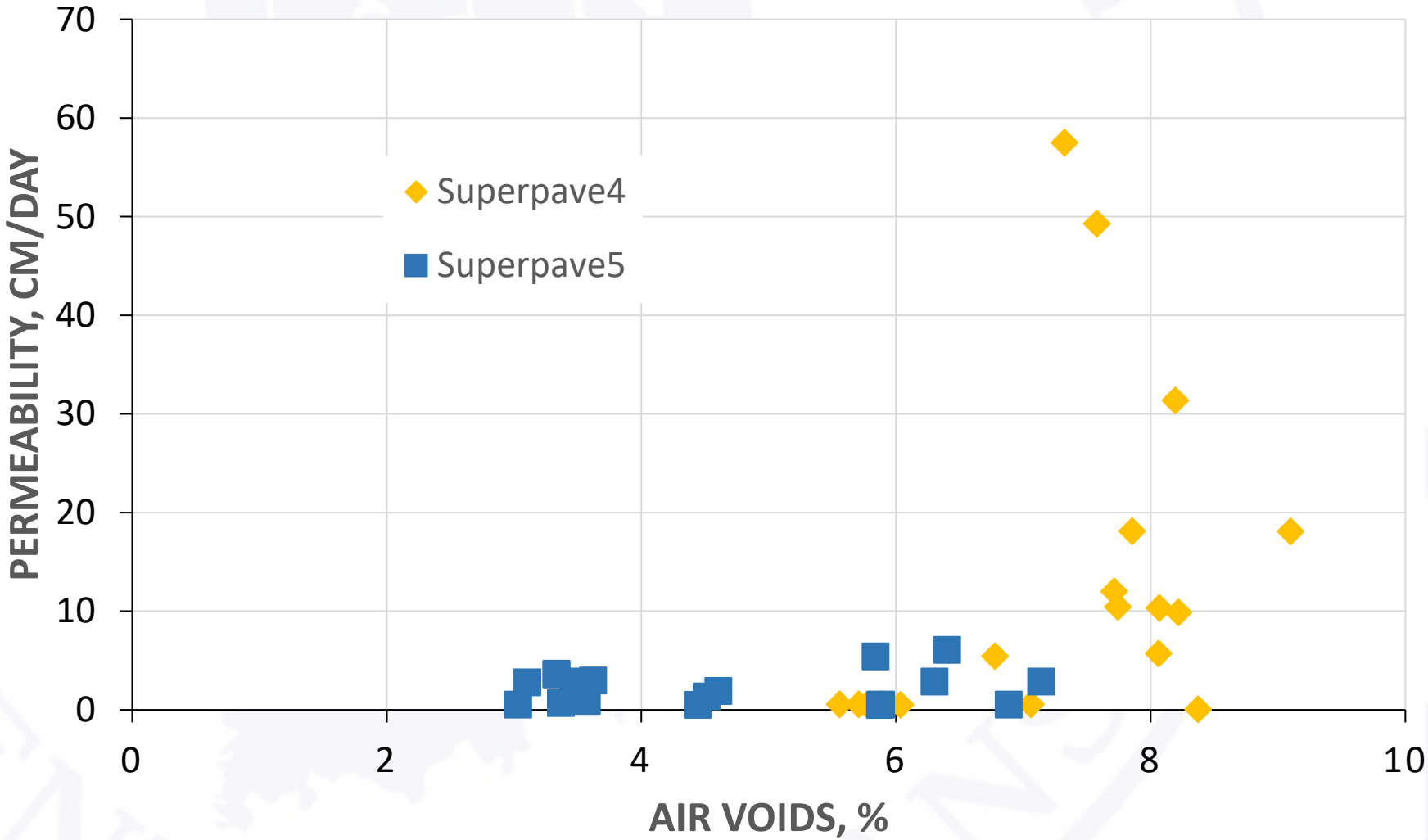
Core Properties

	Superpave4			Superpave5		
	Loc 1	Loc 2	Loc 3	Loc 1	Loc 2	Loc 3
Thickness, mm	37.3	37.7	34.5	35.2	36.2	42.8
Asphalt, %	5.34	5.35	5.56	5.67	5.36	5.82
Density, %Gmm	91.8	94.0	92.3	95.7	93.6	96.6

Level IA

Average Values

Permeability



Recovered Asphalt Binder Grade

	Superpave4				Superpave5			
Location	High Fail Temp., °C	Low Fail Temp m, °C	Low Fail Temp, S, °C	ΔTc, °C	High Temp Grade, °C	Low Temp Grade, m, °C	Low Fail Temp., S, °C	ΔTc, °C
1	99.1	-15.6	-24.8	-9.2	95.4	-20.5	-24.9	-4.4
2	97.0	-20.4	-25.8	-5.4	96.5	-18.5	-23.4	-4.9
3	103.9	-12.7	-23.1	-10.4	90.1	-24.1	-25.7	-1.5
Average	100.0	-16.2	-24.6	-8.3	94.0	-21.0	-24.7	-3.6

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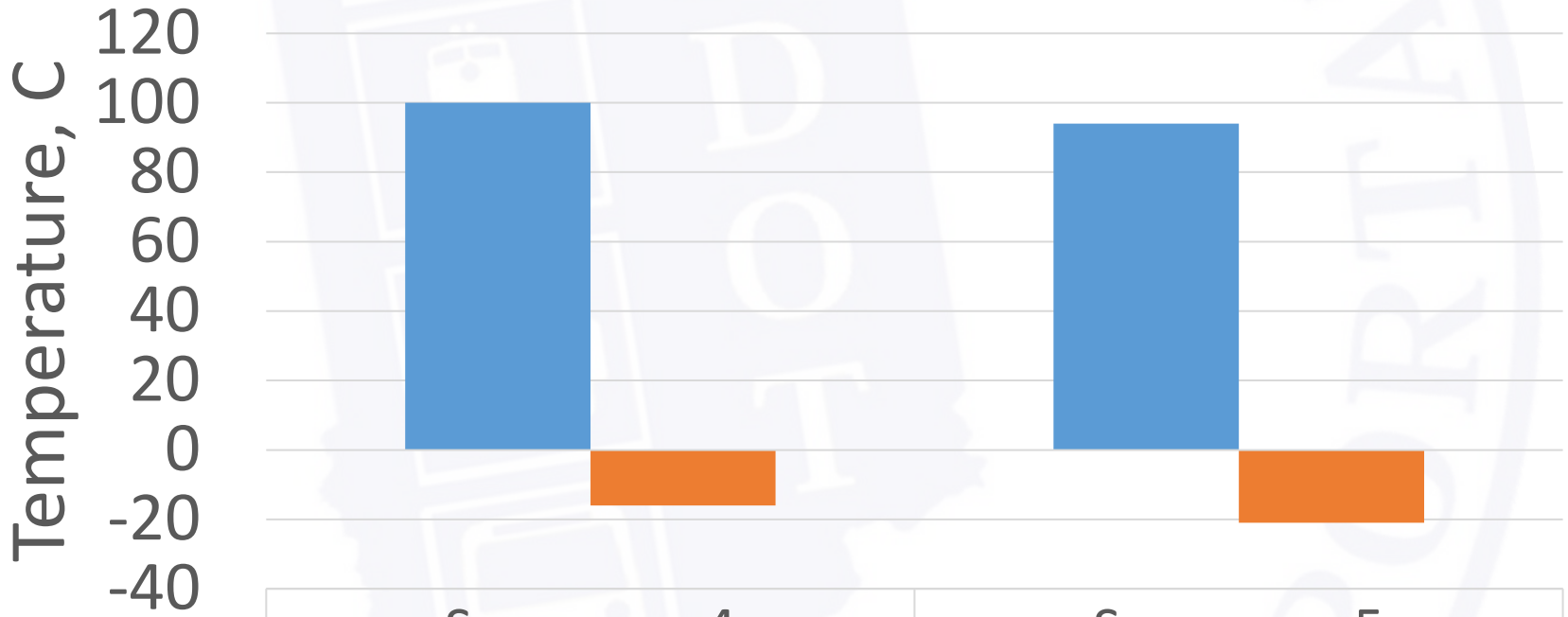
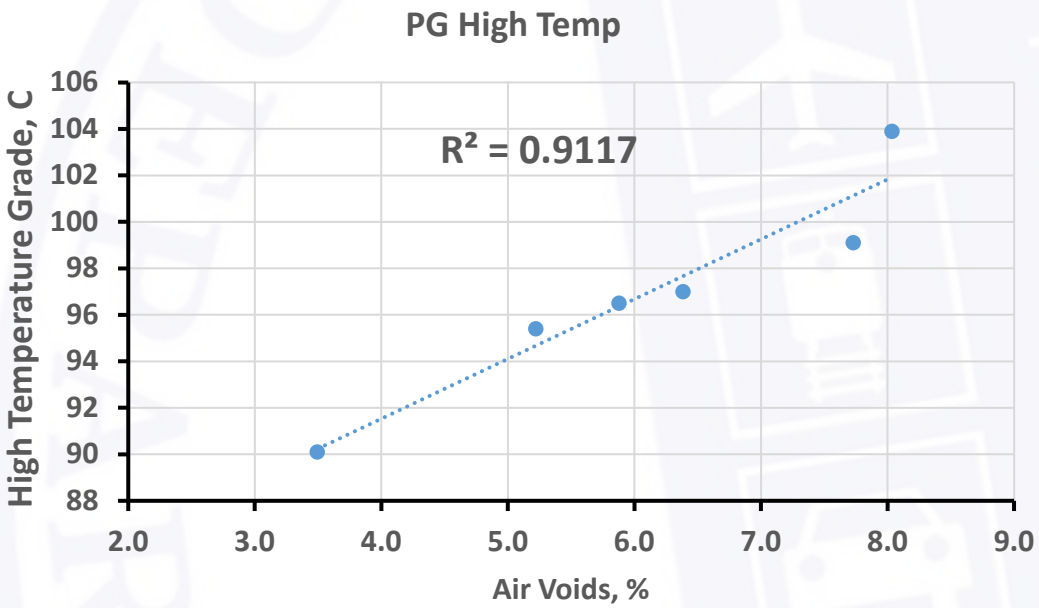
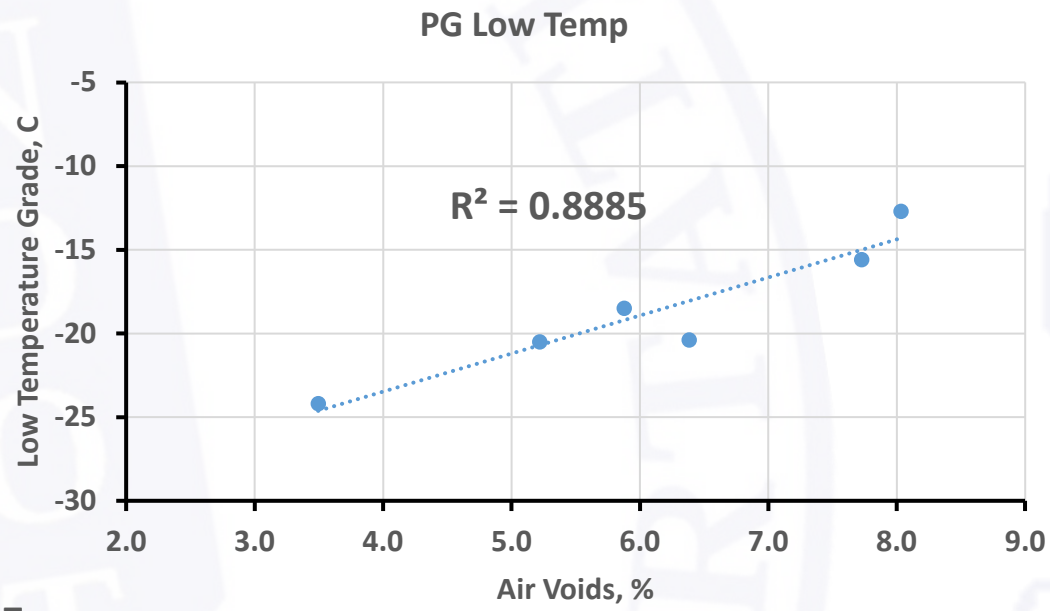
Asphalt Binder Grade

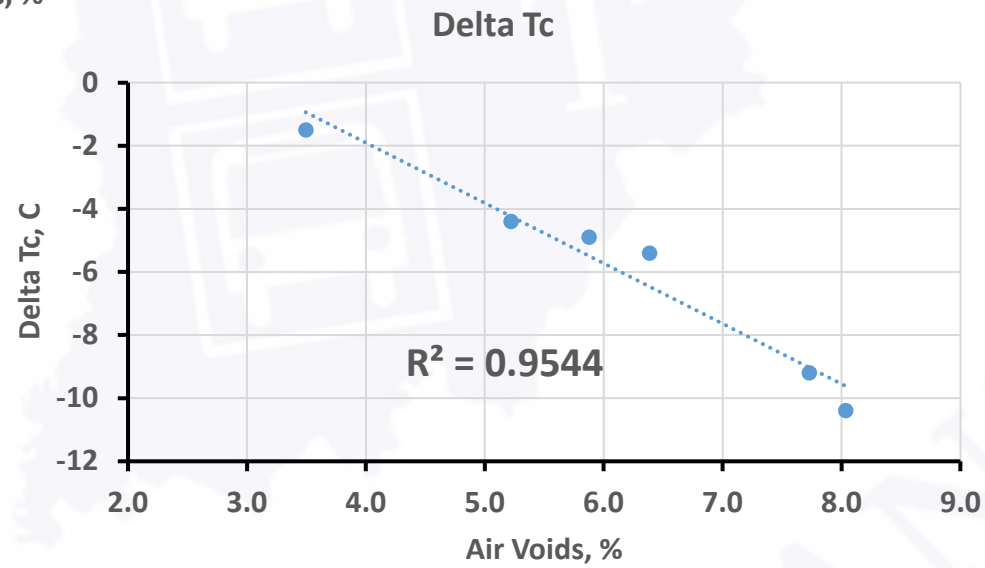


	Superpave4	Superpave5
HT	100	94
LT	-16	-21

Binder Grade Correlation to In-Place Air Voids







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Superpave4
Superpave5


Superpave4


Superpave5


Superpave4
Superpave5


Superpave 5
Superpave 4

Will we see rutting?

	Superpave5		Superpave4	
	Rut Depth, in		Rut Depth, in	
Location	LWP	RWP	LWP	RWP
1	0.2	0.3	0.08	0.17
2	0.12	0.12	0.25	0.13
3	0.09	0.23	0.33	0.64
Average	0.14	0.22	0.22	0.31
Entire Project	0.14	0.26	0.13	0.26

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US 40 Richmond
Arterial Street
3-years old
RICHMOND
INN & SUITES
Richmond Inn & Suites
AUTO PARTS
CHEVEUX
Superpave5
Superpave4

INDOT Specs (pre-2019)

- Air Voids at Ndes = 4.0%

- Gyration levels
  - > 3M ESALs = 100 gyrations
  - < 3M ESALs = 75 gyrations

INDOT Specification Revisions

- Air Voids at Ndes = 5.0%
- Design Gyrations
  - 100 → 50
  - 75 → 30
- Density LSL = 93.0%
- Implemented in 2019 via opt-in, 2020 full spec

Superpave5 2019 Air Voids

- Superpave4
  - 3.78%
  - 1529 sublots
- Superpave5
  - 4.81%
  - 2033 sublots

Superpave5 2019 Density

- Superpave4
  - Average = 93.16%
  - 1529 sublots
- Superpave5
  - Average = 94.41%
  - 2033 sublots

"Based on prior studies, a 1% increase to in-place asphalt pavement density achieved through improved compaction was estimated to improve the fatigue performance of asphalt pavements between 8 and 44% and improve rutting resistance by 7 to 66%. A 1% increase in in-place density was estimated to extend the service life by 10%, conservatively."

~FHWA-HIF-19-052

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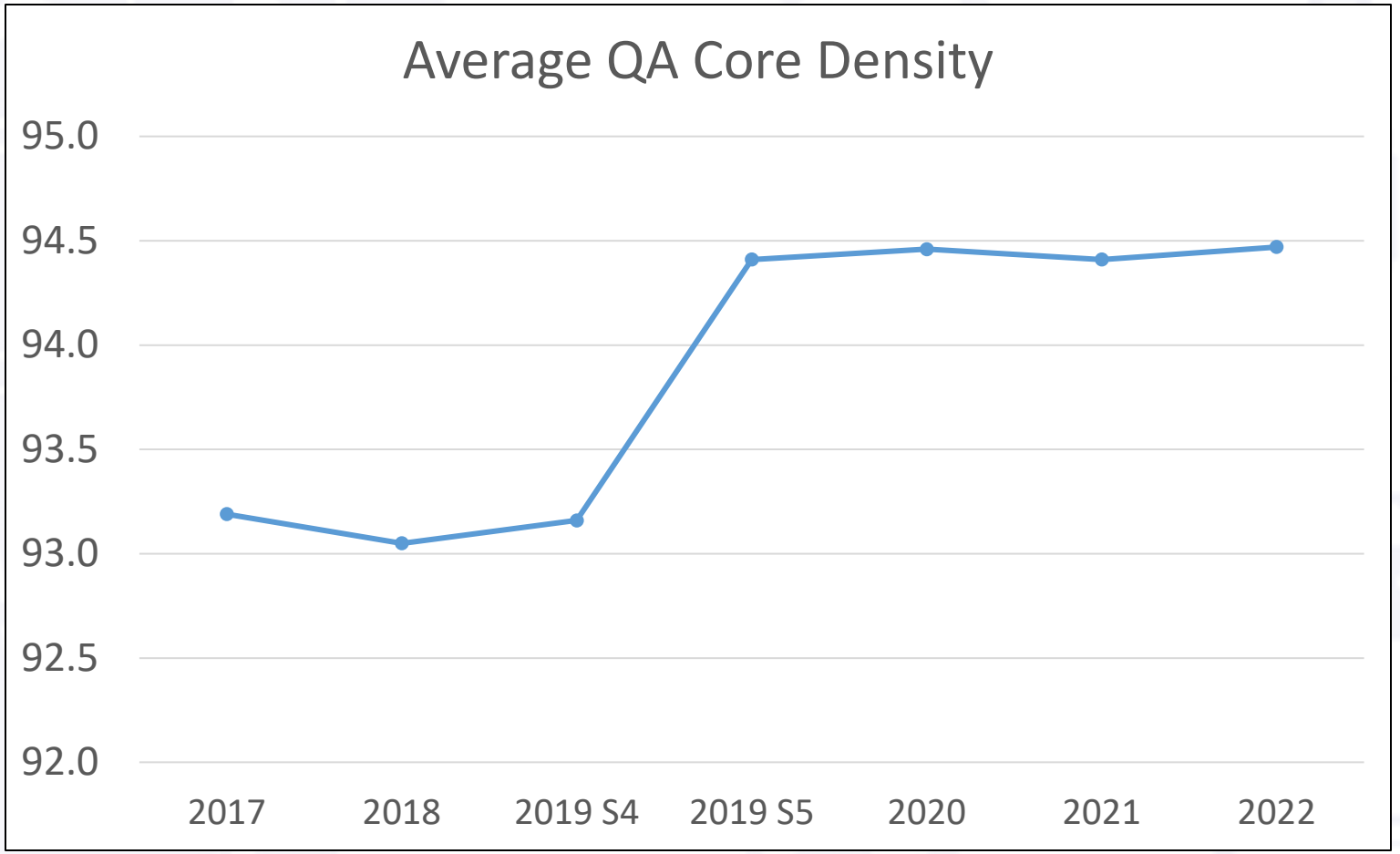
INDOT QA Core Density by Year

- 2017 S4 = 93.19%
- 2018 S4 = 93.05%
- 2019 S4 = 93.16%
- 2019 S5 = 94.41%
- 2020 S5 = 94.46%
- 2021 S5 = 94.41%
- 2022 S5 = 94.47%



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QA Core Density by Gyration

- N_{des} = 50
  - 2019 = 94.30%
  - 2020 = 94.35%
  - 2021 = 94.28%
- N_{des} = 30
  - 2019 = 94.82%
  - 2020 = 95.01%
  - 2021 = 94.93%

Thank you!

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