A Producer's Perspective of a successful Implementation of Balanced Mix Design.

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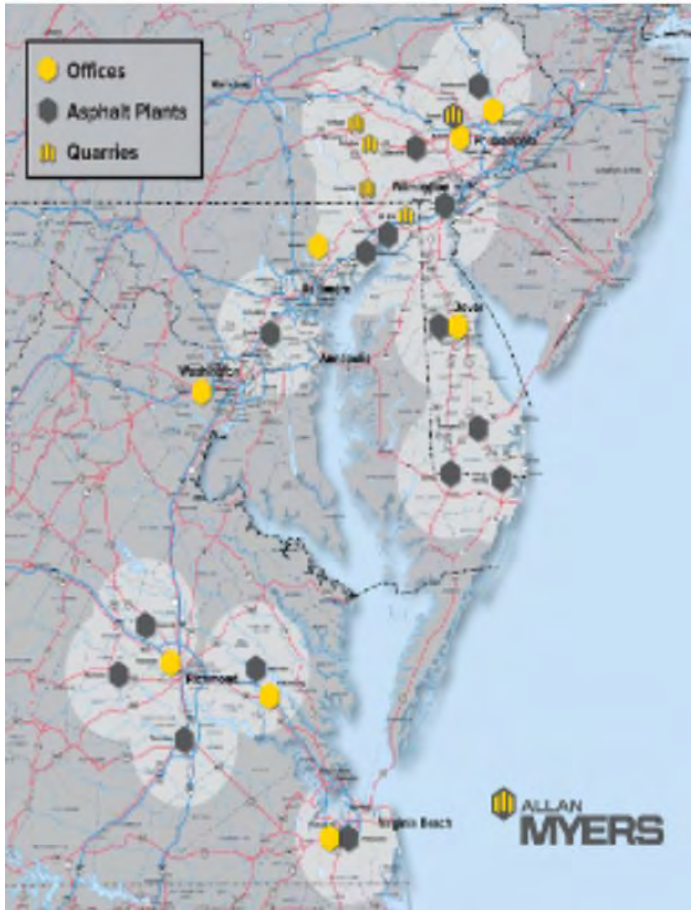
Allan Myers is currently in 4 States with 4 different DOT approaches to BMD implementation.



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2018 VDOT implemented a High RAP BMD option.

- Required testing of production mix:
  - Daily APA Rut Testing
  - 4 cores @ 7% voids less than 8.0 mm rut. Samples ran by VRTC – T340 except 120psi.
  - Cantabro – every 500 tons volumetric cores - less than 7.5% loss.
  - CTindex – every 500 tons 7% voids – At least 70 CT-index.
  - Gradation AC – every 500 tons
  - Volumetrics – every 500 tons – these cores can be used for Cantabro

- No Producers in Virginia volunteered

Allan Myers BMD Prep 2018

- Equipment:
  - Purchased APA Junior from PTI
  - Purchased Smart Jig from Instrotek
  - Serviced and Calibrated Pine Presses
  - Got permission from Quarry QC to use LA Abrasion Machine for Cantabro Testing.
- Plan was to begin establishing baseline values for mixes.
- Concerns:
  - Distance and travel from Virginia, Maryland and Delaware to Paradise Pennsylvania Central Lab.
  - 7% +/- 0.5% Air Voids. Sometimes took multiple tries and material was in the oven for extended periods of time.
  - Keeping CT-Index cores dry while bath at 77F

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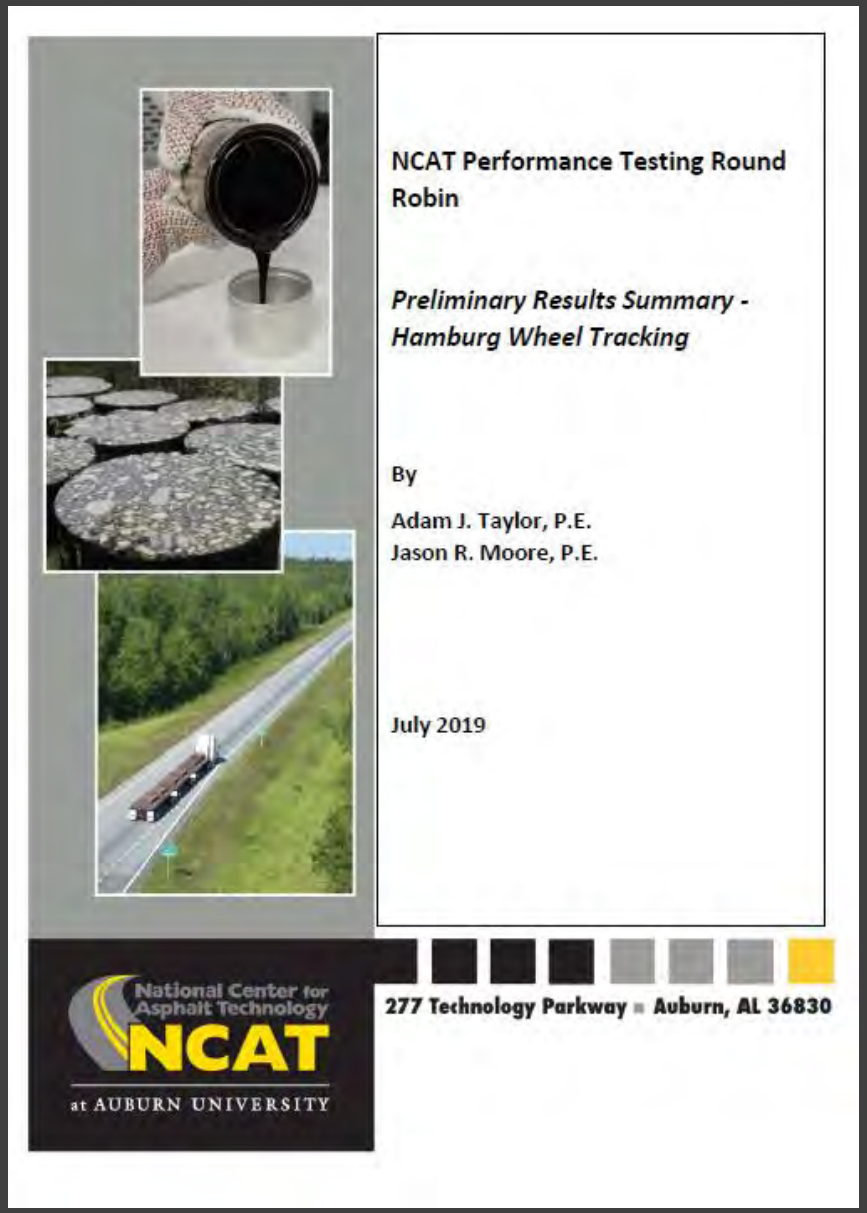
BMD Testing

- APA Junior for APA Rut Test

2019 NCAT Round Robin



At 10,000 passes we reported 2.62 mm of rut.

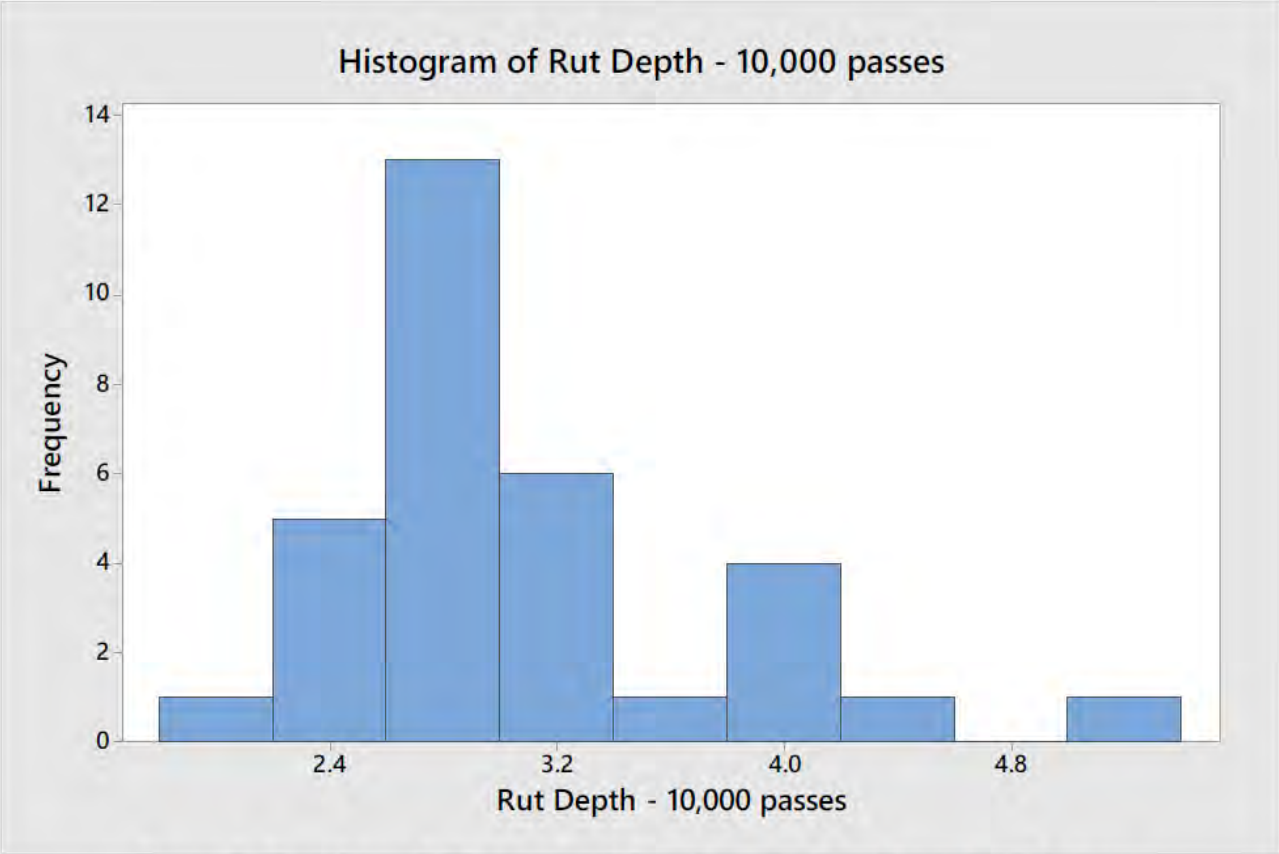


Figure 1: Boxplot and Histogram of Hamburg Rut Depths at 10,000 passes

At 20,000 passes we reported 3.06

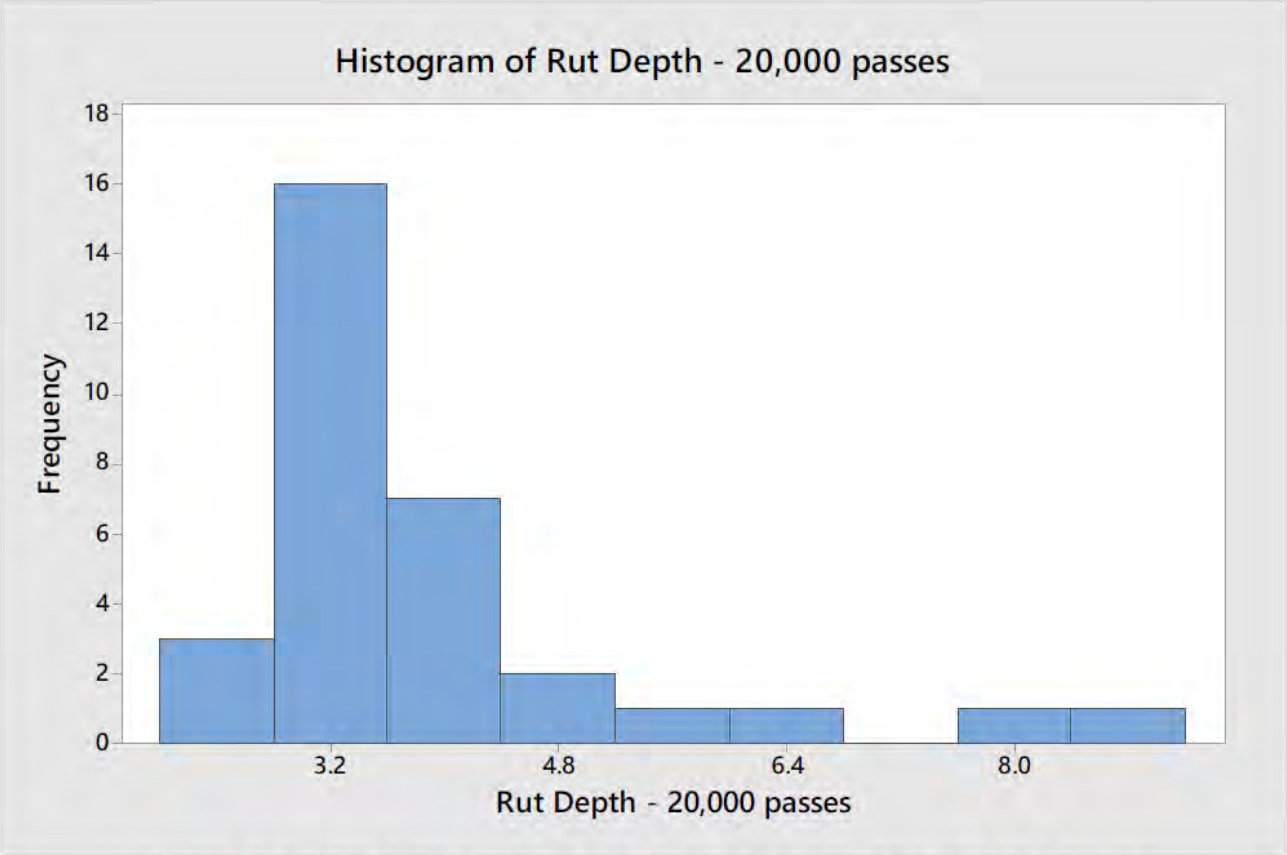


Figure 2: Boxplot and Histogram of Hamburg Rut Depths at 20,000 passes

2020 CT Index Round Robin Ph. 1

VTRC Virginia Transportation Research Council

VDOT

VDOT Round Robin Testing Program for the Indirect Tensile Cracking Test (IDT-CT) at Intermediate Temperature: *Phase I.*

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Summary of Allan Myers results

Summary Data

Table 2. Summary of IDT-CT Parameters for Package 5.

Package ID		Package 5				
Lab Name		Allan Myers Paradise Central			Test Operator	Tim Peffer
Equipment		Instrotek Smart Jig – Pine 850T			Machine Type	Screw-Drive
ID	Data Collection Frequency (Hz)	Average Loading Rate (mm/min)	Reported CT_{index}	Calculated CT_{index}	Observations	
A5	100.0	52.9	38	38	Loading rate outside 50±2 mm/ min	
A59	100.0	52.8	41	41	Loading rate outside 50±2 mm/ min	
A129	100.0	53.1	34	34	Loading rate outside 50±2 mm/ min	
A167	100.0	52.7	50	50	Loading rate outside 50±2 mm/ min	
A221	100.0	52.4	67	67	Loading rate outside 50±2 mm/ min	
Average / Mean			46	46		
Standard Deviation			13.3	13.2		
Coefficient of Variation			28.8	28.8		
B5	100.0	51.9	218	218	No issues	
B63	100.0	51.2	193	192	No issues	
B119	100.0	52.6	107	106	Loading rate outside 50±2 mm/ min	
B176	100.0	51.7	169	169	No issues	
B240	100.0	52.2	127	127	Loading rate outside 50±2 mm/ min	
Average / Mean			163	162		
Standard Deviation			45.9	45.8		
Coefficient of Variation			28.2	28.2		

General Comments:

For test results with loading rate outside the 50±2 mm/min range, the data was only considered in the 2nd analysis "30 data sets per mix type".

Our results were 46 and 163 with COV of 28.8 and 28.2.

A concern with loading rate.

COV over 15 is a concern.

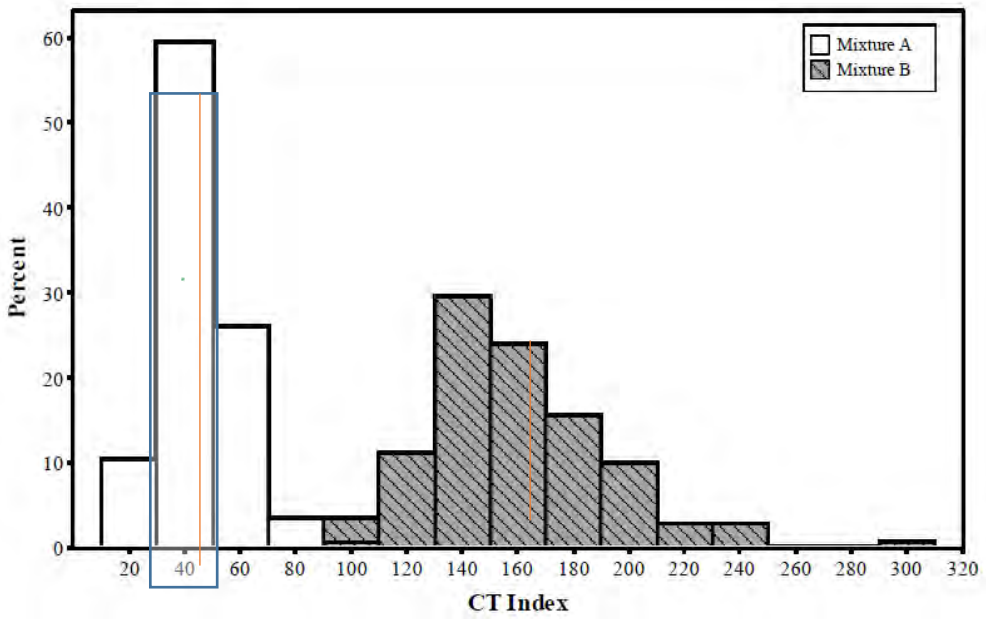

Figure 2. Individual Reported CT_{index} Values for Mixture A and Mixture B.

2021 VDOT BMD Production Testing

Initial Special Provision

2021 Special Provision:

Mix design

Cantabro - design AC and -0.5% AC

APA - design AC and +0.5% AC

CTindex - design AC and ±0.5%, and design AC with long-term aging

Production (4,000T lot)

Property/Test	Frequency (tons)	Total Specimens per Lot
CTindex – QC	1,000	20
Cantabro – QC	1,000	12
CTindex – VDOT QA	2,000	10
Cantabro – VDOT QA	2,000	6
Rutting – VDOT QA	2,000	8

Contractor will make VDOT specimens.

2021 VDOT BMD Pilot at Rockville, Va. Lab

- Design asphalt content stayed the same
- Removed natural sand in order to meet APA Rut.
- Adjusted gradation accordingly
- RAP stayed at 30%. The maximum allowed for the mix spec.
- 2 Lab Technician working exclusively on the BMD testing requirements. A 3rd. Lab Tech worked a second shift to complete Cantabro and CT-Index testing
- Cantabro results were 2% to 5%. Well under the 7.5% maximum.
- CT-Index results were all over 100 but COV's were often over 15%.
- No APA Rut results from VDOT yet.
- Air Voids started at over 5% but were tuned in to 3-4% by end of the project.
- Full incentive pay for AC content = At target and less than .15 StDev

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VDOT Special Provision

Refine Special Provision

2022 Pilot Projects

Testing Frequency (4,000T lot)

Property/Test	Frequency (tons)	Total Specimens per Lot
CTindex – QC	2,000	10
Cantabro – QC	2,000	6
CTindex – VDOT QA	4,000	5
Cantabro – VDOT QA	4,000	3
Rutting – VDOT QA	Once per mix	4 per mix

Testing halved from 2021

Contractor will make VDOT specimens.
Report results w/in 1 week (recommended 48hrs)

No pay adjustment for performance tests
- If failure, stop production and make corrective actions
- Acceptance ranges for volumetrics/gradation follow section 211
- BMD is eligible for Std. Deviation Bonus (and asphalt price adjustment)

2022 VDOT BMD Pilot at Leesburg, Va. Lab

- Mix Design Modifications:
  - Design asphalt content increased 0.1 to 0.2% to increase CT-Index
  - Removed natural sand to meet CT-Index and Cantabro.
  - Adjusted gradation accordingly.
  - RAP stayed at 30%. The maximum allowed for the mix spec.
- Staffing:
  - 2 Lab Technicians working exclusively on the BMD testing. We did not require a 3rd with reduced requirements from 2021
- Lab Test Results:
  - Cantabro results on 12.5mm were higher, up 6%
  - CT-Index for 12.5mm were lower but still over 100. COV on 5 sample sets were almost always over 15%.
  - No APA Rut results yet from VDOT
  - Air voids all within spec. Lessons learned from 2021
- Full Incentive Pay for AC content

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VDOT BMD Production Criteria (2024)

Distress	Test	Limit
Cracking	IDT-CT (reheat)	70 (min)
	IDT-CT (non-reheat)	95 (min)
Rutting	APA rut test	8mm (max)
	IDT-HT	Report
Durability	Cantabro	7.5% (max)
Moisture	Tensile Strength Ratio	80% (min)

VDOT Virginia Department of Transportation

PennDOT Pilot Projects

- CT-Index as low as the 80’s
- Hamburg Rutting approaching 7
- Lab Mix Only
- Requires additional design time
- 2023 Design submittal season so far has seen results in line with prior results.
- No significant changes to existing designs. – SO FAR

Test	AASHTO	DelDOT	Maryland SHA	PennDOT	VDOT
APA Rut	T340	Yes	Design Only		Yes
Hamburg	T324			Design Only	
CT-Index		Yes	Yes	Design Only	Yes
HT-IDT	AMRL 8225		Yes		Yes
Cantabro	TP108				Yes
Texas Overlay		Yes			

Current tests in our footprint

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Lessons Learned

- Hamburg Testing:
  - make sure side spacers are fully locked to the bottom of the spacer plate
  - Allow bottom reservoir to rinse often after test completion. Especially if breakdown occurred.
  - Calibration and maintenance of APA Jr. is important.
- CT-Index:
  - make sure LVDT is slightly compressed at the start of testing 2-5mm
  - Reheating material will typically lower CT-Index results???
- Cantabro:
  - Results are impacted by temperature; Test area should be 75-80F

Thanks!

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