National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Cargill®

BMD for High RAP Mix with Rejuvenator

Nam Tran

SEVENTH
RESEARCH CYCLE

NCAT TEST TRACK CONFERENCE

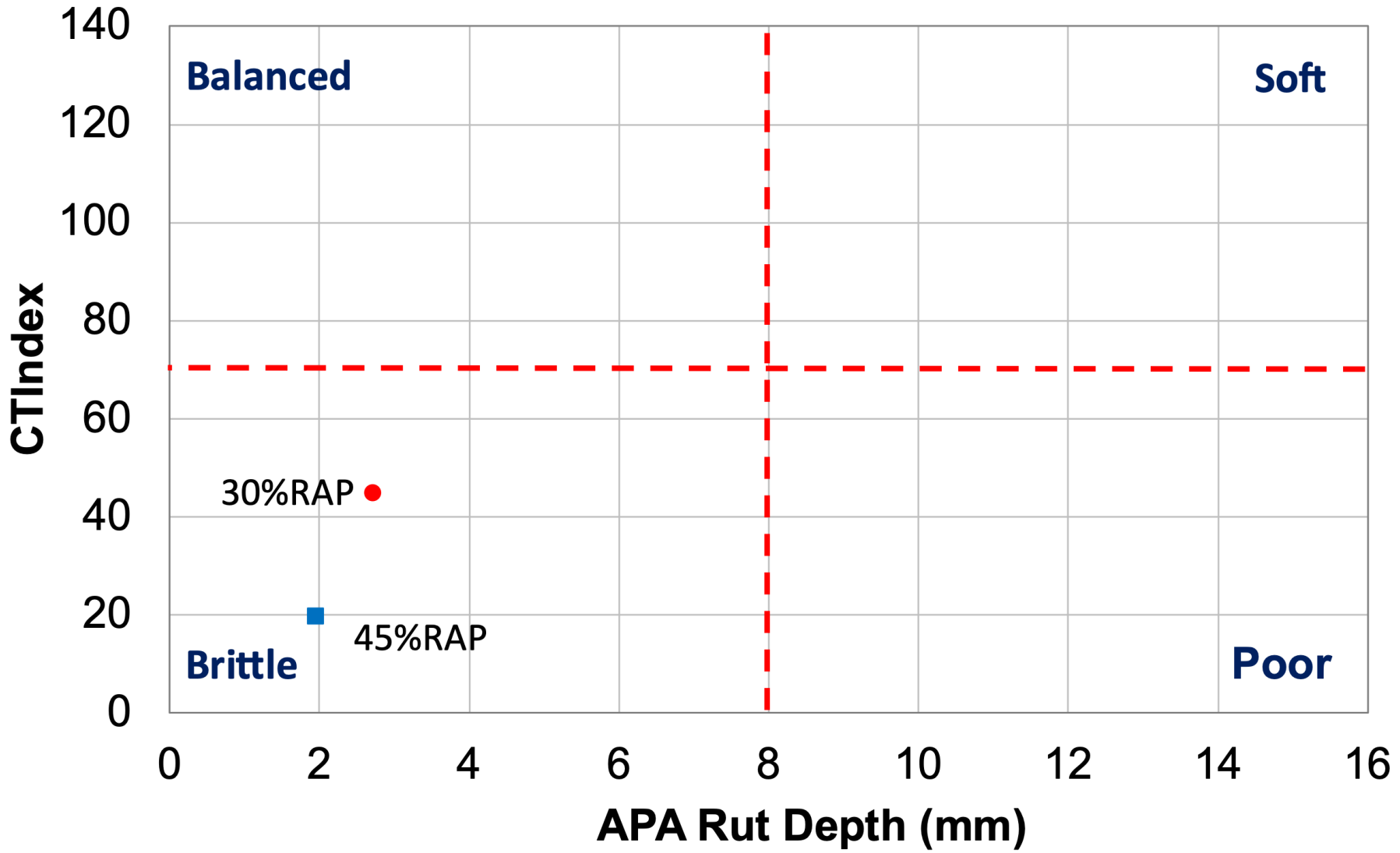

TEST SECTION
NUMBER N-3
CARGILL

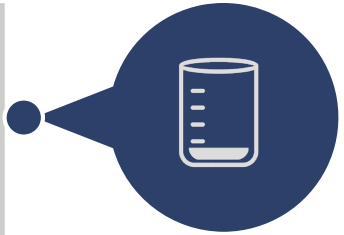
Both designed as BMD mixtures

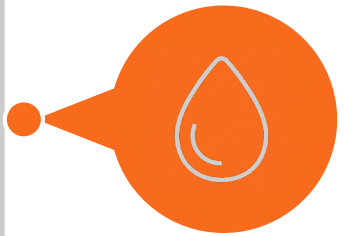
- APA: rut ≤ 8.0mm
- IDEAL-CT: CT_{index} ≥ 70
- Cantabro: mass loss ≤ 7.5%

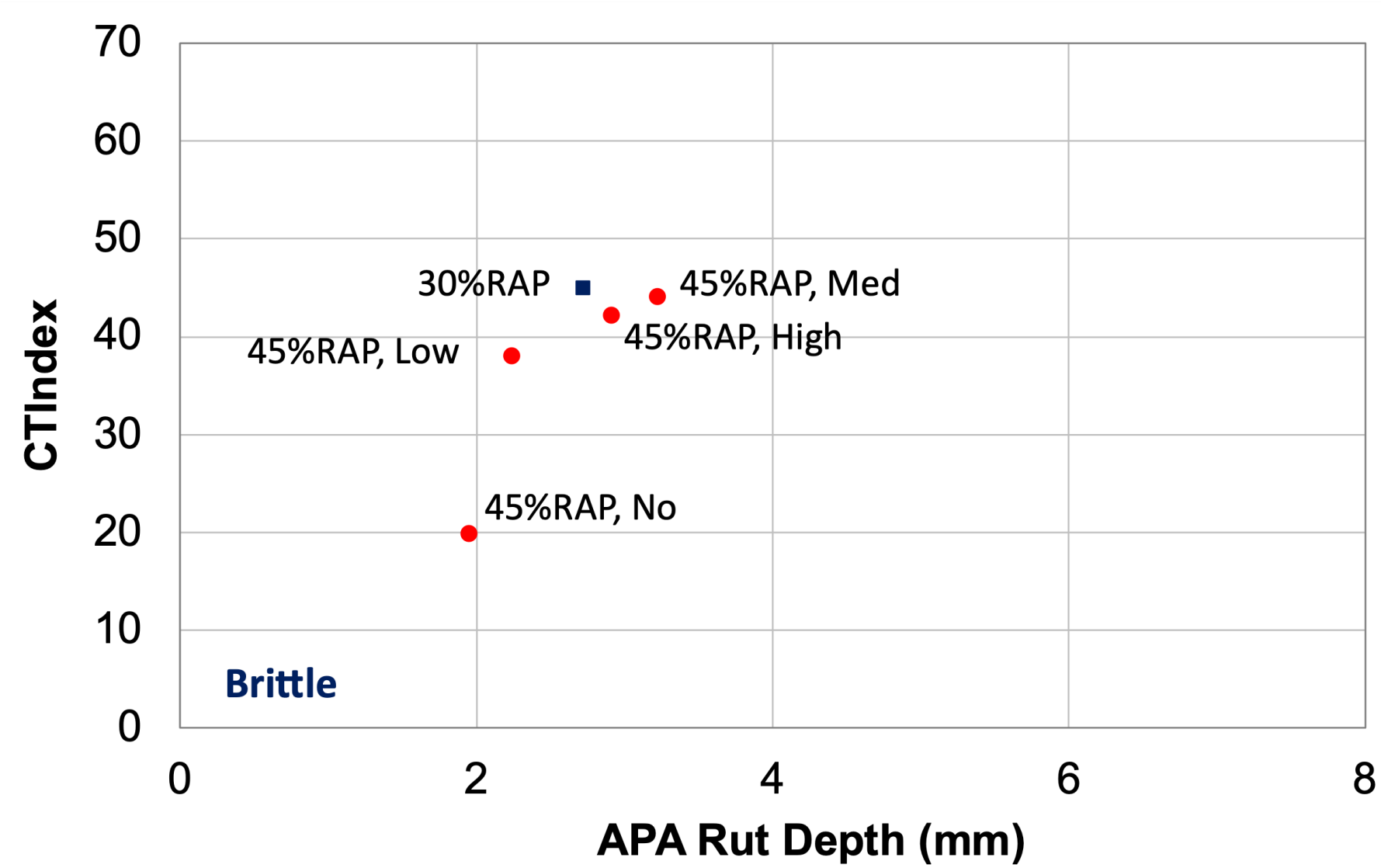
Experimental (N3B): 45% RAP, PG 64-22 and Anova

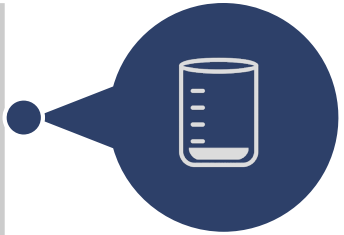
Control (N3A): 30% RAP, PG 64-22

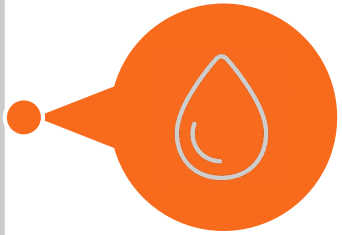

140
120
100
80
60
40
20
0
CTIndex
Balanced
Soft
30%RAP
45%RAP
Brittle
Poor
0
2
4
6
8
10
12
14
16
APA Rut Depth (mm)

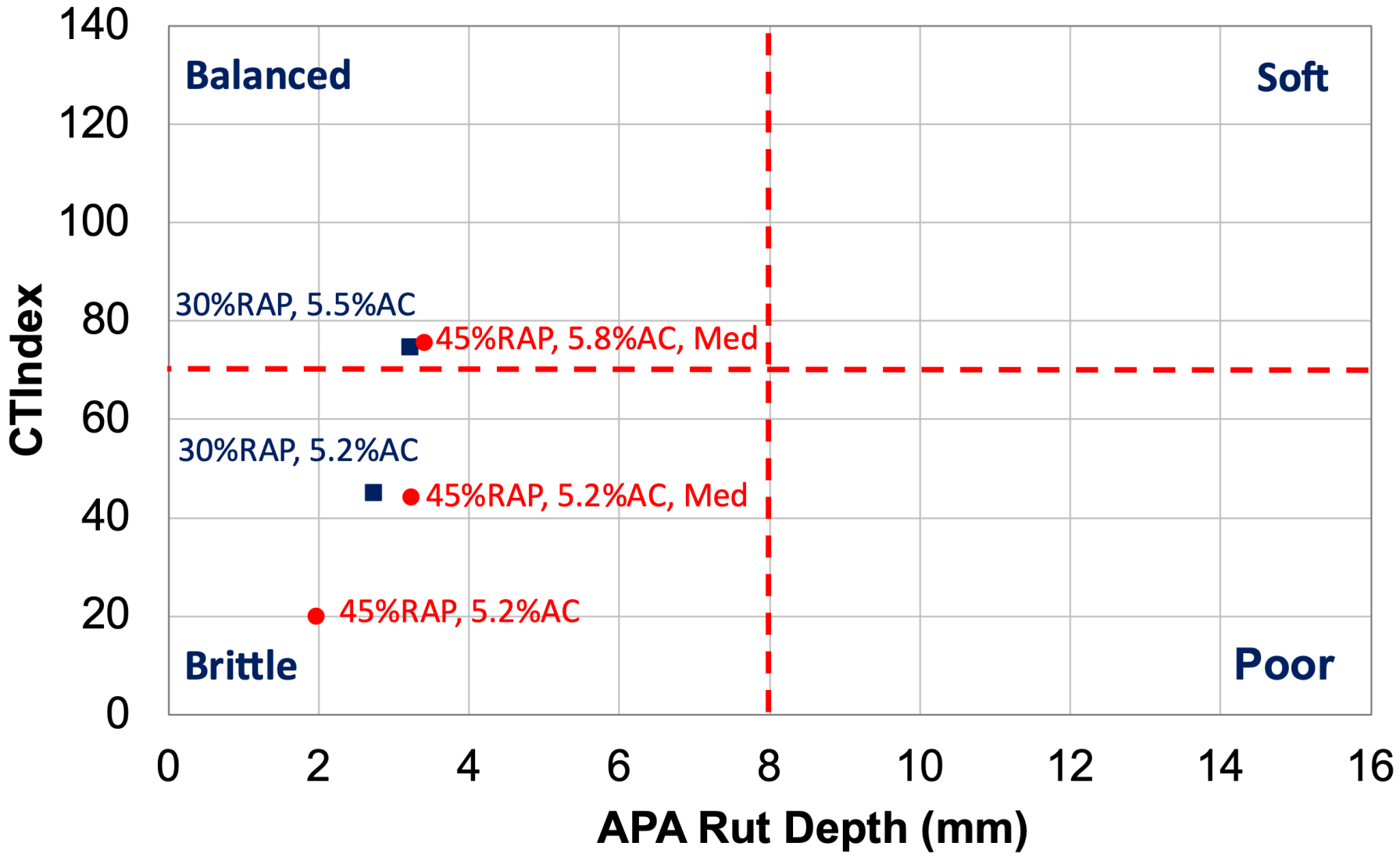


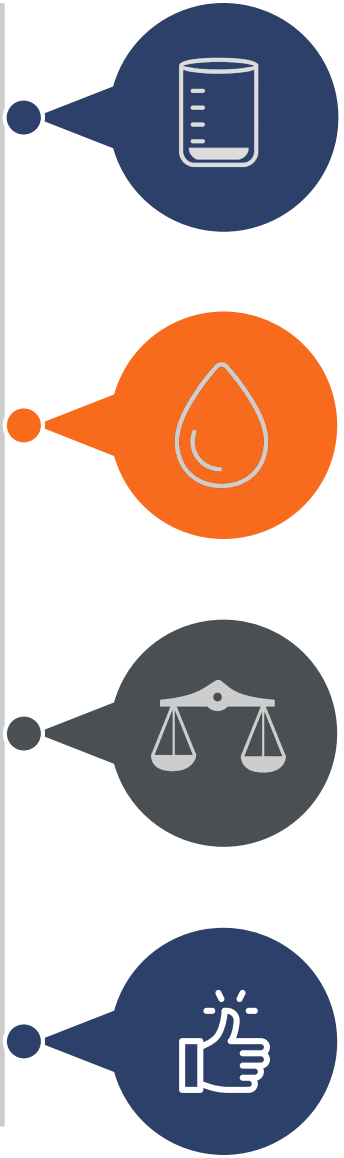



70
60
50
40
30
20
10
0
CTIndex
30%RAP
45%RAP, Med
45%RAP, High
45%RAP, Low
45%RAP, No
Brittle
0
2
4
6
8
APA Rut Depth (mm)

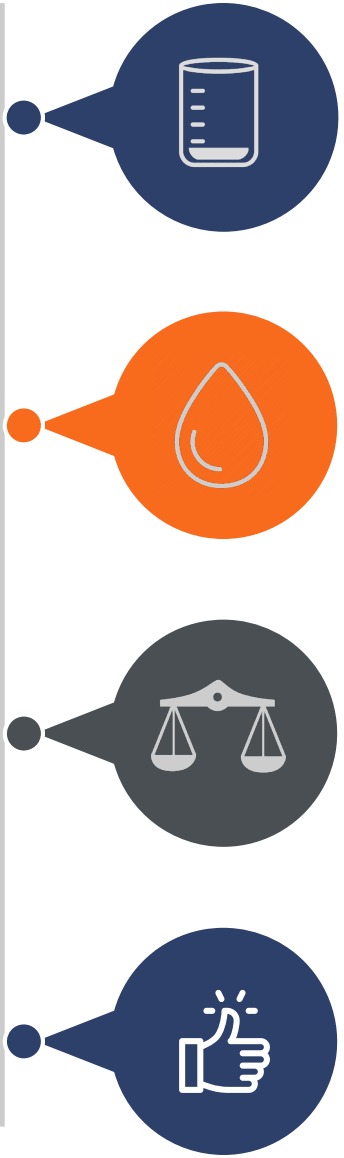





140
120
100
80
60
40
20
0
CTIndex
Balanced
Soft
Brittle
Poor
30%RAP, 5.5%AC
45%RAP, 5.8%AC, Med
30%RAP, 5.2%AC
45%RAP, 5.2%AC, Med
45%RAP, 5.2%AC
0
2
4
6
8
10
12
14
16
APA Rut Depth (mm)



Design Method:	BMD		
Ndes:	50 gyrations		
Binder PG:	64-22		
Mix Properties	30% RAP	45% RAP, Anova	Criteria
% Total AC (Pb):	5.5	5.8	
% Virgin Binder:	4.17	3.59	
% AC from RAP:	1.33	2.21	
RAP Binder Ratio:	24.2	38.1	
APA Rut (mm)	3.2	3.4	Max. 8.0
CTIndex	74.6	75.6	Min. 70
Mass Loss (%)	4.7	2.9	Max. 7.5
Rice Gravity (Gmm):	2.715	2.691	
Design Air Voids (Va):	2.9	2.4	4
VMA*:	15.8	16.2	Min. 16.0
VFA:	82	86	70 - 85
Dust/Binder:	1.0	1.1	0.7 - 1.3
Pbe:	5.21	5.51	
Pba	0.31	0.31	



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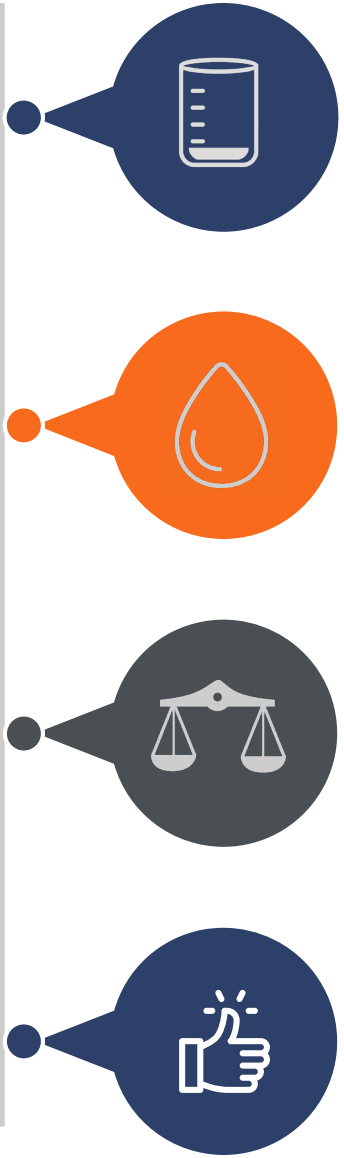

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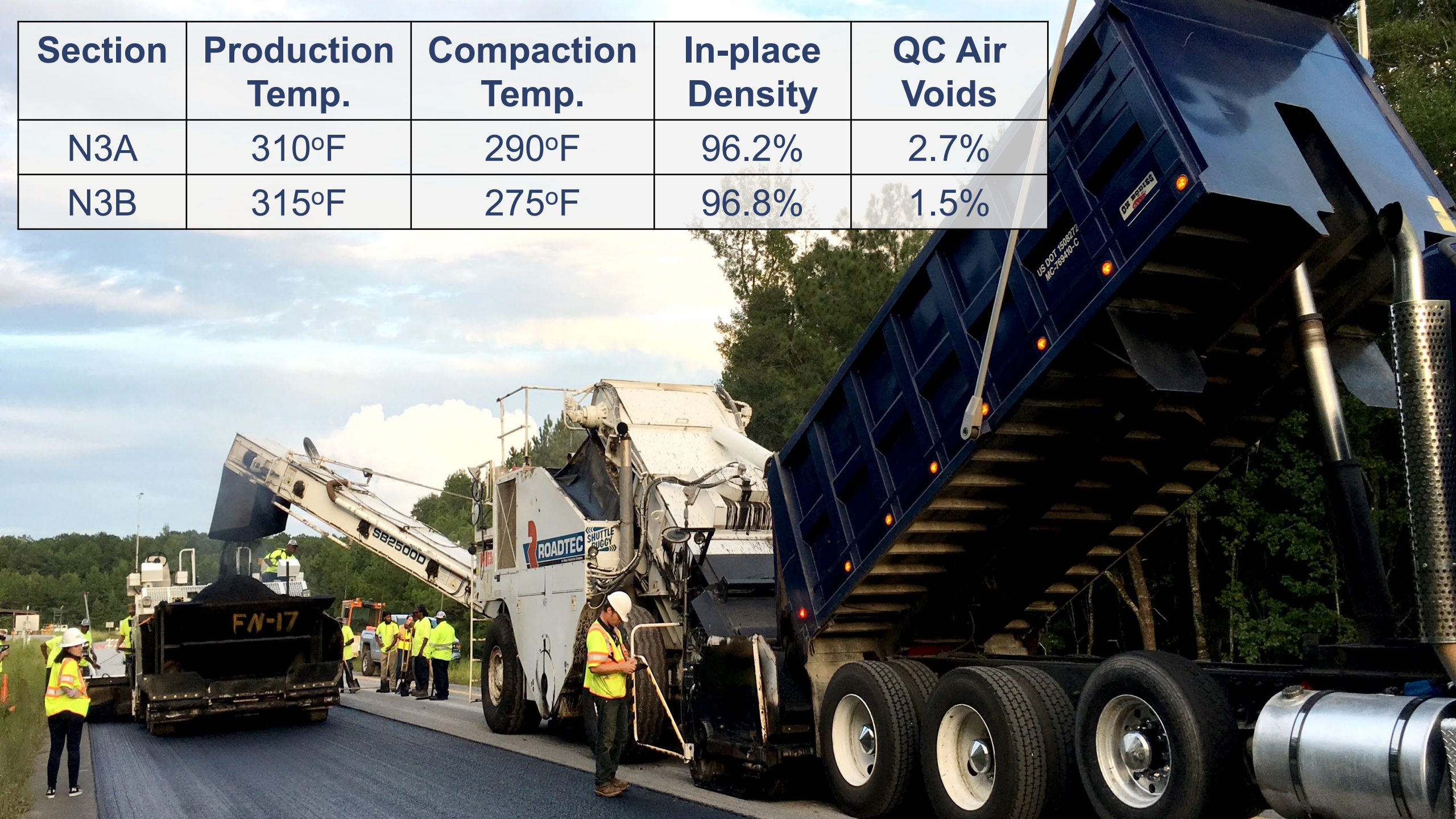
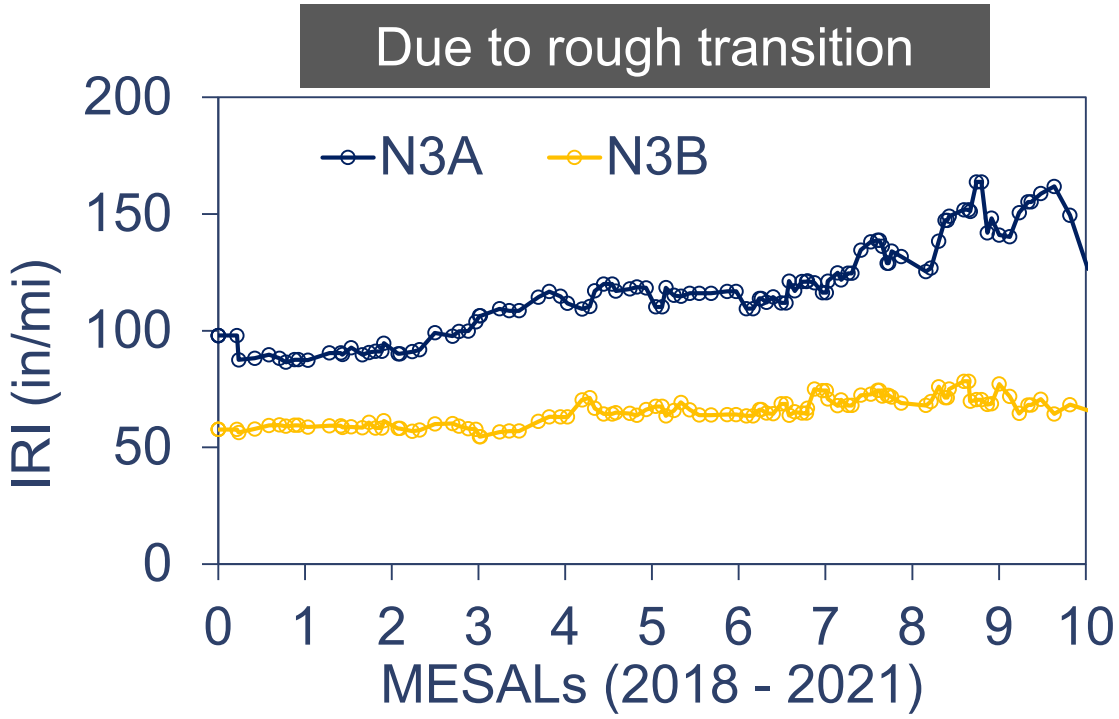
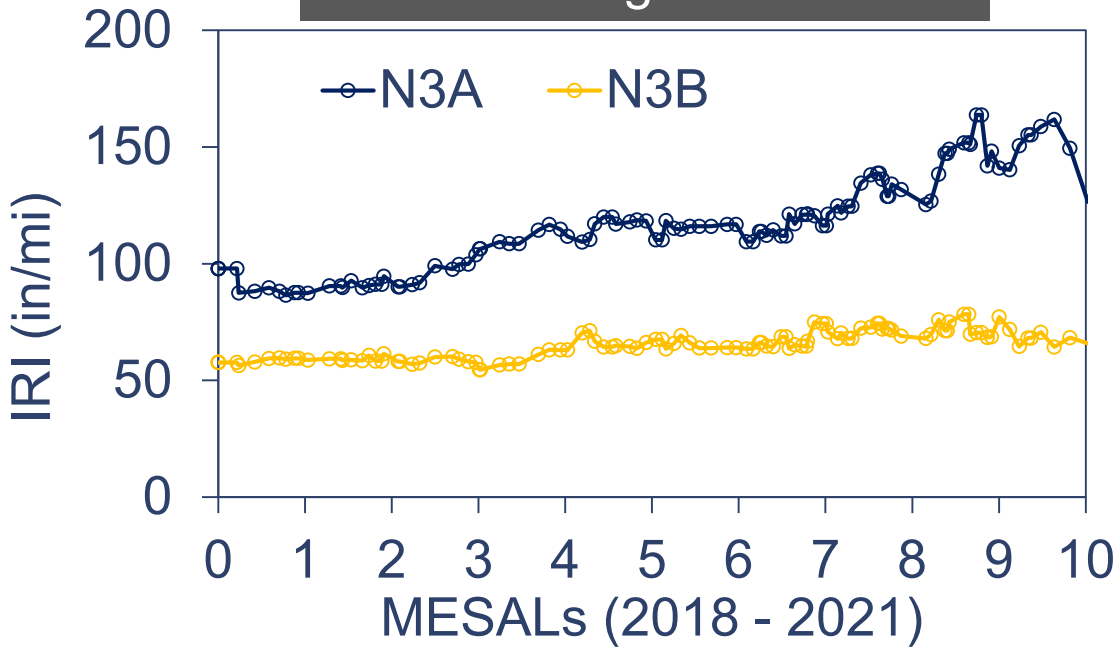
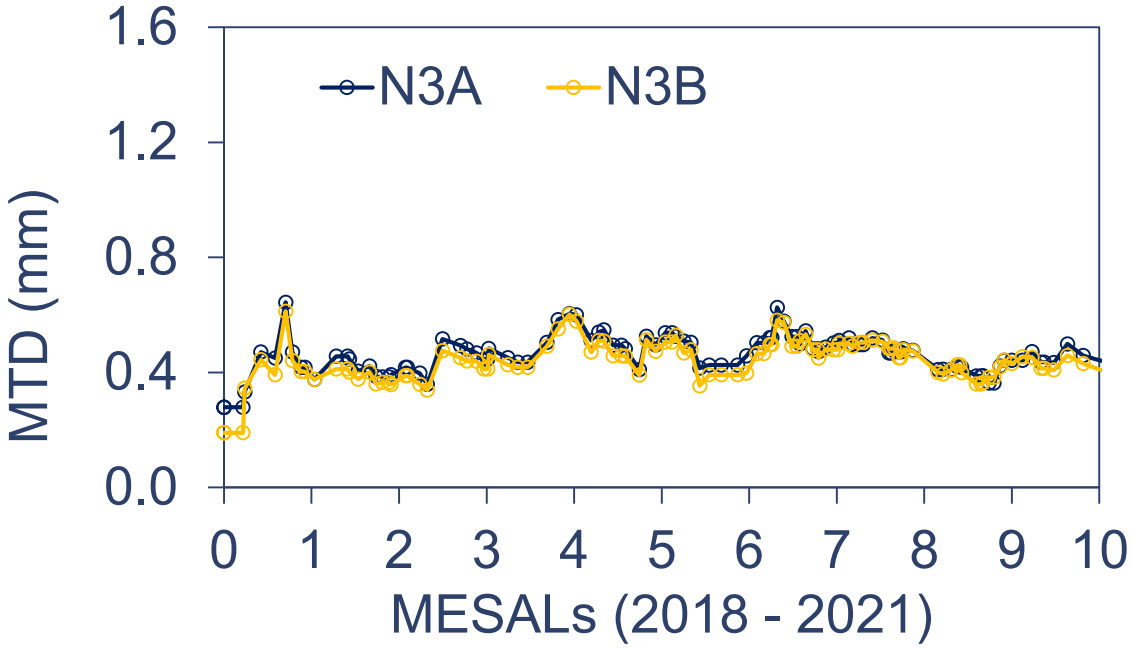
Section	Production Temp.	Compaction Temp.	In-place Density	QC Air Voids
N3A	310°F	290°F	96.2%	2.7%
N3B	315°F	275°F	96.8%	1.5%

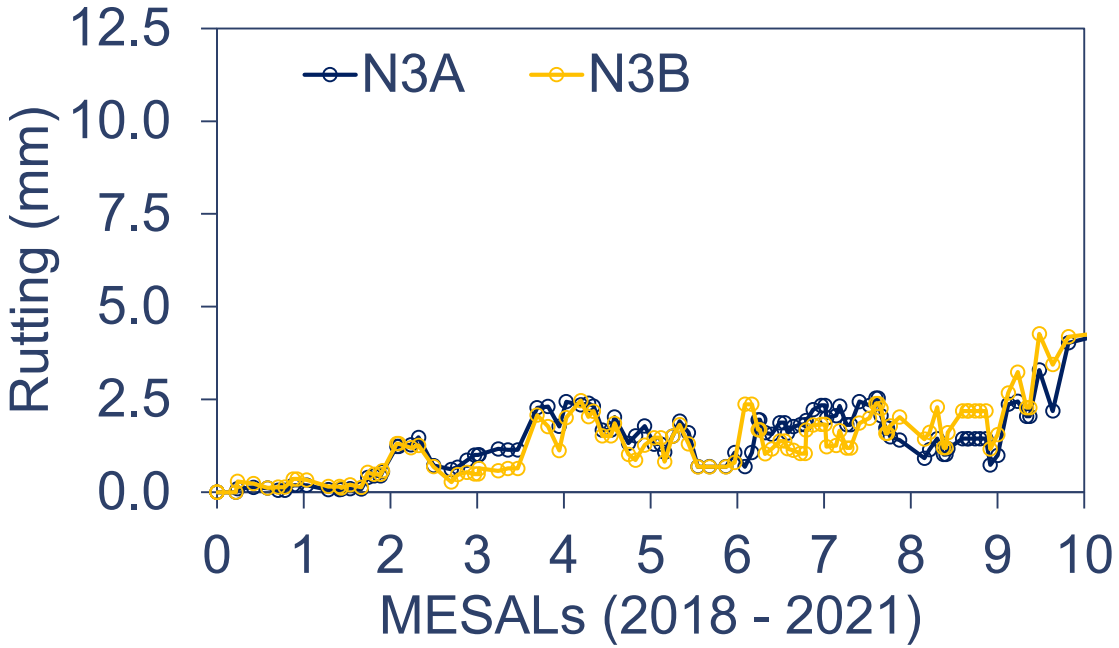



Due to rough transition
200
150
100
50
0
IRI (in/mi)
N3A
N3B
0 1 2 3 4 5 6 7 8 9 10
MESALs (2018 - 2021)

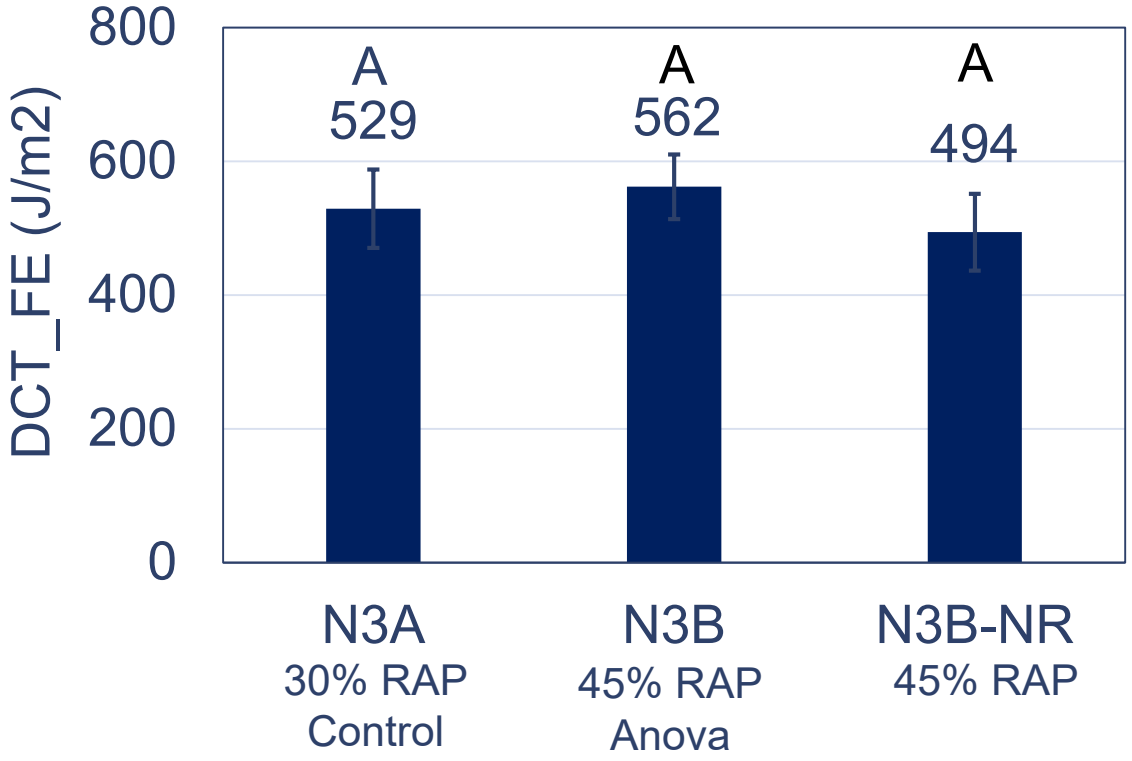
Due to rough transition

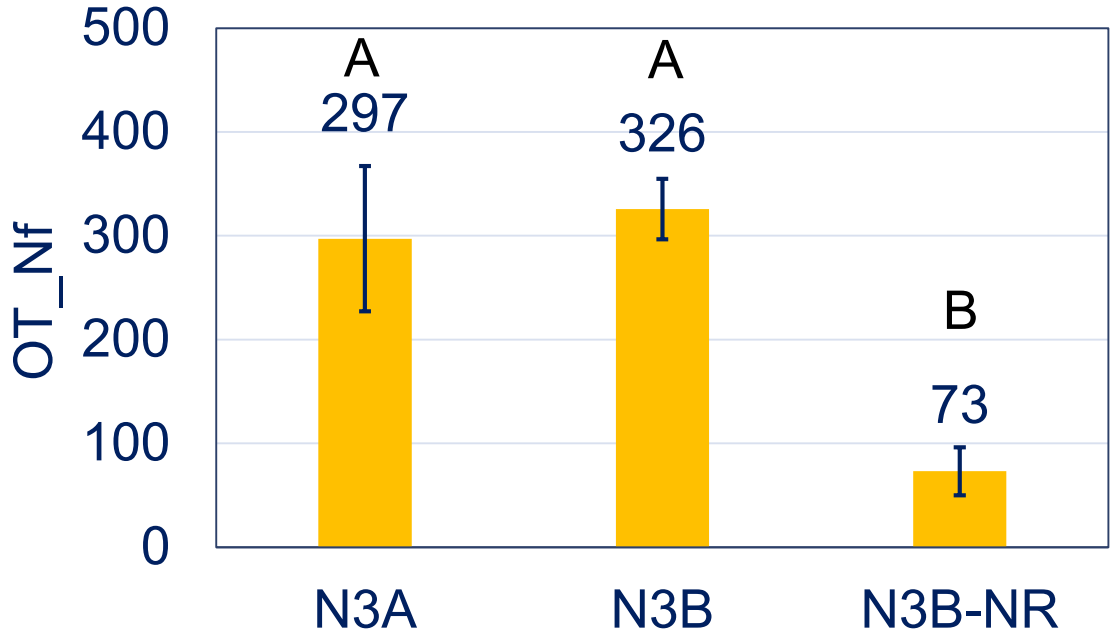


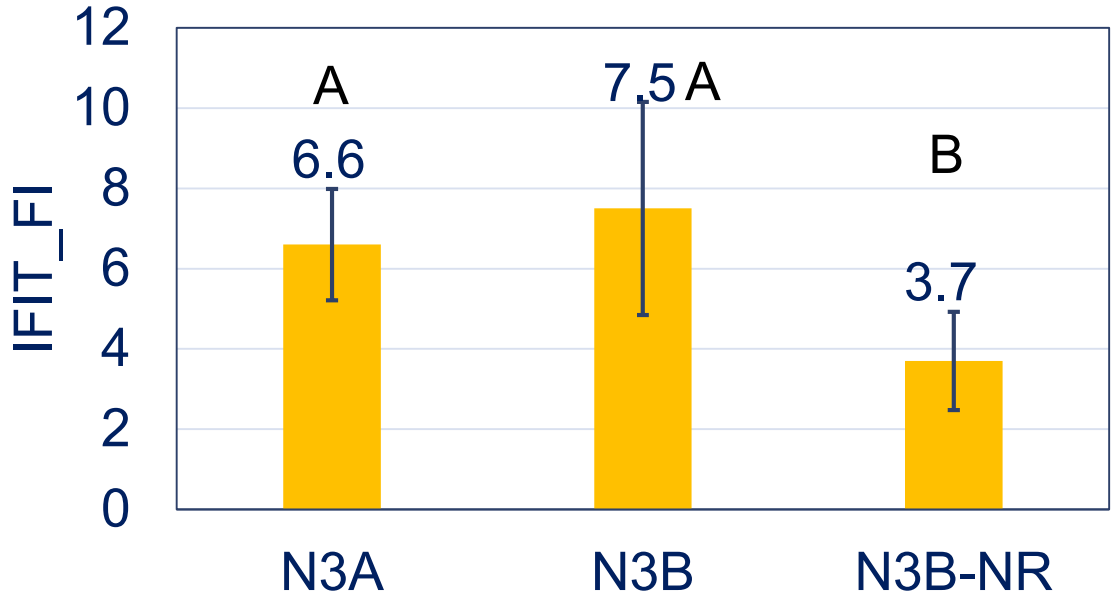


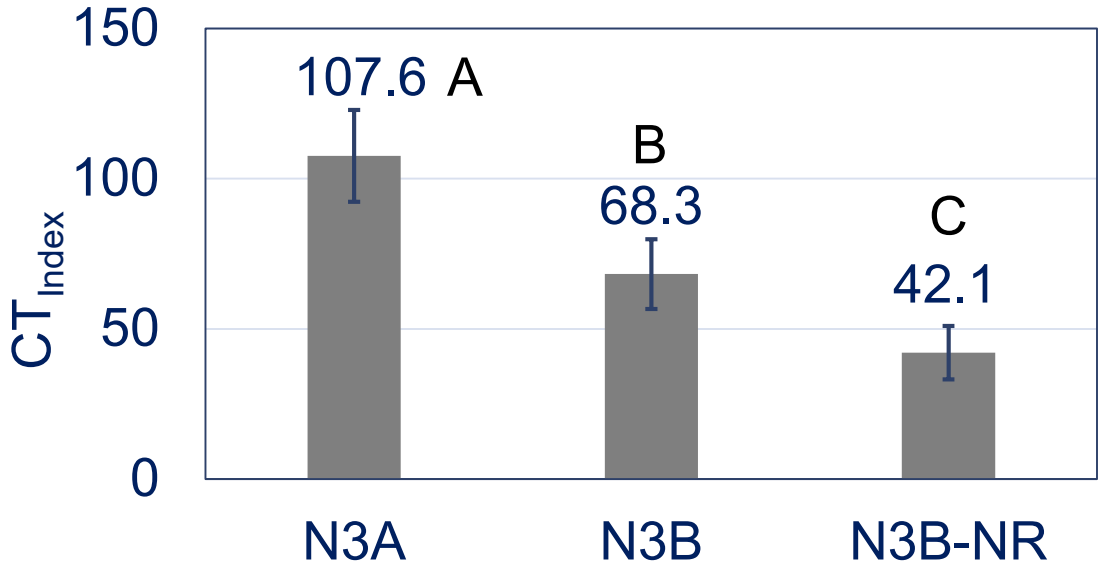


No Cracking


DCT_FE (J/m2)
800
600
400
200
0
A
529
A
562
A
494
N3A
30% RAP
Control
N3B
45% RAP
Anova
N3B-NR
45% RAP


OT_Nf
500
400
300
200
100
0
A
297
A
326
B
73
N3A
N3B
N3B-NR


IFIT_FI
12
10
8
6
4
2
0
A
6.6
7.5 A
B
3.7
N3A
N3B
N3B-NR


CT Index
150
100
50
0
107.6 A
B
68.3
C
42.1
N3A
N3B
N3B-NR

Key Findings

- BMD was used to design both mixes (w/wo rejuvenator)
  - BMD mixes did not meet VMD requirements (e.g, Va)
- Both mixes were compacted to achieve high density (> 96%)
- Both sections show good performance on Test Track
- Cracking tests show different rankings for the mixes
- Both sections will be kept in place for traffic continuation

Questions and Answers

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Simple BMD Implementation for Purchase Order Mix by Alabama Counties

Buzz Powell

SEVENTH RESEARCH CYCLE

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Content

- Background
- Specification development
- Mix design process
- Mix production/placement
- Performance to date
- Takeaways

Background

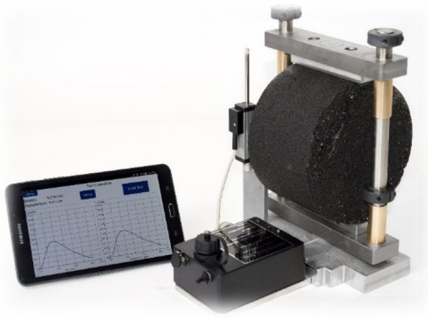
- Poor cracking performance history of some “PO mix”
- Many counties have no inspection presence, documentation
- Initial request for assistance for RAP elimination (like RAS)
- NCAT’s recommendation for “simple BMD” implementation
- ALDOT’s long-term plan to implement a BMD specification
- Shadow projects, trial projects, and annual PO mix.

Specification Development

- ALDOT “424” (Superpave) except N_{des} testing/frequency
- Up to 35% RAP and relaxed aggregate requirements
- Replaced with N_{height} and ASTM D8225 at 77F and 122F
- Replaced “deformation” with “displacement” in 6.1.1
- Unaged production $CT_{Index} \geq 50$ and Hot-IDT ≥ 17 psi
- Test strip verification then BMD daily within first 100 tons
- Testing repeated after 5 hours of shipping and 500 tons
- Retest with failing results, new test strip with 2nd failure.

Mix Design Process

- Used existing Superpave mixes as starting point
  - Low CT Index (Crack), Higher Hot IDT (Rut)
  - Lower RAP mixes performed better
- Incentive to maximize recycle usage (RAP)
- Tried blends more closely resembling Marshall
  - Higher binder content (½ to ¾ percent total AC)
- Longer time to get results (one point per day)
- More attention to detail (times, temps, technology).



Mix Production/Placement

- Also need AC, G_{mm}, Gradation, and V_a (time, ovens)
- RAP binder quality is of utmost importance!
- Differences from design to production (↑CT_{Index}, ↓Hot-IDT)
- Double the time to get results (due to conditioning)
- Oven upgrade (for precise temperature control)
- More workability in the field
- Lower compactive effort to achieve density.

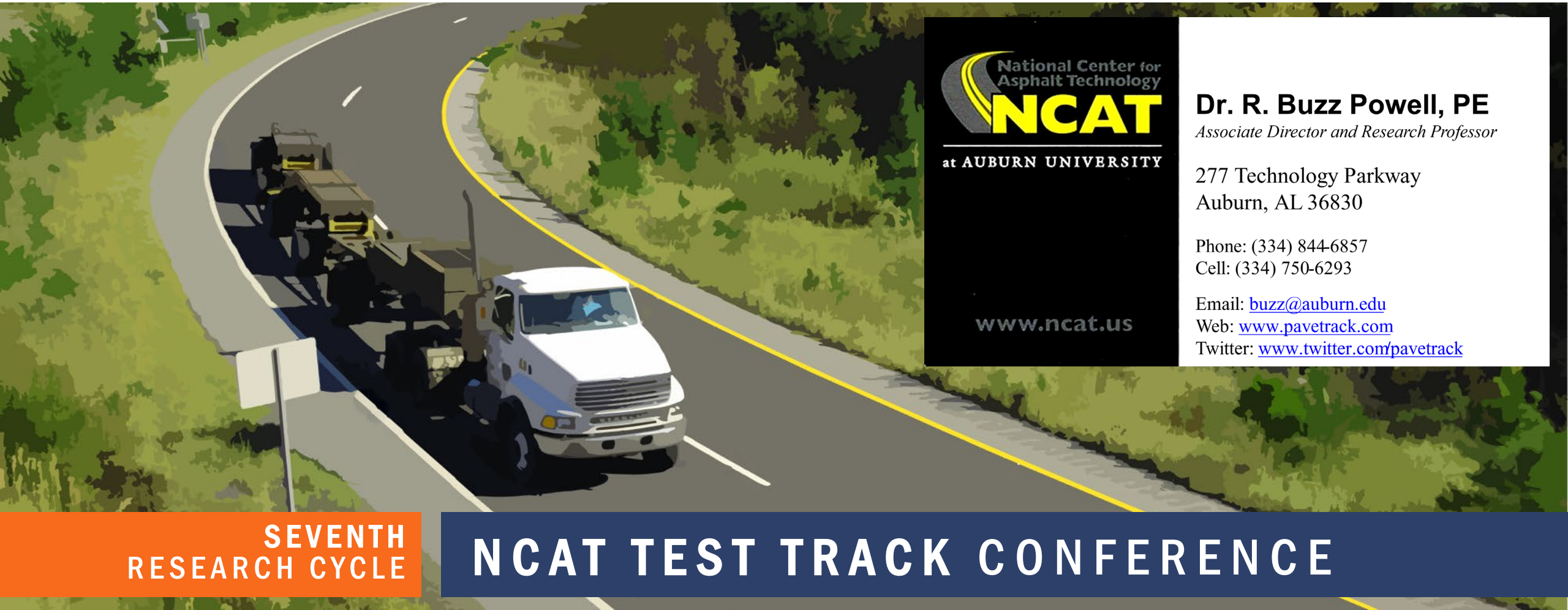
Performance to Date

- Majority of PO mix miles using BMD spec in 2020
- From 20 to 35 percent RAP, ½ to ¾ percent more total AC
- CT_{Index} started high, ran +15 to +30, Hot-IDT ran +10
- Very pleased with both construction and performance
- Plan to use again for the 2021 paving season
- Hope to use for overlays on badly cracked roadways…
- Several other counties have since adopted.

Takeaways

- Potential for higher life cycle value from BMD
- More innovation without volumetric boundaries
- Learning curve from new county specification
- Contractors are enthusiastic about innovation
- Counties are pleased with results (so far), growing
- State of Alabama is collecting shadow BMD data
- Need to establish local thresholds for BMD results.

Questions and Answers



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