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Performance Testing for Improved Asphalt Mix Quality

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Quality (noun)

qual·i·ty \ ˈkwä-lə-tē \

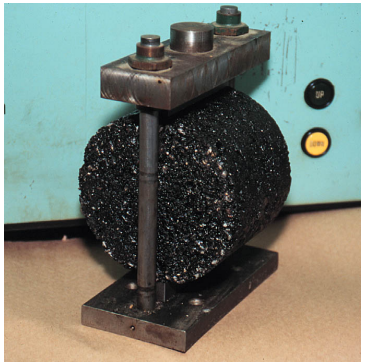
Definition

1a: peculiar and essential character : NATURE
b: an inherent feature : PROPERTY
2a: degree of excellence : GRADE
b: superiority in kind

excerpted from Merriam – Webster.com

Traditional Measures of Mix Quality

- Material criteria
  - Aggregate, binder, additives
- Volumetric criteria
  - Gradation, asphalt content, VMA, air voids
- Permeability
- Moisture sensitivity
  - TSR or Hamburg test
- Density



What Defines a Quality Mix?

- Use of premium materials?
- Consistent production characteristics?
- Easier laydown / better compactability?
- Increased density?
- Resistant to cracking / rutting?
- Longer life?

Sources of Good Mix Performance

- Asphalt mixture quality → conformity in volumetrics
  - Components
  - Design
  - Production

- Construction quality → density and uniformity
  - Trucking logistics
  - Use of MTV
  - Paver operation
  - Handwork
  - Roller operation

- Existing foundation condition

Future of Mix Design

- How will we design for performance?
  - Volumetric properties versus performance
    - What are impacts of being “out-of-spec”?
  - Consideration of variability
    - What are impacts of lot-to-lot variability?
  - Performance testing
    - Numerous tests are available to characterize rutting, fatigue, and cracking susceptibility

What is Performance Testing?

Performance testing

- the process of evaluating the quality or capability of a product

Evaluation of a mix to determine its ability to resist rutting, cracking, and deterioration *for an expected period of time*

Why Performance Testing?

- Volumetrics do not tell the whole story
  - Can change performance w/out changing volumetrics
  - Can not adequately evaluate mix variables
    - recycle, warm-mix additives, polymers, rejuvenators, fibers
- Premature mix deterioration
  - Volumetric designs can be under- or over-asphalted

Performance Tests

- AMPT tests
  - Dynamic modulus
  - Repeated load permanent deformation (flow test)
  - Simplified viscoelastic continuum damage (SVECD) fatigue test
- Moisture susceptibility (TSR) test
- APA rut test
- Hamburg test
- Overlay test
- Indirect tension test
  - Strength, Ideal-CT
- Semi-circular bend test
  - LA-SCB, I-FIT
- Beam fatigue test

Applications

- Mix design and evaluation
- Pavement design
  - Engineering properties for mechanistic design
- New material evaluation
- Construction acceptance
  - Performance-related specifications

Important Considerations

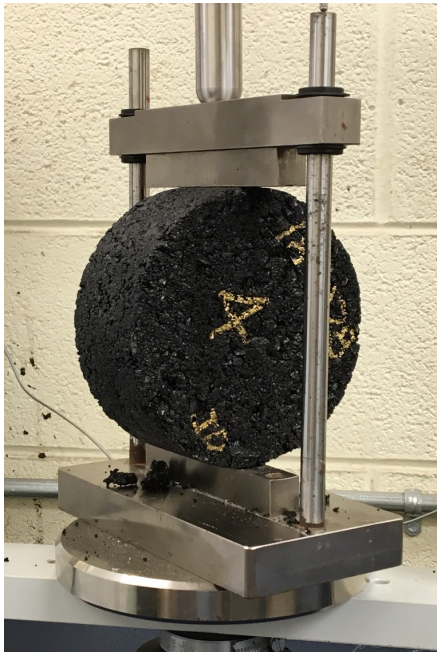
- What are the relationships between test results and actual performance?
- How are test results influenced by:
  - Differences between design and production
  - Inherent variability in materials and production
  - Aging
- Can we leverage performance test results to improve pavement designs?

APPLYING PERFORMANCE TESTING TO THE REAL WORLD: BALANCED MIX DESIGN

What does BMD Mean – Practically?

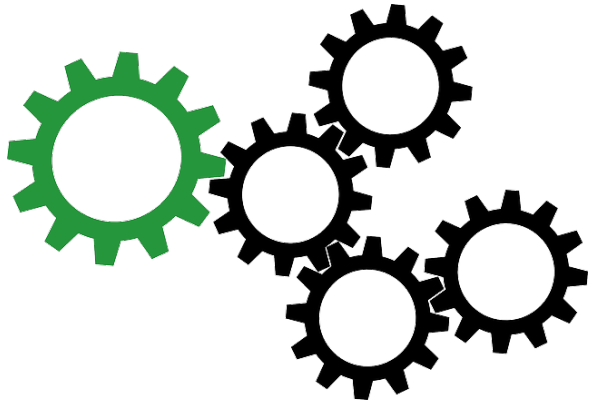
- Designing mixtures to meet performance criteria:
  - Rutting
  - Cracking
  - Durability

Ultimately use volumetrics as a ***tool***, rather than a requirement

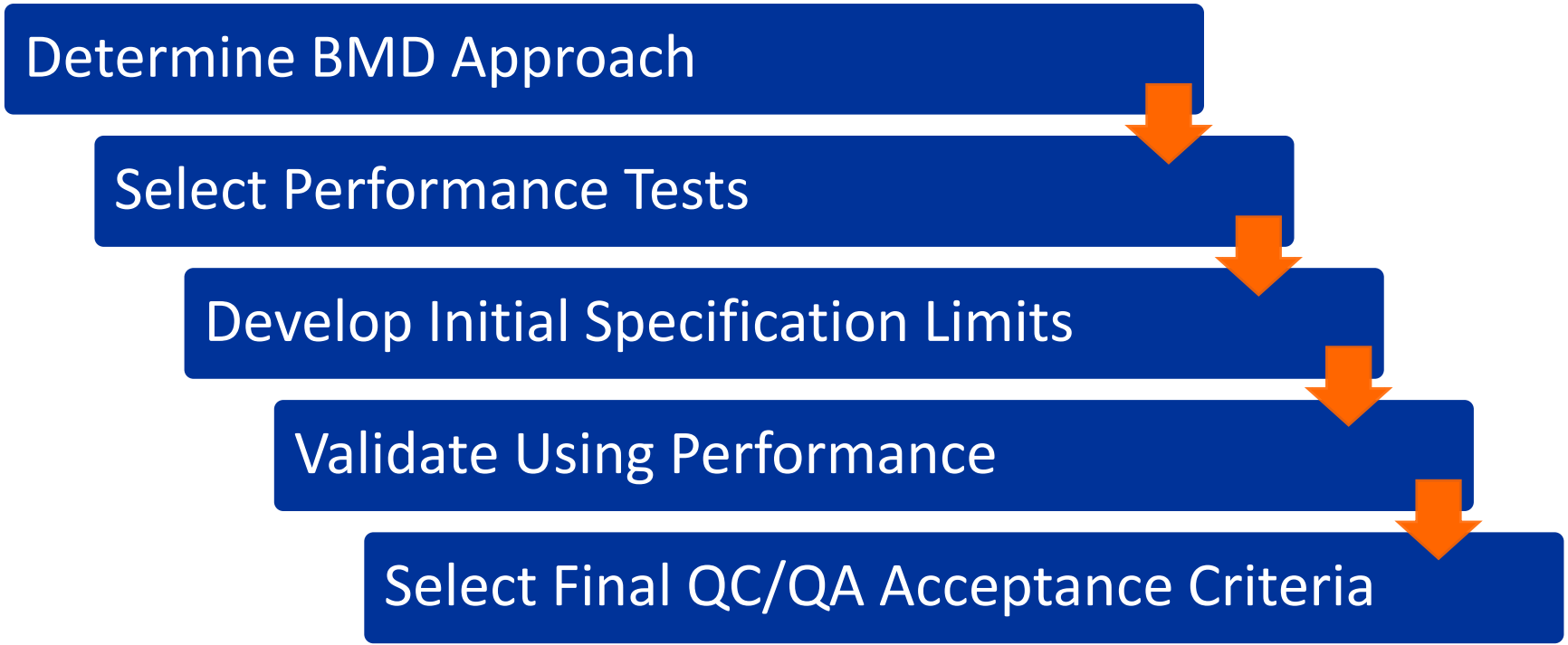


Building a BMD Specification

- Know existing mix/pavement performance
- Determine baseline/expectation for performance
- Select appropriate test procedure
- Develop testing and specification structure
- Re-evaluate and validate

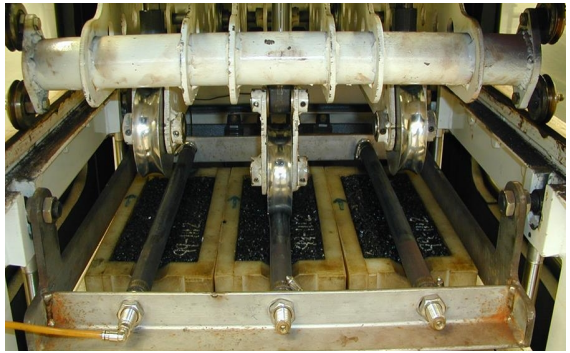


Virginia's Approach to BMD



Selecting Test Procedures

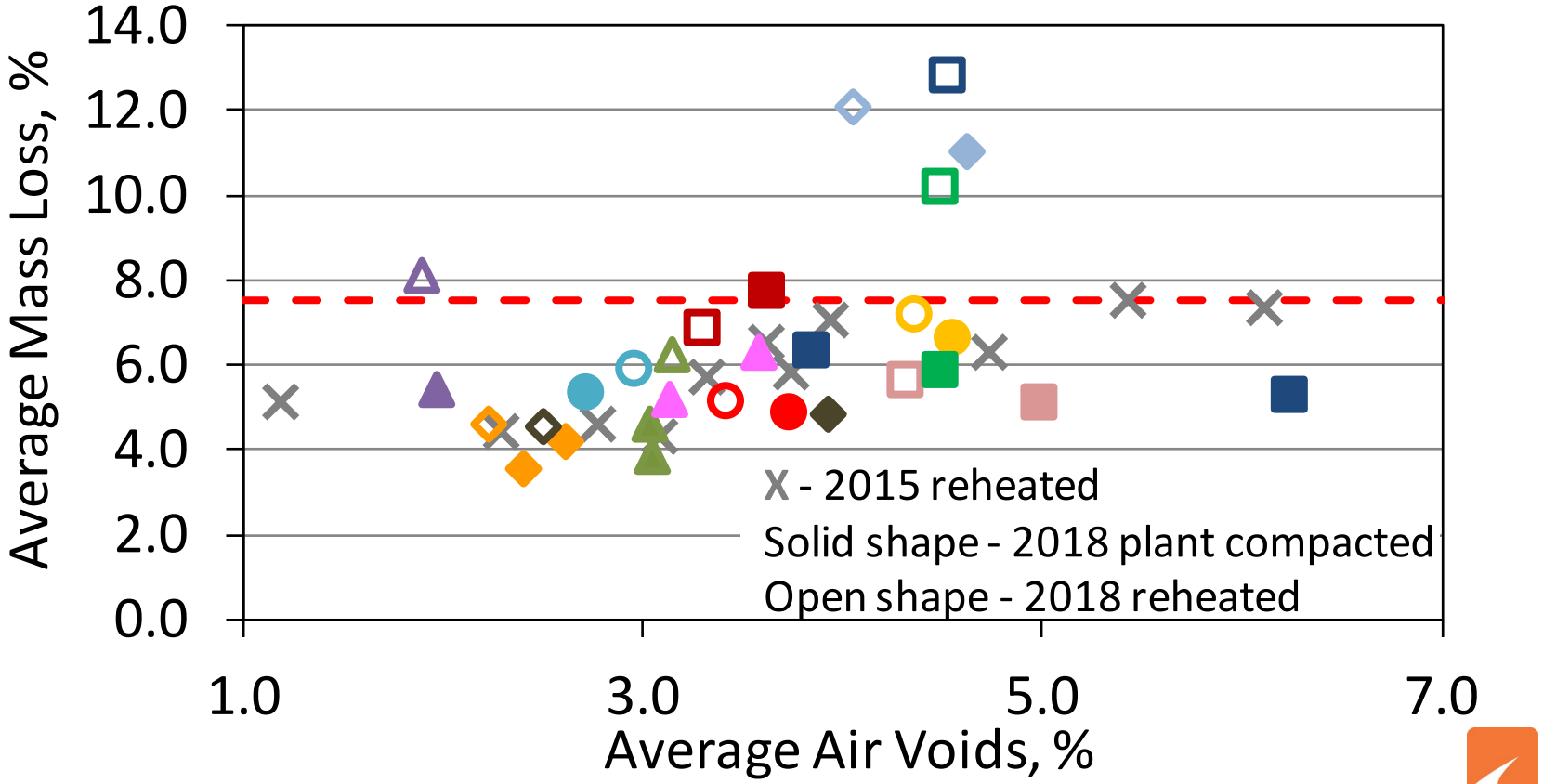
- Correlates to field performance
- Sensitive to mix properties
- Repeatable
- Ease of use
- Availability/cost



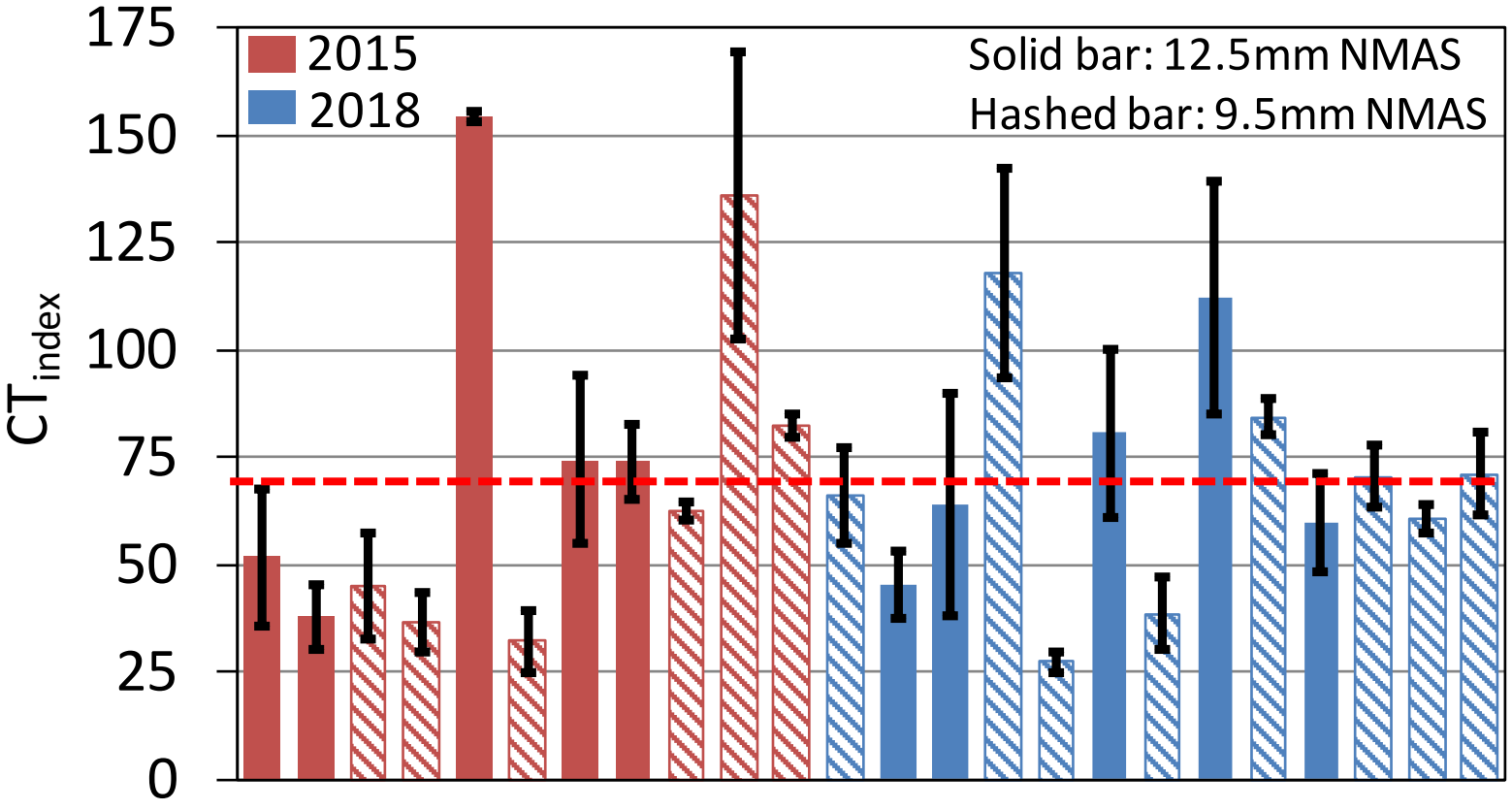
Benchmarking / Shadow Testing

- Surface mixtures with 9.5mm & 12.5mm NMAS
- 2015 - 11 field projects
  - Testing on reheated specimens
- 2018 - 13 mixtures
  - 6 field projects
    - Plant-compacted, reheated, & field core specimens
  - 7 plant sampling only
    - Plant-compacted & reheated specimens

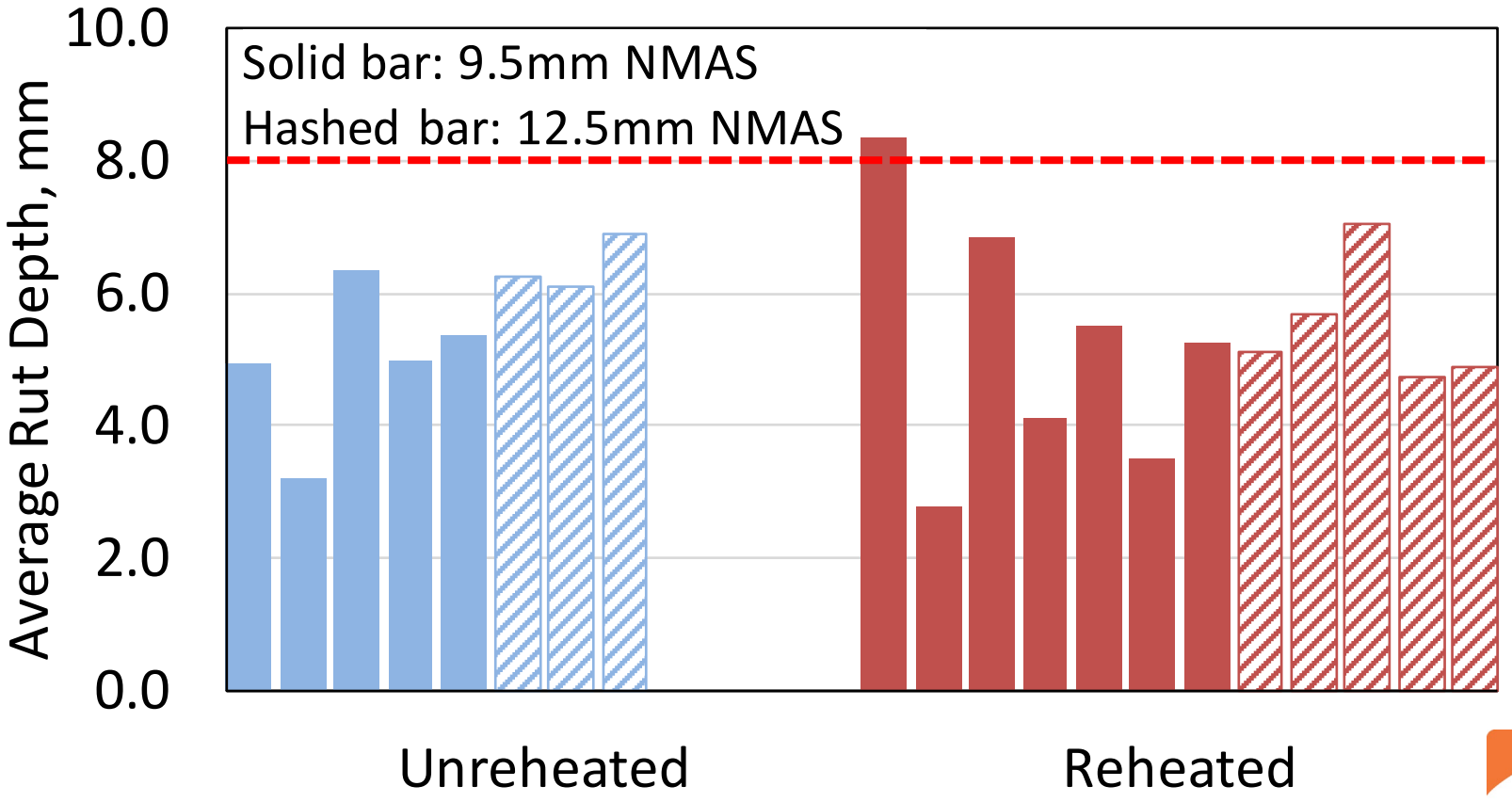
Cantabro Mass Loss



CT_{index} – Reheated Mix



APA Rutting


Solid bar: 9.5mm NMAS
Hashed bar: 12.5mm NMAS
Average Rut Depth, mm
10.0
8.0
6.0
4.0
2.0
0.0
Unreheated
Reheated

BMD Special Provisions

- Control (volumetric design)
  - Meets current volumetric specs
- Type Volumetric + Performance
  - Meets volumetric specs AND performance criteria
- Type Performance Only
  - Volumetric requirements waived
  - Design must meet performance criteria
  - Design volumetrics must be met during production

Performance Test Criteria

Test	Test Temp.	Specimens	Criteria
AASHTO T340 (APA rutting)	64ºC	2 replicates of 2 pills (APA Jr) [Note: Plant-mix shall not be reheated when producing APA rut specimens.]	Rutting ≤ 8.0mm
AASHTO TP108 (Cantabro mass loss)	25ºC	3 replicates Report air voids	Mass loss ≤ 7.5%
ASTM D8225 2019 (CT_{index})	25ºC	3 replicates	CT_{index} ≥ 70

Lab-produced mix – loose mix shall be conditioned 2hrs (4hrs for CT_{index}) at the design compaction temperature prior to compacting

Production Testing Frequency

Table 2. Production Testing Frequency[1]

Entity	Gradation/AC	Volumetrics	APA rutting	Cantabro	CT_{index}
Producer	500T	500T	-	500T	500T
VDOT	500T	1,000T	-	1000T [2]	1000T [2]
VTRC	500T	500T	500T [2]	500T (reheat)	500T (reheat)

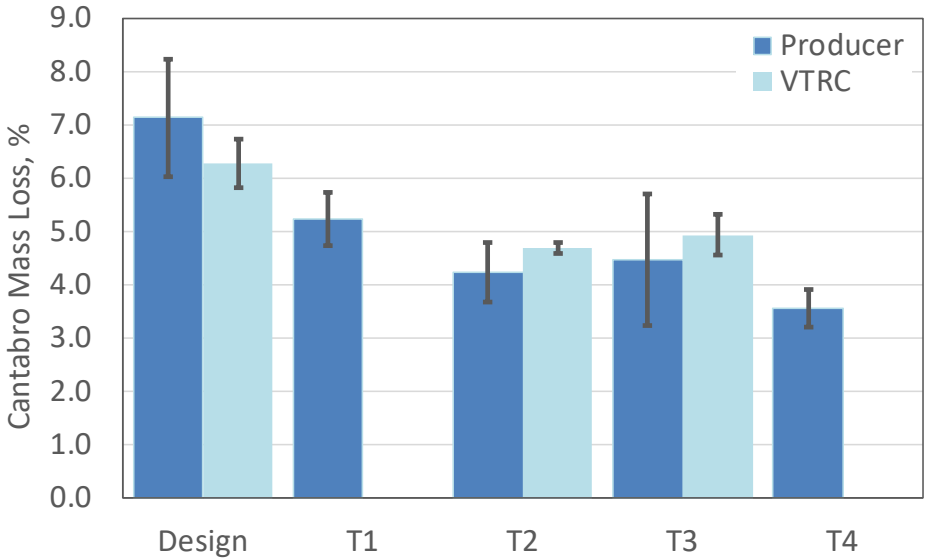
[1] With a minimum of 1 sample per day, per entity, per test.

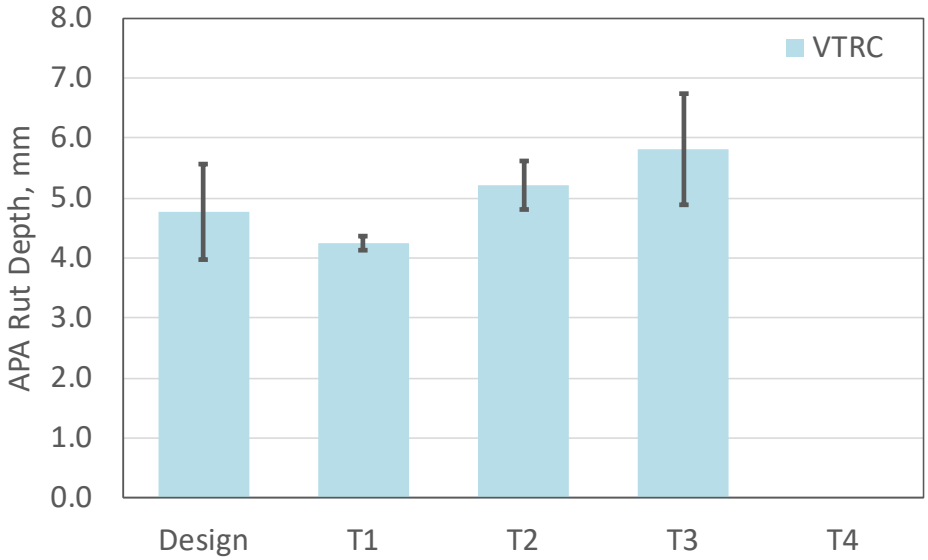
[2] Minimize any cooling of the plant-produced mix and bring the specimens to the compaction temperature ad compact immediately, to the specimen size requirements in Table 1. Specimens shall be fabricated and provided to the Department by the Contractor.

2019 BMD Projects

Mix Type	RAP Content	Binder	Rejuvenator	Days of Production
9.5mm Surface Mix	40%	64S-22	Yes	2
		64S-22	No	½
		58-28	No	2
	30%	64S-22	No	2
		58-28	No	2
	26%	64S-22	No	1
		64S-22	Rejuv. 1	1
		64S-22	Rejuv. 2	1

Control: 30% RAP, PG64S-22





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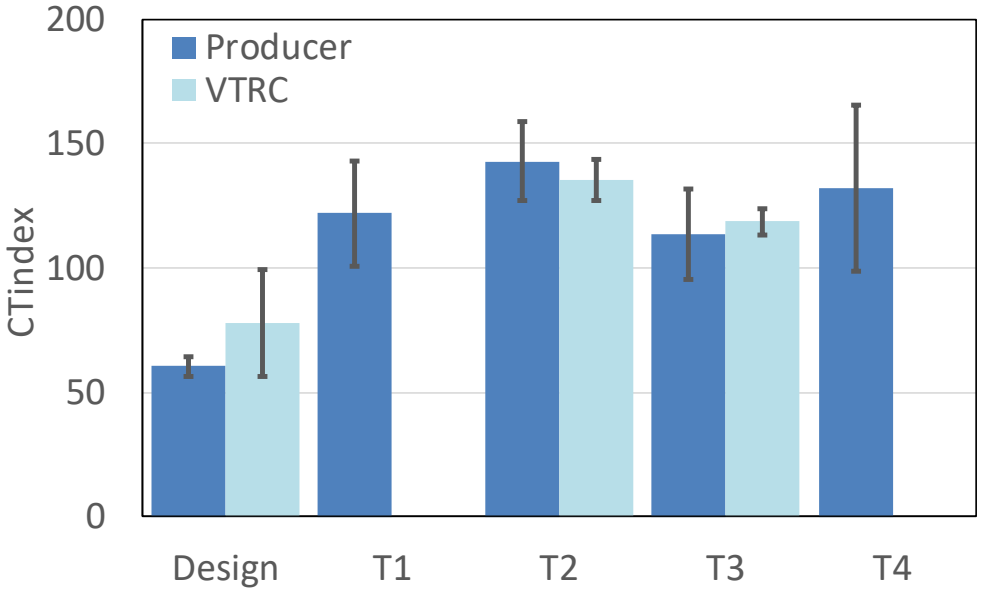
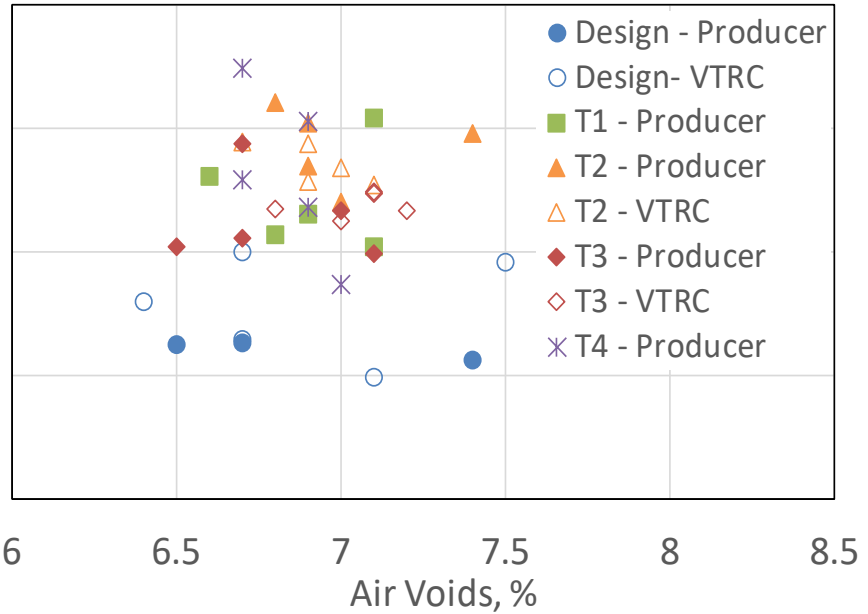
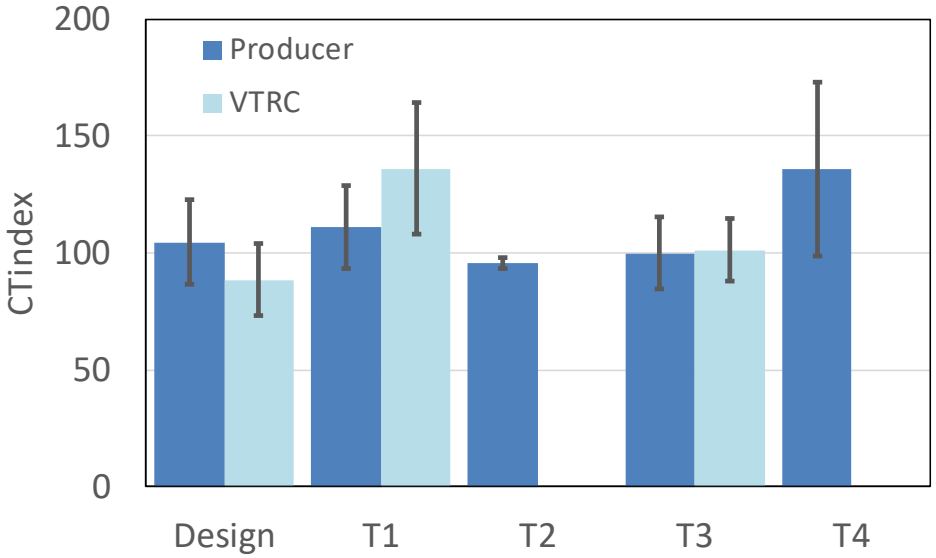
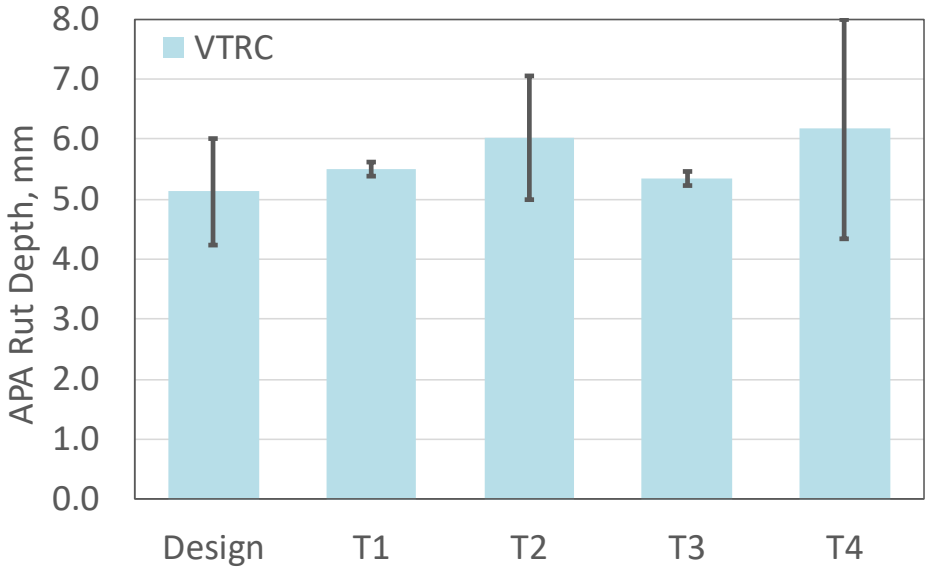


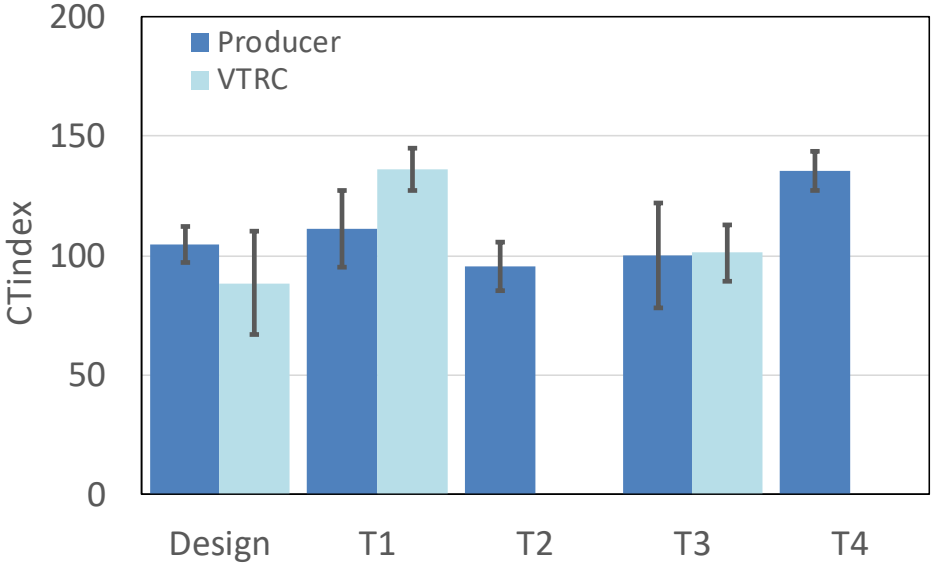


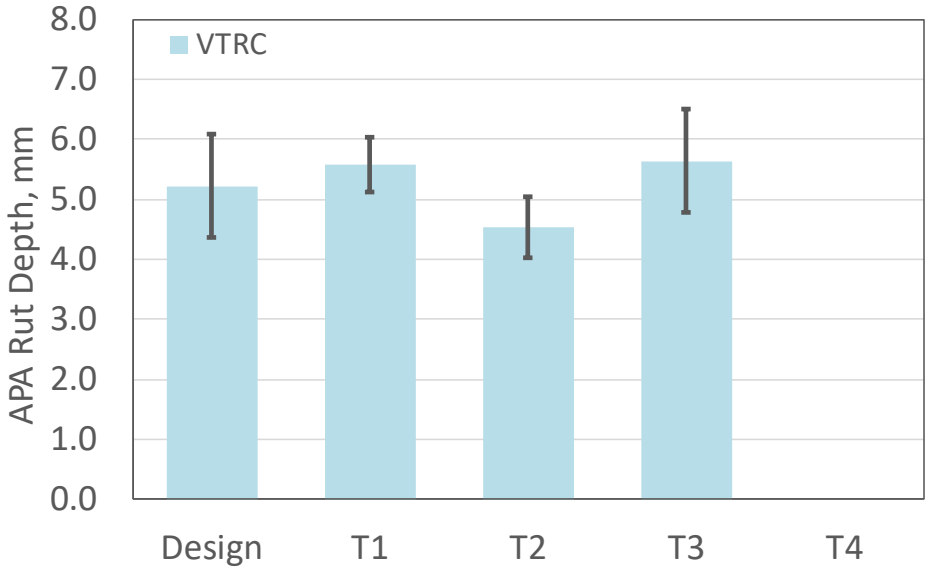
40% RAP, PG64S-22, Rejuvenator



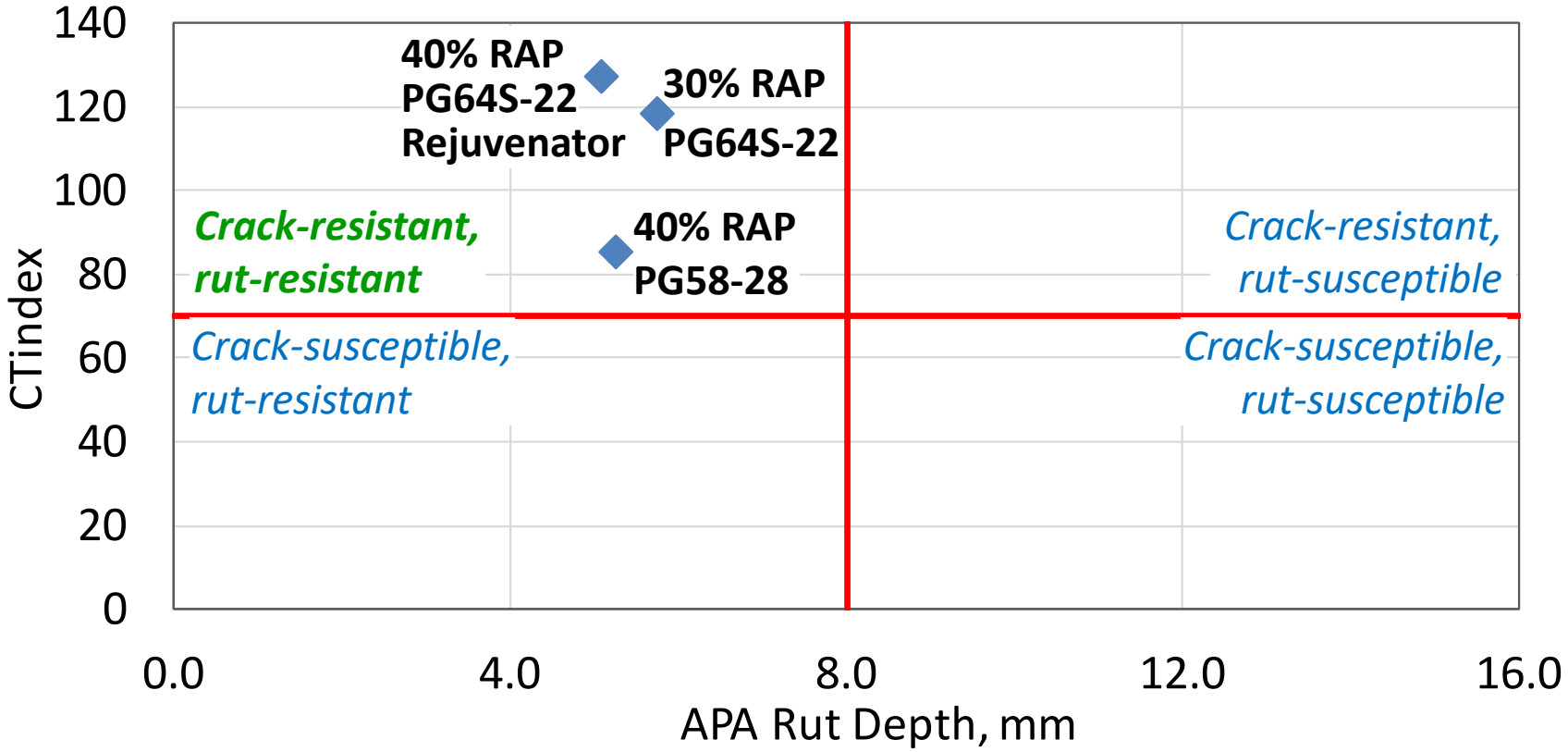


40% RAP, PG58-22





Performance Space

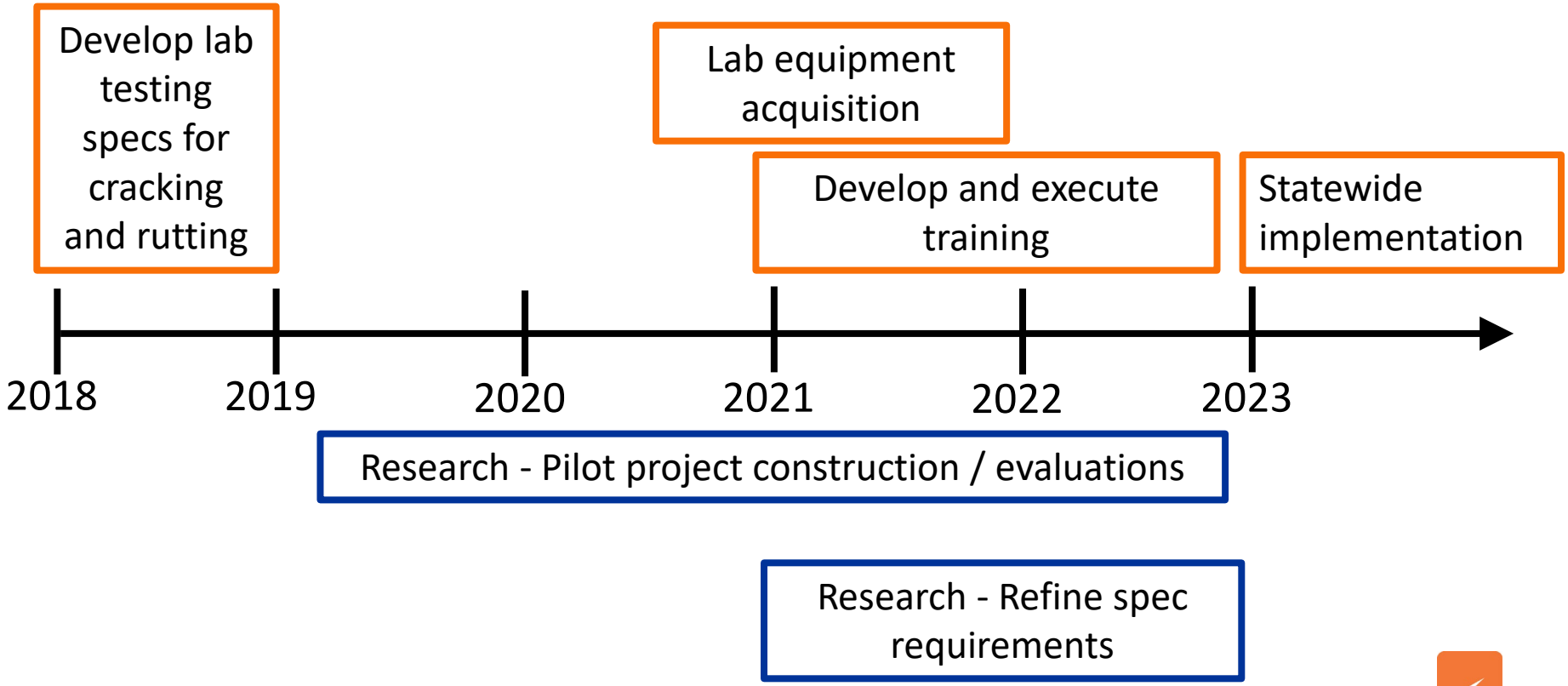


Challenges Moving Forward

- Performance testing
  - How do design changes influence test results?
  - What is the impact of aging?
  - Need precision and bias statements
  - What is impact of production variability?
  - Need rutting test for production use

- In-service performance data and relationships

Agency Timeline



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