

Virginia's Progress in Implementing Balanced Mix Design

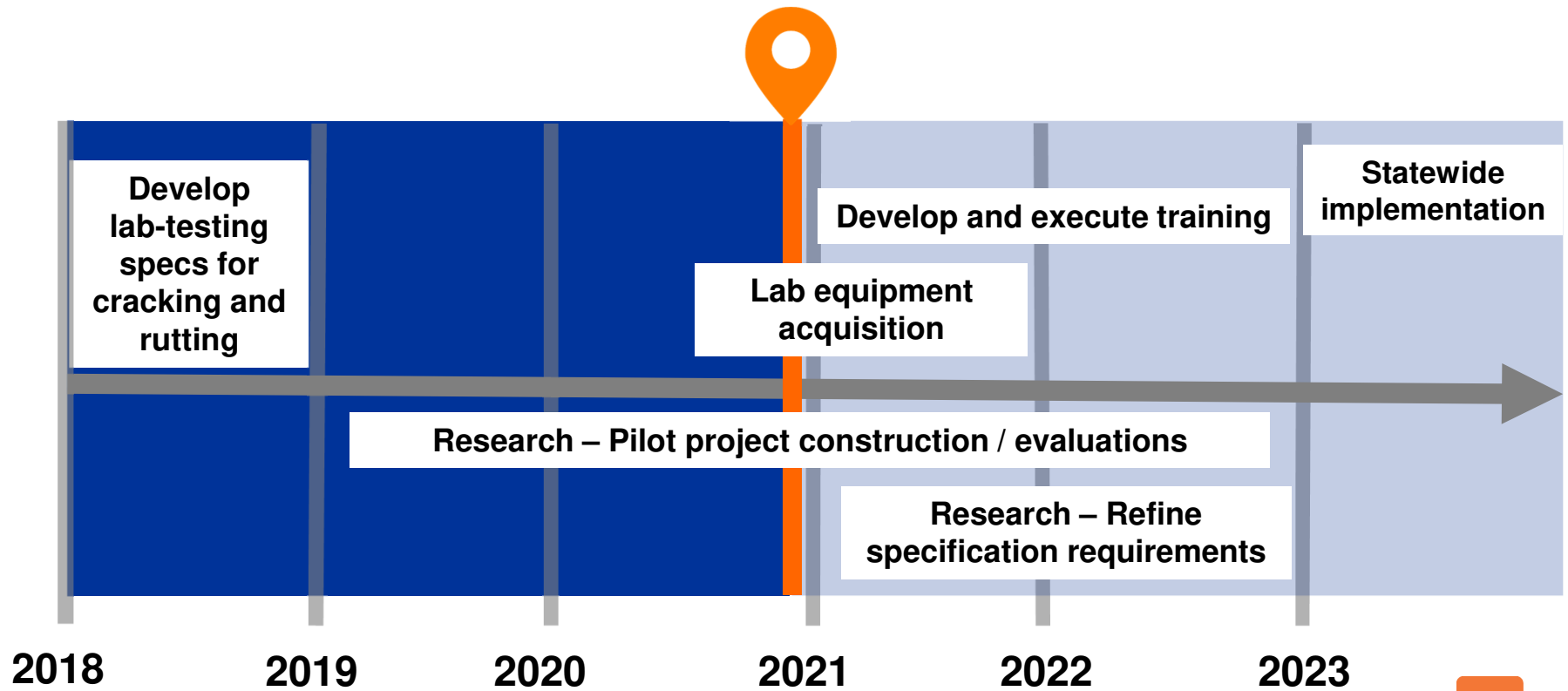
Stacey Diefenderfer, Ph.D., P.E.
NEAUPG Meeting
October 28, 2020

Acknowledgements

- Ilker Boz, Jhony Habbouche, VTRC
- VTRC Lab Staff
- VDOT Materials Division
- VDOT Districts
 - Fredericksburg, Lynchburg, Northern Virginia, Richmond, Salem
- Virginia Asphalt Association
- Industry partners
 - Superior Paving, Boxley Materials, Colony Construction, Lee Hy Paving



Virginia's Approach to Implementation



Departmental & Industry Collaboration

- BMD Advisory Group
 - Executive level stakeholders
- BMD Technical Advisory Committee
 - Research, operations, industry, FHWA
 - Technical guidance and feedback
- Workshops, training, round robin efforts



Research In Progress

- Performance Mix Design – Phase I
- Balanced Mix Design Field Trials
- Impact of Production Variability on BMD in VA
- Feasibility of Using Monotonic Loading-Based Tests to Evaluate Rutting Performance of Asphalt Mixtures
- IDT Cracking Test Round Robin
- Evaluating Recycling Agents' Acceptance for Virginia: Test Protocols and Performance-Based Threshold Criteria
- VDOT Heavy Vehicle Simulator



Initial BMD Trials: 2019-2020

- Location
 - ~2000T per mix
 - Uniform traffic, pavement condition/structure
- JMF submittal and approval
 - High RAP mixes (>30% RAP)
 - Dense-graded surface mixes (\leq 30% RAP)
- Production
 - Volumetric and density acceptance
 - Modified sampling rate
 - Performance test pills provided by contractor
 - Loose mix sampling
 - Coring



Performance Test Criteria

Test	Test Temp.	Specimens	Criteria
APA rutting (AASHTO T340)	64°C	4 specimens 7.0 ± 0.5% voids	Rutting ≤ 8.0mm
Cantabro (AASHTO TP108)	25°C	3 specimens Report air voids	Mass loss ≤ 7.5%
CT _{index} (ASTM D8225)	25°C	5 specimens 7.0 ± 0.5% voids	CT _{index} ≥ 70

Lab-produced mix: loose mix shall be aged at the design compaction temperature prior to compacting

- APA and Cantabro - 2 hours
- CT_{index} - 4 hours



Balanced Mix Design Approval

- Design submitted to District for approval
- Performance testing
 - 5 CT_{index} pills – standard 4hr short term aging
 - **5 CT_{index} pills – additional 8hrs @135°C long term aging**
 - 3 Cantabro pills
 - 4 APA rut pills
- Beginning in 2020:
 - Cantabro mass loss: at design AC and design AC–0.5%
 - CT_{index} : at design AC and design AC±0.5%
 - APA rut depth: at design AC and design AC+0.5%
 - Aged CT_{index} : at design AC



CT_{index} Long Term Aging

- Need to consider aged performance of mixes
- Rejuvenator/additive performance can change drastically after aging
- Long-Term Oven Aging (LTOA)
 - Apply short term aging (4hrs at compaction temp for lab-made mix)
 - Then, apply LTOA:
 - Spread loose mix in shallow pans
 - Age in forced draft oven 8hrs @ 135°C (275°F)
 - Heat to compaction temperature and compact



Trial Production Sampling/Testing

Producer Testing & Pills

Tonnage	Gradation / AC	Volumetrics	APA pills (7±0.5% AV)	Cantabro pills	CT _{index} pills (7±0.5% AV)
1-500	X	X	4*	3	5
500-1000	X	X	4*	6**	10**
1000-1500	X	X	4*	3	5
1500-2000	X	X	4*	6**	10**

* APA pills will be tested by VTRC.

** Half of pills are for producer testing, half are to be turned over to VDOT/VTRC for testing.



Trial Production Sampling/Testing

- VDOT/VTRC Testing

Tonnage	Gradation / AC	Volumetrics	APA pills (7±0.5% AV)	Cantabro pills	CT _{index} pills (7±0.5% AV)
1-500	X		4*		
500-1000	X	X	4*	3**	5**
1000-1500	X		4*		
1500-2000	X	X	4*	3**	5**

* APA pills will be made by Contractor and tested by VTRC

** Cantabro & CT_{index} pills will be made by Contractor and tested by VTRC/VDOT



Trial Production Sampling/Testing

- VTRC Sampling / Testing

Tonnage	Boxes	Cores
1-500	6	10*
500-1000	12	
1000-1500	6	10*
1500-2000	6	

* Maximum 10 cores per day.

- Once per mix
 - 2 quarts of binder
- Every 500T loose mix sample for:
 - Gradation/AC
 - APA rut test
 - CT_{index}
 - Volumetrics
 - Cantabro
- Extra sampling at 500-1000T for additional testing - PavementME

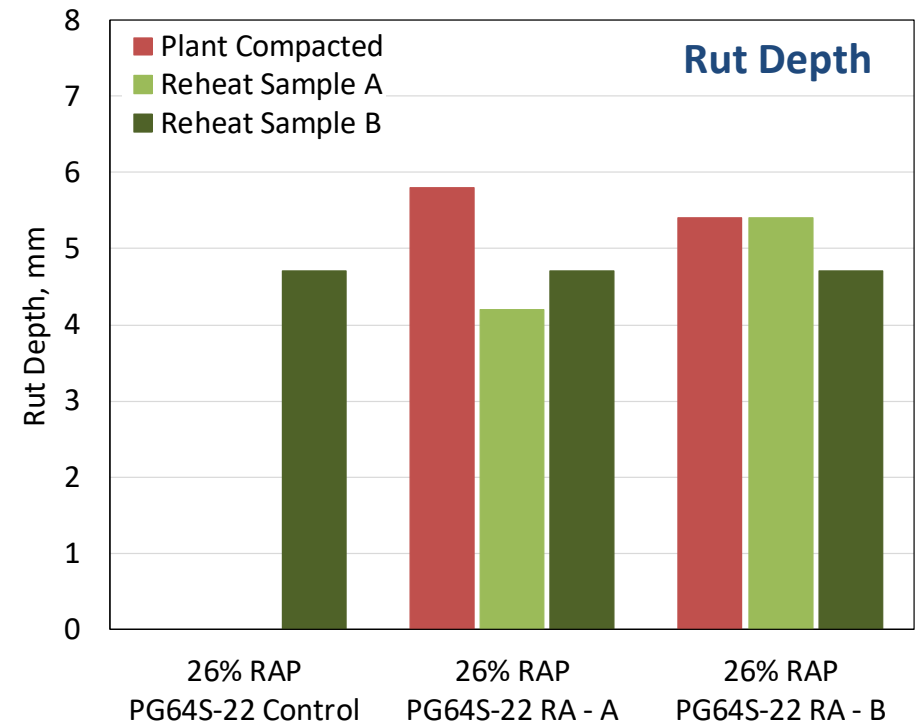
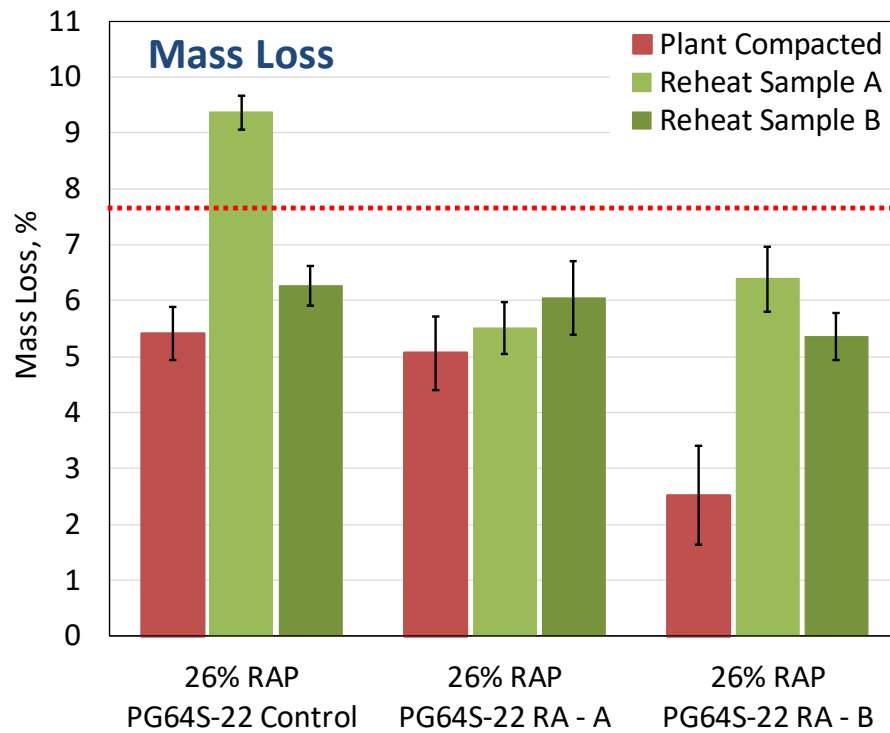


2019-2020 Trials

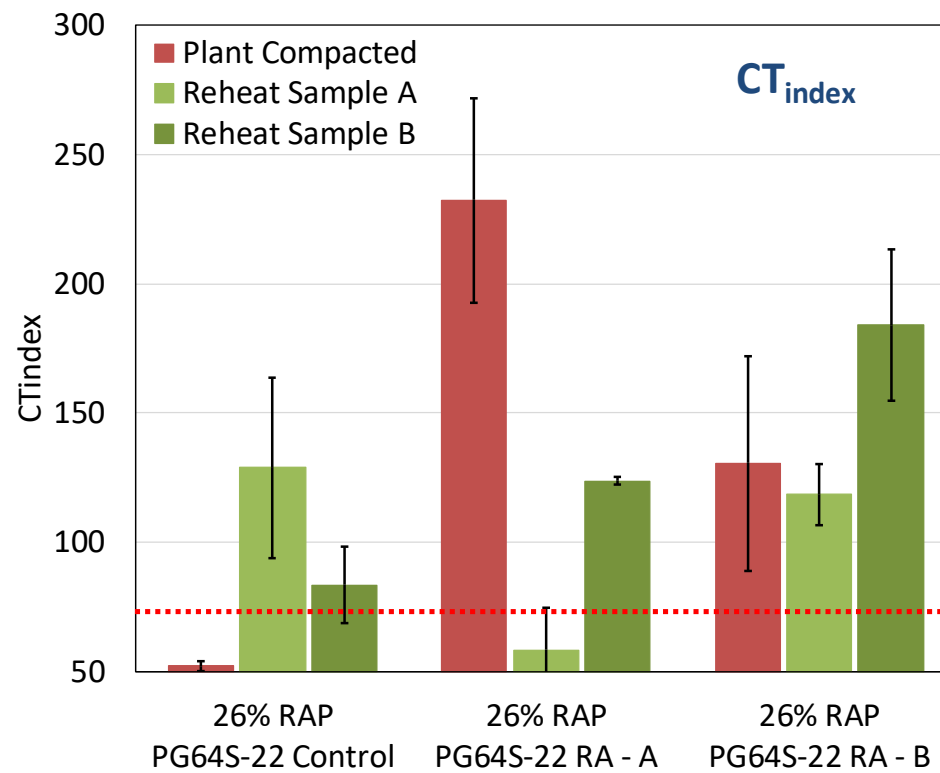
- Contractor 1
 - Plant 1: 40% RAP + PG 58-28 / 40% RAP + PG 64S-22 + RA 1 (2019)
 - Plant 2: 40% RAP + PG 58-28 / 40% RAP + PG 64S-22 + RA 2 (2020)
 - Plant 3: 40% RAP + PG 58-28 / 40% RAP + PG 64S-22 + RA 3 (2020)
- Contractor 2 (2019)
 - 26% RAP + PG 64S-22 + RA 1
 - 26% RAP + PG 64S-22 + RA 2
- Contractor 3 (2020)
 - Plant 1: 35% RAP + PG 58-28 + RA 4
 - Plant 1: 35% RAP + PG 58-28 + softener + fibers
 - Plant 2: 40% RAP + PG 58-28
- Contractor 4 (2020)
 - 35% RAP + PG 58-28



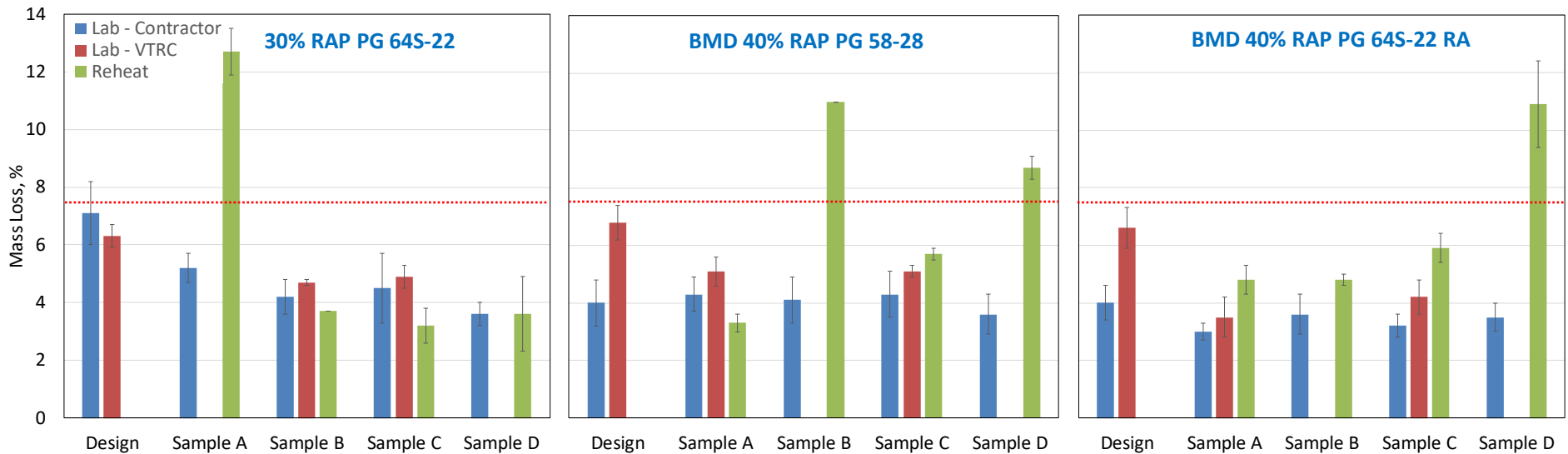
BMD – Mass Loss and Rut Depth



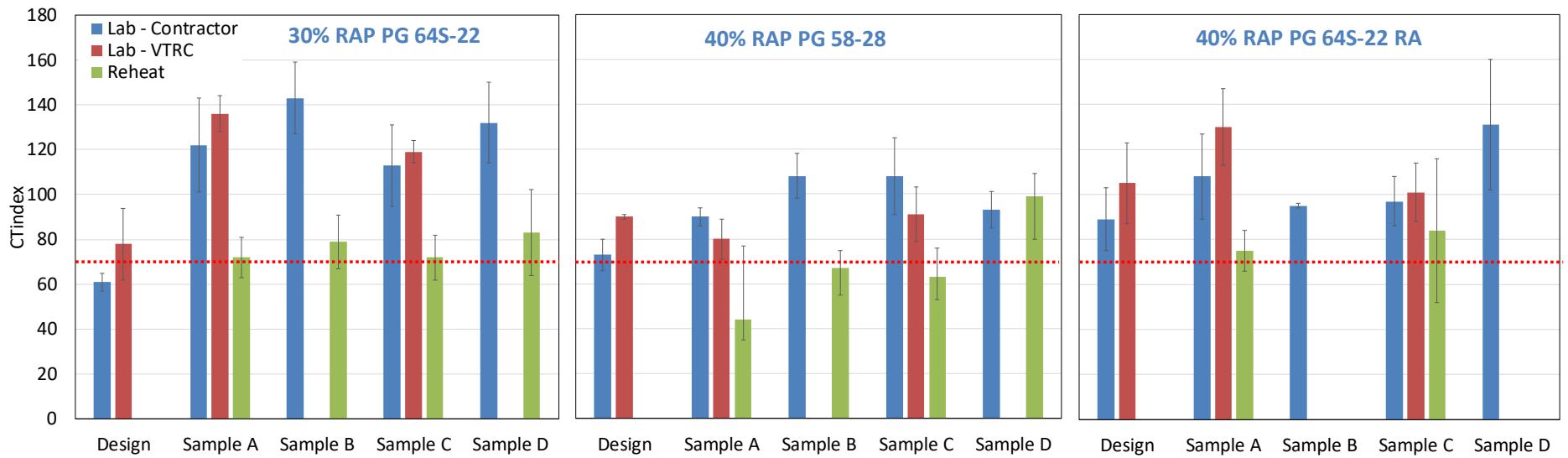
BMD - CT_{index}



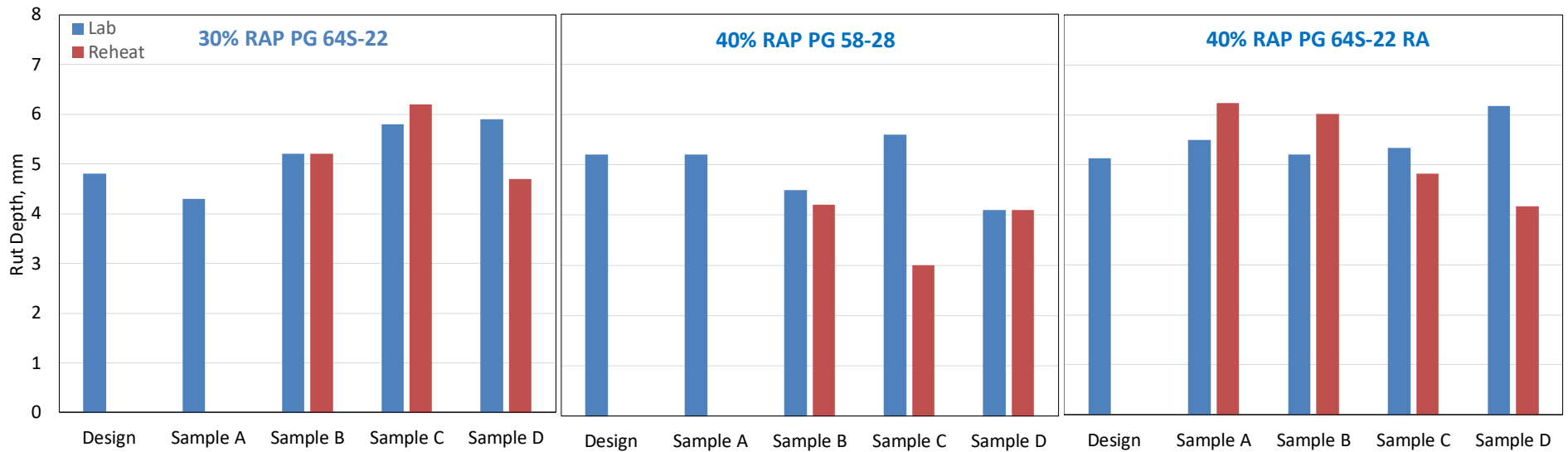
High RAP BMD - Cantabro Mass Loss



High RAP BMD - CT_{index}



High RAP BMD – Rut Depth



Takeaways from 2019

- Important details to consider
 - Specimen preparation
 - Test variability
 - Reheating impacts
 - Differences between design and production
- Any factors that contribute to variability are magnified in performance testing
- Source material differences can be significant



VDOT Heavy Vehicle Simulator

- BMD Experiment
 - Control 30% RAP PG 64S-22
 - BMD 30% RAP PG 64S-22
 - BMD 45% RAP PG 64S-22
 - BMD 45% RAP PG 64S-22 + recycling agent
 - BMD 45% RAP PG 58-28
 - BMD 60% RAP PG 58-28 + recycling agent
- Evaluating rutting and cracking



2021 BMD Trials

- Oriented toward standard production
- Include BMD in contracts
- Still research focused:
 - Appropriate cracking, rutting, and Cantabro criteria?
 - Accounting for heating/re-heating of samples
 - Developing aging protocols – predicting performance
- Incorporate district staff into testing efforts
 - Support research and gain experience



2021 BMD Trials

- Assess BMD under typical production conditions
- BMD mixes in certain contracts
 - 2 contracts with stand-alone BMD projects (~13,500T)
 - 8 contracts in 4 Districts with BMD routes (~58,000T)
- BMD mixes are separate pay items
- Acceptance still per current processes using volumetrics and density



2021 Sampling and Testing

Property/Test	Frequency (2,000T / lot)	Frequency (4,000T / lot)	No. of Specimens (per lot)
CT _{index} – Contractor QC	500 T	1,000 T	20
Cantabro – Contractor QC	500 T	1,000 T	12
CT _{index} – VDOT QA	1,000 T	2,000 T	10
Cantabro – VDOT QA	1,000 T	2,000 T	6
Rutting – VDOT QA	500 T	2,000 T	8
Loose mix sample – VTRC	500 T	2,000 T	12 boxes

- VDOT QA specimens are fabricated by the Contractor and submitted to the Department



Moving Forward

- Develop training and certification process
- Additional trials in 2022
 - More industry participation
- Address aging
- Define implementation for 2023
 - What mix designations/traffic levels will be addressed
 - Will acceptance and pay be based on performance test results





We bring innovation to transportation.

Thank you!

For more information:
stacey.diefenderfer@vdot.virginia.gov

