NATIONAL ACADEMIES *Sciences Engineering Medicine*

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: TRB Webinar: Balancing Act—Fine-Tuning Asphalt Mixtures for Balanced Mix Design

June 10, 2024

2:00 – 3:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING RCEP REGISTERED CONTINUING EDUCATION PROGRAM

Purpose Statement

This webinar will share four approaches (A through D) for optimal BMD and the benefits of moving towards a performance design approach (approach D), establishing and adjusting mixture components and proportions based on performance analysis with limited or no requirements for volumetric properties.

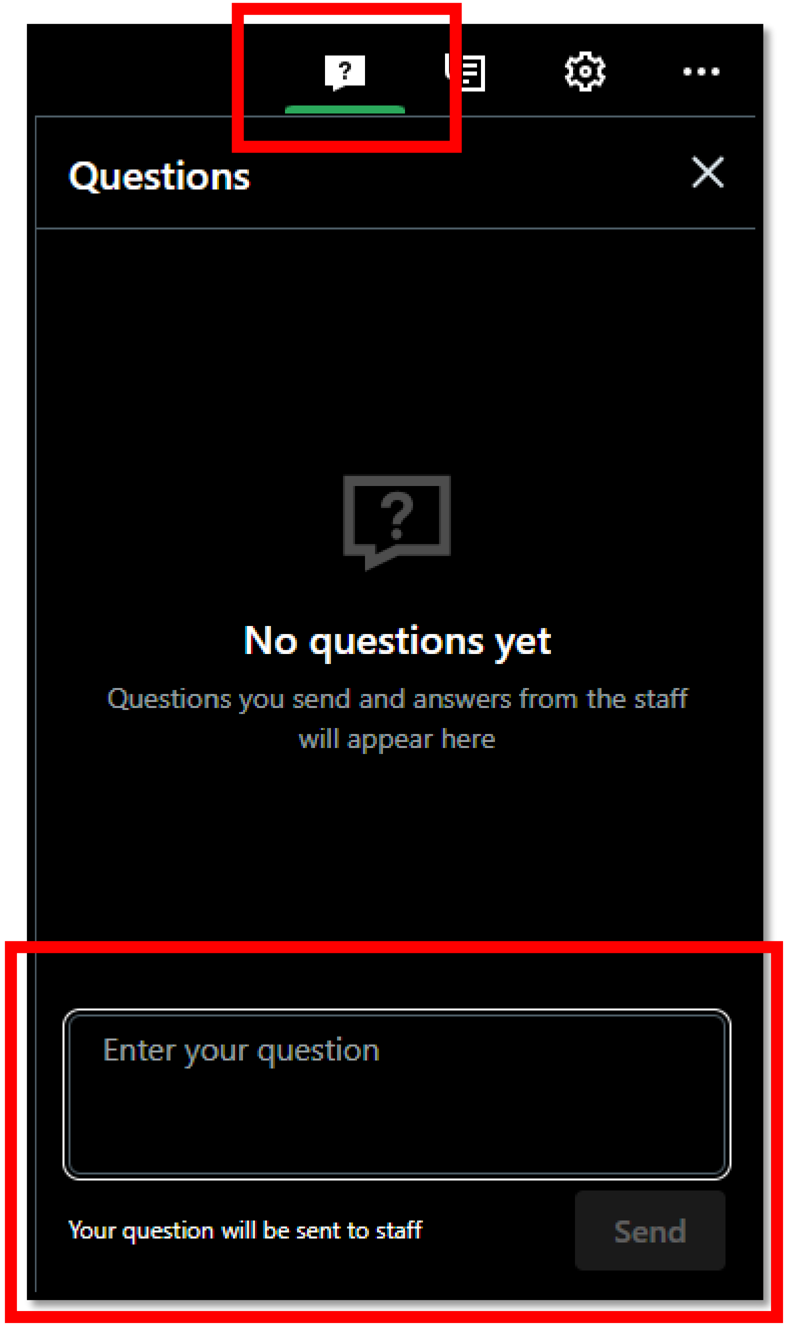
Learning Objectives

At the end of this webinar, you will be able to:

- Make asphalt mixture adjustments to pass a BMD specification
- Understand what specifications need to be adjusted when adding a mechanical mixture performance test
- Relate the overall BMD specification to the Superpave specification

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's Presenters

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Balanced Mix Design Approaches A to D

Moving Toward Approach D

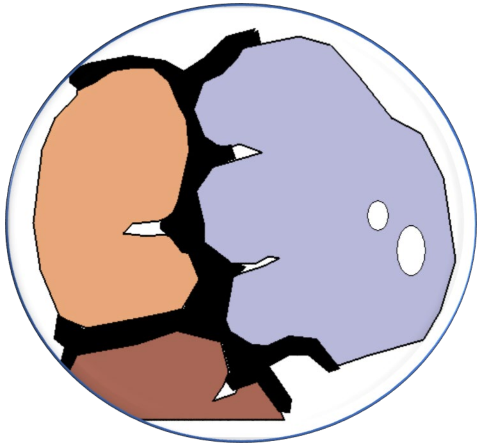
Randy West, Ph.D., P.E.
Director & Research Professor

Superpave to BMD: Why Change?

DOTs and industry acknowledge that Superpave (Superior Performing Pavements) has not lived up to its promise.

Superpave to BMD: Why Change?

- The key mix properties in Superpave are air voids (V_a) and volume of effective binder (V_{be})



- Volumetric properties do not tell us anything about the **quality** of the binder or about the interactions of different binder components and additives

Superpave to BMD: Why Change?

- Volume of effective binder (V_{be}) is dependent on the aggregate bulk specific gravity (G_{sb}), which is not a reliable property
  - G_{sb} is subject to change over time but not often verified
  - G_{sb} has a low level of precision
  - G_{sb} of RAP aggregate is questionable

AASHTO / ASTM	**Acceptable Range of Two Results (d2s) Bulk specific gravity (SSD)**	
Precision	Coarse T85/C127	Fine T84/C128
Single-operator	0.020	0.027
Multi-laboratory	0.032	0.056

With the current volumetric mix design system…

Balanced Mix Design

Cracking Resistance

"asphalt mix design using performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mix aging, traffic, climate and location within the pavement structure."

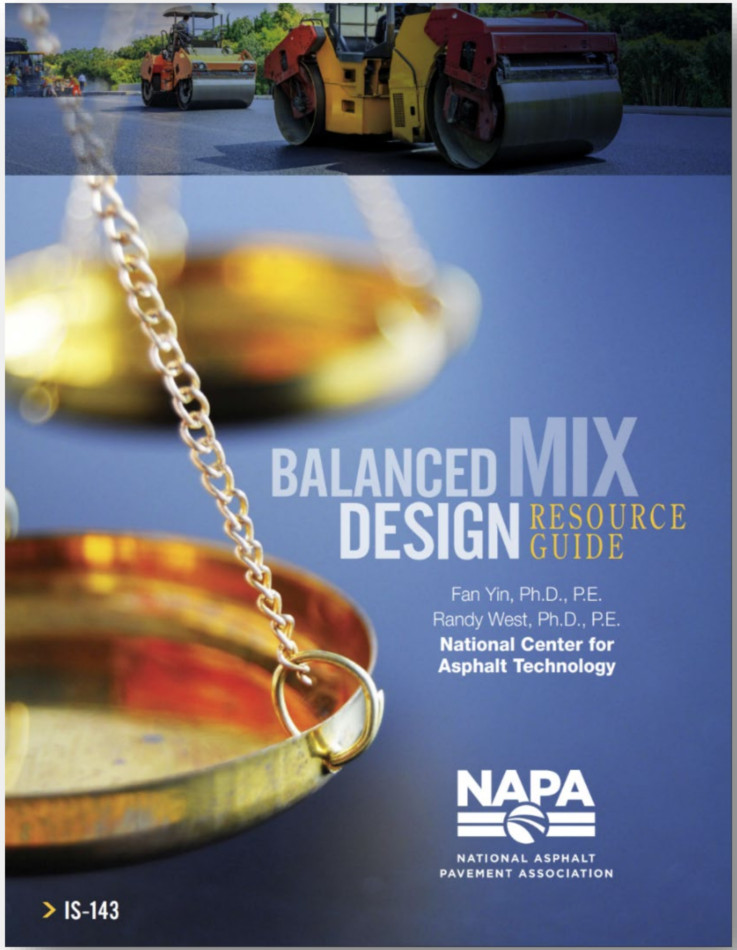
Rutting Resistance

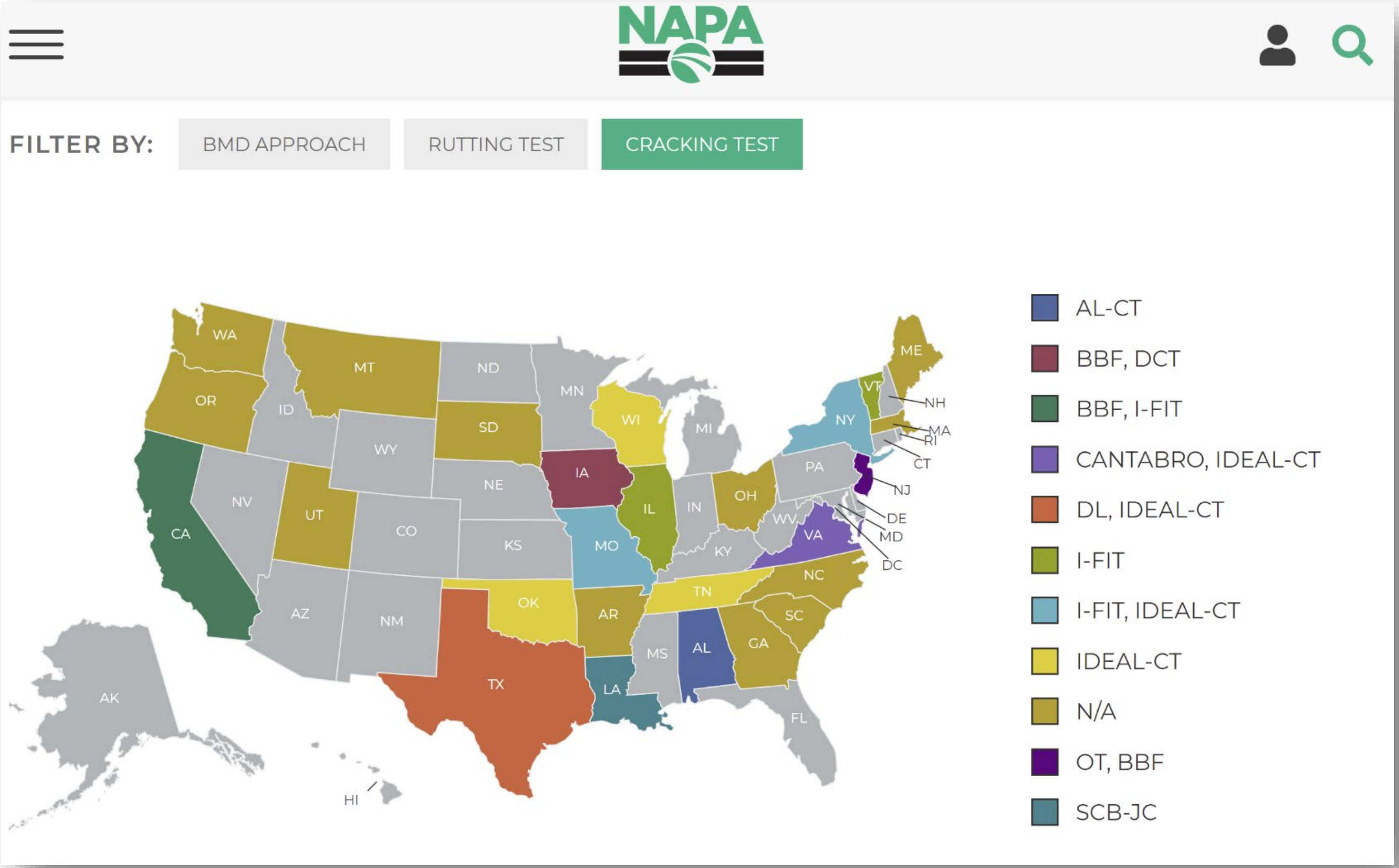
Anticipated Benefits of BMD

Ensure Performance

Enable Innovation

Optimize Cost





BMD Resources

Scan this code or visit aub.ie/bmd for useful resources related to balanced mix design

Standard Practice for Balanced Design of Asphalt Mixtures AASHTO PP 105

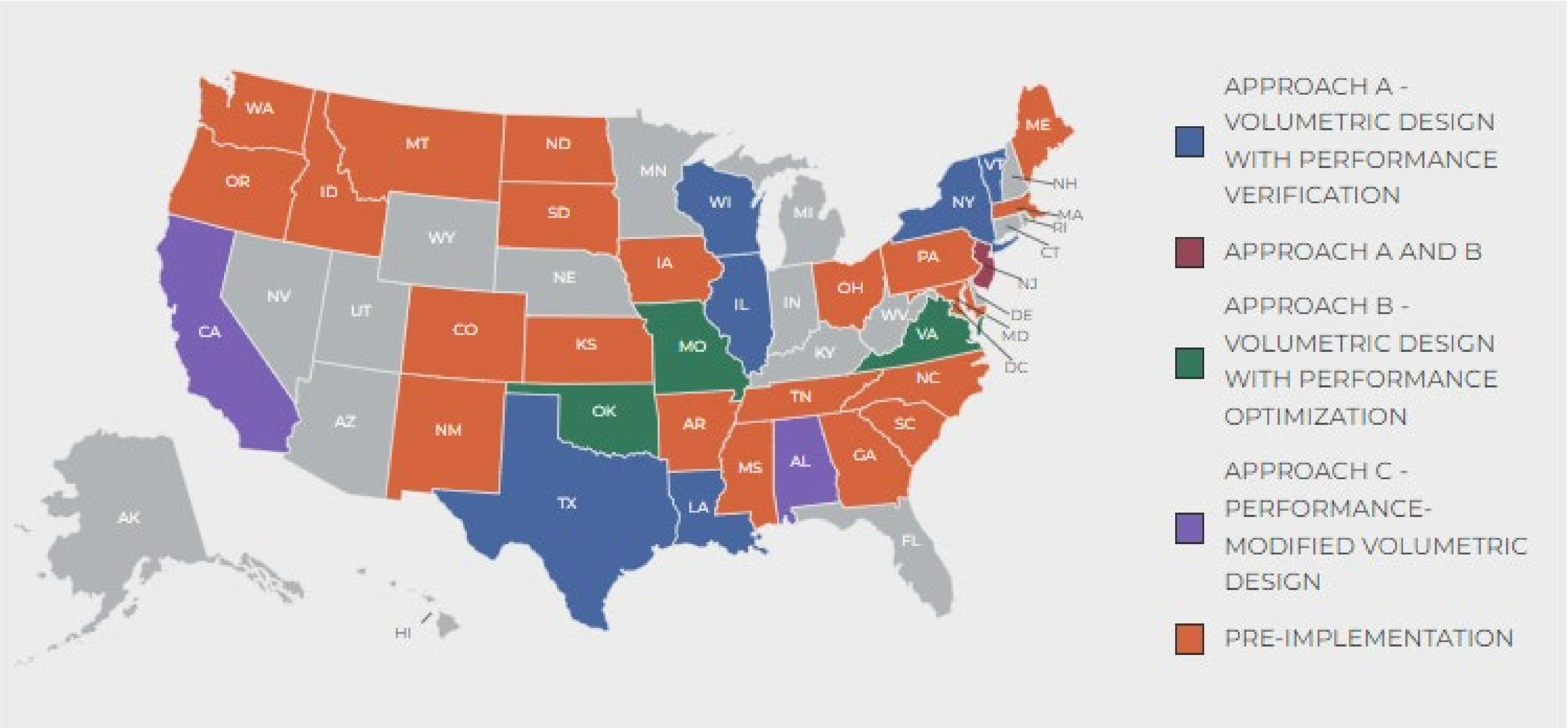
A
V+
- Volumetric Design
- +
- Performance Test Criteria

B
V. Opt. P_b
- Initial Volumetrics
- Perf. Tests @ Vol. Opt. Binder ± 0.6%

C
Perf-Mod V
- Volumetric Design
- Perf. Criteria
- Adjust components
- Perf. Criteria

D
Perf Design
- Performance Criteria
- No Volumetric Requirements

Implementation Status



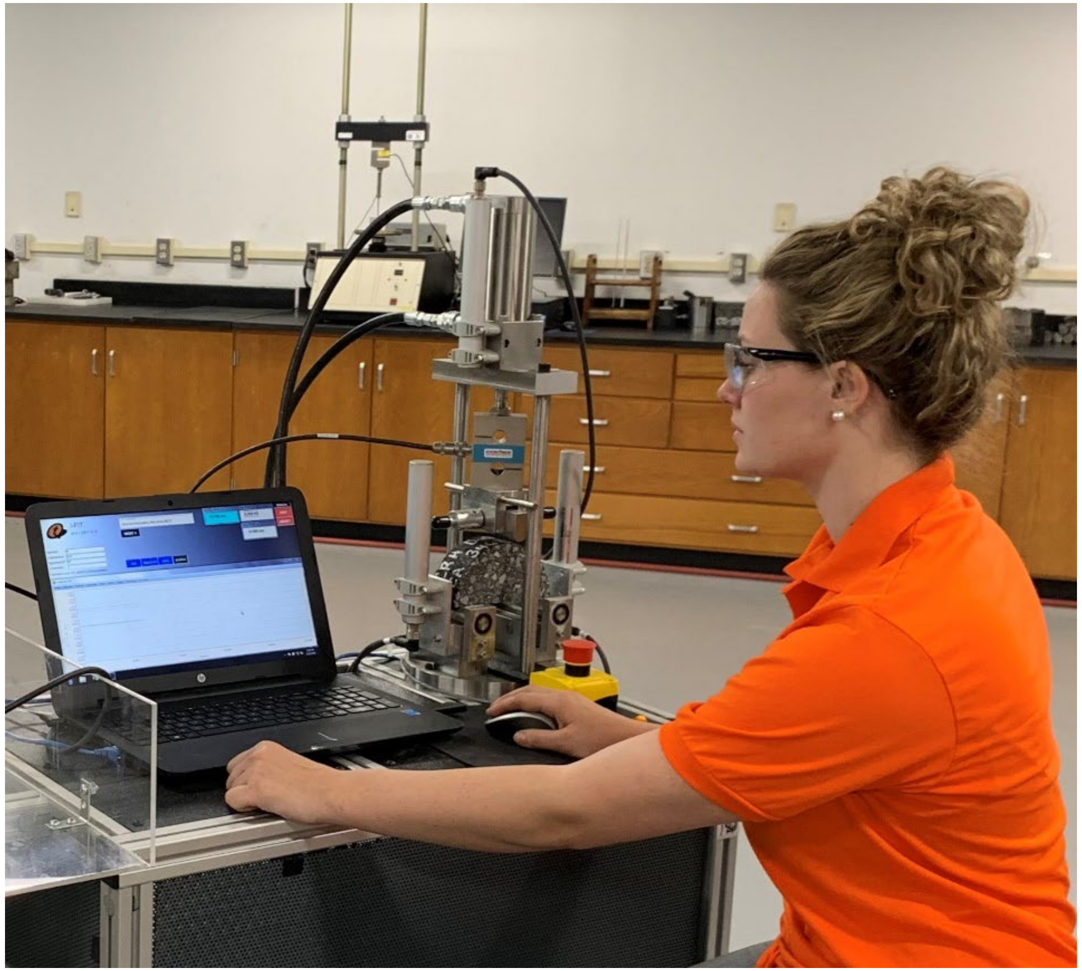
Source: NAPA BMD Resource Guide: https://www.asphaltpavement.org/expertise/engineering/resources/bmd-resource-guide

Why BMD Method A?

- ✓ Appears the easiest from an Agency perspective
- ✓ Just adds performance testing to Superpave
- ✓ No change in consensus properties or Superpave volumetrics
- ✓ Allows current AQCs to continue to be used for acceptance

Method A Challenges

- Increases cost and time
- Iterative mix design with only option to increase mix VMA
- Limits improvements to sustainability:
  - Limits local aggregate
  - Limits RAP and other recycled materials
  - Increases carbon footprint of mix design



Why BMD Method B?

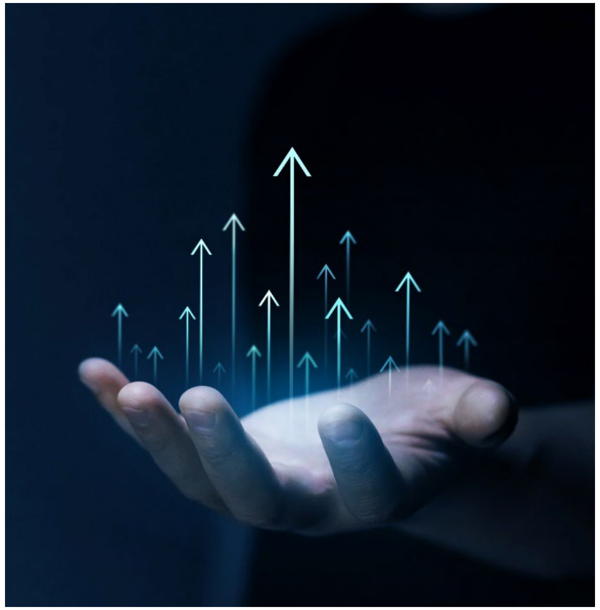
- ✓ Easy from an Agency perspective
- ✓ Just adds performance testing to Superpave
- ✓ Only binder content can be adjusted
- ✓ No change in consensus properties
- ✓ Air void and VFA criteria must be relaxed
- ✓ Allows current AQCs to continue to be used for acceptance, with a shift in air voids target

Approach C

- Volumetric criteria and consensus properties may be relaxed or eliminated as long as performance test criteria are satisfied
- Mix Designers have the freedom to:
  - Utilize a binder grade of their choice
  - Alter the gradation
  - Increase utilization of recycled materials
  - Use other mix additives (recycling agents, fibers, innovative materials)

Approach D

- No criteria for volumetric or consensus properties
  - They can still be used as a guide
- Only the performance test criteria must be satisfied
- Mix designers have the freedom to:
  - Utilize a binder grade of their choice
  - Alter the gradation
  - Increase utilization of recycled materials
  - Use other mix additives (recycling agents, fibers, innovative materials)



For more information, check out this special report

https://aub.ie/BMDapproaches

» Balanced Mix Design, Special Report 228

NAPA NATIONAL ASPHALT PAVEMENT ASSOCIATION

GUIDANCE ON PROGRESSING THROUGH
BMD APPROACHES

Randy West and Fan Yin

INTRODUCTION

Balanced Mix Design (BMD) continues to be one of the most talked about topics in the asphalt pavement industry. As the State Departments of Transportation (DOTs) work toward BMD implementation, one of the important early decisions is how to approach BMD for mix design approval. This guide presents the pros and cons of different approaches in AASHTO PP 105 to implement the new BMD performance tests that DOTs should consider in this decision. Other relevant guide documents for implementing BMD specifications and conducting field validation of performance test criteria can be found on the National Asphalt Pavement Association (NAPA's) Balanced Mix Design Resource Guide website.

WHY CHANGE?

The motives for any change are typically rooted in dissatisfaction with the status quo. Feedback from BMD Peer Exchanges in 2023 (Bittner et al., 2023a; Bittner et al., 2023b; Bittner et al., 2023c) indicates that the most common reasons why state DOTs want to implement BMD include:

- Improving the service lives of asphalt pavements
- Eliminating premature failures of some asphalt pavements
- Reducing the carbon footprint of asphalt pavements
- Optimizing asphalt mixtures for specific applications

Most stakeholders realize that it is not possible to accomplish the above goals by continuing to use existing specifications, mix design practices, and construction methods. Although tweaks to existing Superpave specifications and methods, such as with Superpave 5, regressed air voids, and the corrected optimum asphalt content (COAC) concept, can provide some performance improvements, they do not fix the underlying limitations of a volumetric mix design system.

There are two recognized deficiencies of mix design systems based on volumetric properties: (1) the reliability and accuracy of VMA are challenging because of the difficulties in accurately determining the bulk specific gravity (G_{sb}) of aggregates, and (2) there is no way to determine the interaction effects of virgin binders, recycled binders, and other additives such as recycling agents. These issues are further discussed below.

Concerns regarding VMA

The two primary volumetric properties used in asphalt mix design and QA specifications are air voids (*Va*) and voids in the mineral aggregate (VMA). Air voids represent the volume of void space within a compacted specimen at a specific compactive effort, which has been related to rutting resistance (Brown and Cross, 1992). VMA is defined as the volume of the intergranular void space between the aggregate particles of a compacted asphalt mixture that includes the air voids and the effective binder content. A minimum VMA is important to ensure a mixture contains an adequate volume of effective asphalt. Although many asphalt technologists know that the minimum VMA criteria were established by Norman McLeod in the late 1950s, some are surprised to know that he provided no mix performance data to support the criteria (Kandhal et al., 1998). Numerous other researchers have also discussed the weakness of VMA as a mix design criterion (Coree & Hislop, 2000).


Thank you

Industry Practices and Suggestions for Adjusting Asphalt Mixtures to Meet Balanced Mix Design (BMD) Specifications

PRESENTED BY:

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NOTICE

Research Projects and Papers

- Final Technical Brief
  - Adjustment of Mixture Design/Job Mix Formula to Satisfy Mechanical Properties, WRSC-TB-22-01
    - Praveen Gopisetti, Harold Von Quintus, Thomas Bennert, Elie Hajj and Tim Aschenbrener
    - https://www.unr.edu/wrsc/tools/asphalt/dapt-publications
    - Simply Google: “UNR BMD FHWA”

WOLF PACK NEVADA

TechBrief

WRSC-TB-22-01
January 2023

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Adjustment of Asphalt Mix Design/Job Mix Formula to Satisfy Mechanical Test Properties

This Technical Brief summarizes information related to practices and suggestions being used by industry for asphalt mixture adjustments to get acceptable test results to meet Balance Mix Design (BMD) specifications set forth by agencies. This was achieved through interviews with eight individuals with vast experience on BMD. General considerations for making adjustments and for improving rutting or cracking resistance are summarized.

Introduction

Asphalt mixture mechanical tests (e.g., Hamburg Wheel-Track, Asphalt Pavement Analyzer, Indirect Tensile Cracking) are growing in use by numerous State Departments of Transportation (DOTs) as part of their standard material specifications to complement volumetric properties and help ensure satisfactory asphalt mixture performance. These mechanical tests have been used by State DOTs as part of their Balanced Mix Design (BMD) process on pilot, shadow, or standard asphalt pavement projects. Efforts are also being made by some State DOTs to advance mechanical tests within their long-life asphalt pavement program or their mechanistic-empirical pavement design process. Thus, with well-developed asphalt mixture mechanical test methods and practices, State DOTs, contractors and consultants have valuable experiences and lessons learned that could facilitate the implementation of a mechanical test into practice by other DOTs. This Technical Brief aims to share information on the experience of individuals with adjusting mix designs to meet mechanical test requirements.

In 2020, information on positive practices, lessons learned, and challenges when implementing BMD and mechanical testing of asphalt mixtures were collected through virtual site visits.[1] The collected information was organized into three categories or topics:

- Positive practices which are those successful efforts that were used by a State DOT that could also be considered by other DOTs.
- Lessons learned which are those efforts that a State DOT would reconsider if had to do it over again.
- Challenges which are those efforts that a State DOT is still in the process of addressing.

General Approach

- Select 7 industry personnel
  - Vast experience on Balanced Mix Design (BMD)
  - Regionally diverse
  - Organizationally diverse
- Interview each over a 2-day period
  - Questions provided ahead of time so interviewee could prepare
- Conduct post interview to verify interview responses/content
- Consolidate findings and develop best practices
  - Serve as a guide to contractors planning their own experiments
  - Assist to accelerate the learning curve and facilitate implementation of BMD concepts

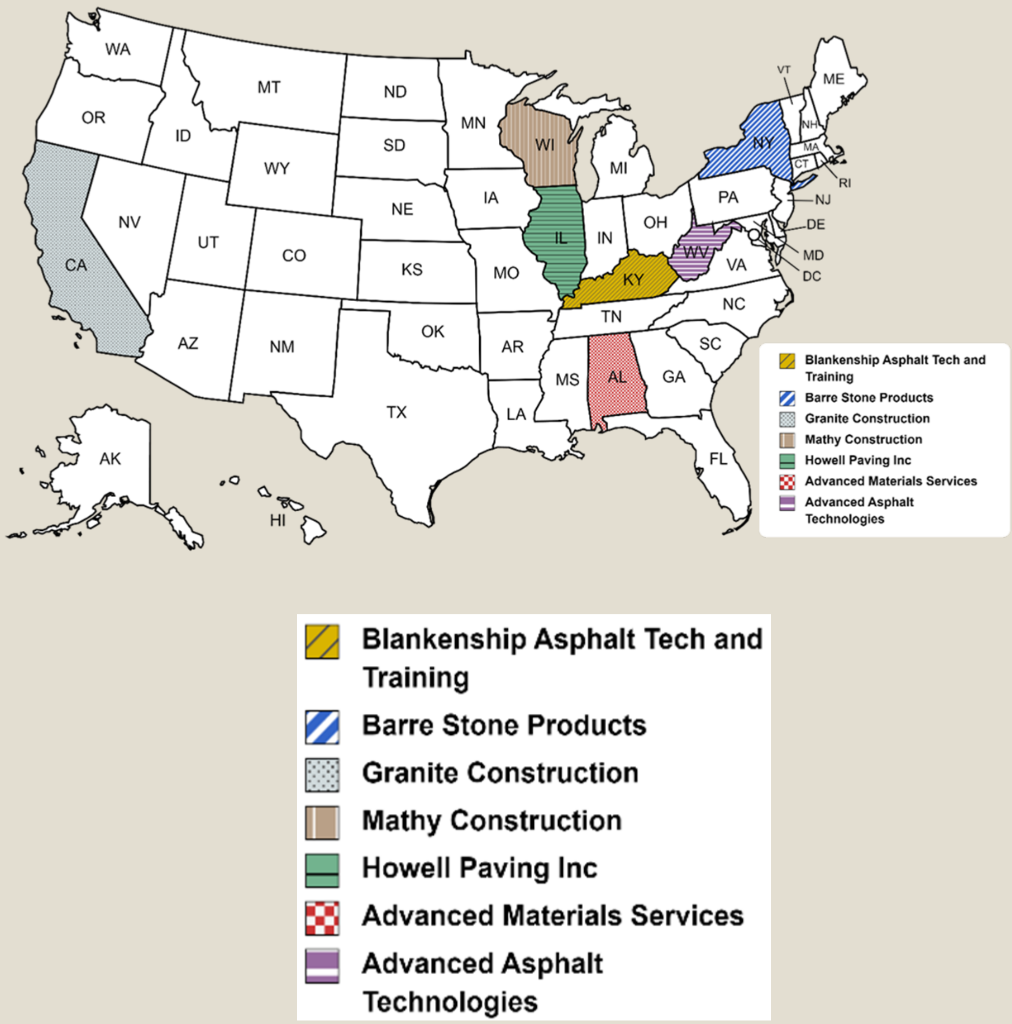
Overview

1. Interviewees and Their Experience
2. BMD Approach Considerations & Mechanical Testing
3. Adjustments to Asphalt Mixture Components to Satisfy BMD
4. Suggestions for Improvements Going Forward
5. Conclusions

Interviewees & Their Experience

Interviewees

Names of the Interviewees	Current Position and Organization	Number of Years in Current Position	Positions/Experience with other Organizations
Ramon Bonaquist	Chief Operating Officer, Advanced Asphalt Technologies	24 years	Research Engineer, FHWA (10 years)
Andrew Hanz	Vice President of Technology and Research, Mathy Construction	8 years	Graduate student and Postdoctoral associate at University of Wisconsin Madison
Brian Prowell	Principal Engineer, Advanced Materials Services	15 years	Assistant Director- NCAT Virginia Transportation Research Council Instructor – Virginia Tech
Michael Kleames & Marty McNamara	Quality Manager III & Director of Quality Control, Granite Construction	7 years & 21 years	Geotechnical consultant for private engineering firms & Consultant focusing on pavement management systems and pavement design
Philip Blankenship	Owner and CEO, Blankenship Asphalt Tech and Training	4 years	Asphalt Institute Kentucky Transportation Cabinet Koch Industries
Greg Rose	Quality Manager, Barre Stone Products	6 years	Material Producer for private firms- 30 years
Pat Koester	Vice President (Production), Howell Paving Inc	17 years in current position and 28 years overall with the organization	Illinois DOT (District 7) – 10 years



Balanced Mixture Design (BMD) Approaches

- Approach A – Volumetric Design with Performance Verification
- Approach B – Volumetric Design with Performance Optimization
- Approach C – Performance Modified Volumetric Design
- Approach D – Performance Design

- References:
  - AASHTO PP 105-20 (2022), *Standard Practice for Balanced Design of Asphalt Mixtures*
  - FHWA Tech Brief, 2022, *Balanced Asphalt Mix Design: Eight Tasks for Implementation*, FHWA-HIF-22-048

Interviewee/Organization Experience with BMD Approaches

- Enormous experience by the interviewees
- Each organization in table has implemented an in-house approach to incorporating BMD practices
  - In some cases, it was found that a hybrid approach (combining philosophies of different approaches) work best for them

Organization	States worked with on BMD Projects	BMD Approach	Number of Annual Projects/Asphalt Mixture Tonnage
Advanced Asphalt Technologies	Pennsylvania	• Approach A	Mostly involved in Research and Development projects. Mixture designs are typically done by producers in West Virginia.
Mathy Construction	Wisconsin, Minnesota, Iowa	• Approach A	30 to 40 projects.
Advanced Materials Services	Alabama, New Jersey, Florida, California, Arizona	• Approach A • Approach B • Approach C for 50% RAP mixes and also with the AASHTO Pavement ME® software for forensic analysis	15 to 20 projects. Multiple projects on high performance pavements (racetracks and port facility pavements).
Granite Construction	California	• Approach D	238,300 tons (2020 and 2021 paving seasons).
Blankenship Asphalt Tech and Training	Kentucky	• Approach A • Kentucky is still in the process of implementing BMD	10 to 20 projects.
Barre Stone Products	New York	• Approach A	25,000 to 100,000 tons a year.
Howell Paving Inc	Illinois	• Approach A • Approach B	Varies.

BMD Approach Considerations & Mechanical Testing

Current Critical Volumetric Criteria & Mechanical Tests Used

- Effective asphalt-based volumetric parameters and air voids found to be most critical by all interviewees
- Mechanical tests highly influenced by regional State DOTs use
  - “Simpler the better…”

Organization	Volumetric Properties	Mechanical Tests for Mix Design	Mechanical Tests for Production or QA
Advanced Asphalt Technologies	• Air Voids • Binder Content by Volume	• HT-IDT • IDEAL-CT	• HT-IDT • IDEAL-CT
Advanced Materials Services	• Air Voids • VMA • VFA	• HWT • IDEAL-CT	• HWT
Granite Construction	• Air Voids • VMA • OBC • DPe	• FN • HWT • SCB	• FN • HWT • SCB
Blankenship Asphalt Tech and Training	• VMA • Air Voids	• HWT • IDEAL-RT • IDEAL-CT	• HWT • IDEAL-RT • IDEAL-CT
Barre Stone Products	• VMA • Air Voids • VFA	• HT-IDT • IDEAL-RT • SCB • IDEAL-CT	• N/A
Howell Paving Inc	• Air Voids • VFA • VMA • Asphalt Content	• HWT • SCB • I-FIT • TSR	• HWT • SCB • I-FIT

BMD Approach Considerations – Volumetric Properties vs Mechanical Testing -

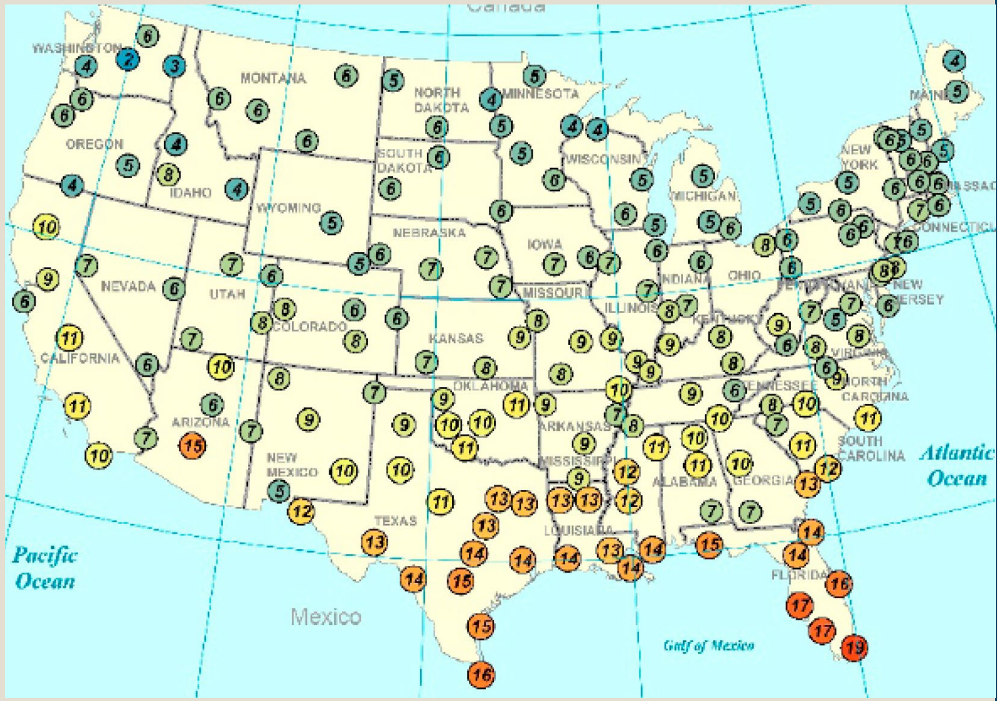
- Lack of understanding regarding impact of mixture component adjustments to final mix performance
  - High degree of experience with respect to asphalt plant modifications and change in volumetrics
  - How to make plant adjustments to improve rutting? Cracking?
- State DOTs need to understand some volumetric criteria may need to be relaxed to achieve desired performance
  - Ex. – Relax volumetrics to achieve fatigue cracking, while verifying rutting resistance
  - Ex. – Allow higher dust to binder for high RAP mixes when fatigue cracking passes

Primary Reason for Selecting BMD Approach to Mix Design (not in any order)

- Practicality and simplicity ("BMD process is not that complicated")
- Higher quality asphalt mixtures
  - Net result of better performing asphalt pavement
- Easier to obtain high quality, standardized test equipment
- Coordination and communication with State DOTs improved
- Results in a better QA program with the State DOTs
- Helps with distress specific issues
  - Ex. – Approach A found to help address NJDOT issues with
    - Composite pavement reflective cracking
    - Perpetual pavement design
    - Bridge deck waterproof overlays

BMD Approach Considerations
–Mechanical Test Specimen Conditions -

- **Aging** for fatigue cracking will be challenging for day-to-day operations
  - Some interviewees noted impact of long-term aging can be estimated by impact of short-term aging (Bonaquist – WHRP Report, WisDOT ID No. 0092-14-06)
    - AAT – for typical materials, long-term aging not necessary – utilize agency material specifications
- NCHRP Project 9-54
  - Number of days of loose mix conditioning at 95C to simulate 8 years of field aging
    - NJ: 8 days
    - WI: 5 days
    - TX: 9 to 16 days
- Continuing research
  - NRRA (Pooled fund program by Minnesota DOT)
  - NCHRP Project 9-70 (under contract)



Adjustments to Asphalt Mixture Components to Satisfy BMD

EXAMPLES OF INDIVIDUAL RESPONSES/RECOMMENDATIONS

Adjustments to Asphalt Mixture Components to Satisfy BMD –**Advanced Asphalt Technologies** -

- **Rutting:**
  - Use of "Resistivity Rutting Model" provides insights into factors that significantly impact rutting
  - IDT at high temperature is great for rutting assessment – fast and cheap
  - Limit or reduce VMA (effective asphalt content) to reduce rutting
  - Rutting decreases as RAP content increases
  - Stiffer binders (PMA, RAP) will generally improve rutting resistance

- **Cracking:**
  - Effective volume of binder is generally governing factor (higher = cracking resistance)
  - Pay close attention to recycled asphalt
  - Cracking tests will provide justification relative to reclaimed binder ratio (RBR) and effectiveness of recycling agents
  - If low temperature cracking, binder properties is predominant factor (except for case of weak aggregates)

Adjustments to Asphalt Mixture Components to Satisfy BMD –**Advanced Asphalt Technologies -**

- Resistivity-Rutting Model
  - Christensen and Bonaquist (2015), TRR
  - Developed from NCHRP 9-25 and 9-31
  - Includes Jnr, AV%, VMA%, gradation, Gsb, design & field compaction, aging, and ESAL traffic speed
  - Provide MESAL's to a maximum rut depth of 12 mm (95% confidence interval)

UNR/FHWA Webinar link:
https://scholarworks.unr.edu/handle/11714/8447

$$TR = 1.31\times10^{-4} N_{des}^{1.578} (\mathrm{P}K_a K_s)^{1.238} \left(\frac{V_{QC}}{V_{IP}}\right)^{1.09}$$

Where:

TR = million ESALs to a maximum rut depth of 12 mm (95 % confidence level)
P = resistivity, s/nm
= $\frac{S_a^2 G_a^2}{4.9 J_{nr,3.2} VMA^3}$
$J_{nr,3.2}$ = the non-recoverable compliance at 1 second loading and 3.2 kPa stress (Pa)
K_a = age hardening ratio, determined from the Mirza-Witczak global aging system
≅ $0.62 \times (t/2)^{0.37}$, where t is total design life in months
K_s = speed correction
= $(v/70)$, where v is the average traffic speed in km/hr

Resistivity Parameter Calculation

Inputs

Sa =	5.70	m^2/kg
Ga =	2.719	Gsb, unitless
Jnr, 3.2 =	0.00096	1/Pa
VMA =	15.3	%, unitless
Resistivity, P =	14.2	s/nm

LTPP High Temp @ 20mm Below

Temp, C =	54	Select PG grade	Known
$J_{nr, 3.2kPa}$ =	N.A.		
If $J_{nr, 3.2 kPa}$ Known, Select "Known" Above and Enter Value Here			0.96

Determined at the yearly, 7-day average maximum pavement temperature at 20 mm below the surface according to LTPPBind 3.1

Design, Field, and Project Information

Existing Service Time in Field =	6	months
Ka (age hardening ratio) =	0.88	
Vehicle Speed =	56.5	km per hr
Ks (speed correction) =	0.81	
V_{QC} (design air voids, %) =	4	%
V_{IP} (in-place air voids, %) =	6	%
Lab Compaction Level =	75	Gyrations

(50 gyr = 35 blows; 75 gyr = 50 blows; 100 gyr = 75 blows)

Typical Aircraft Speeds (kmh)

Taxiways = 37 to 56
Runways = Up to 270
(1 kmh = 0.62 mph)

Final Calculation

Rut Resistivity, TR =	1.3	**MESAL's to 7.2mm rut depth (50% Confidence)** **MESAL's to 12mm rut depth (95% Confidence)**

Mix Gradation	
Size (mm)	% Passing
37.5	100.0
25	100.0
19	100.0
12.5	96.8
9.5	89.3
4.75	55.8
2.36	35.9
1.18	26.6
0.6	19.9
0.3	12.9
0.15	8.4
0.075	6.2
Sa_1 (m^2/kg)	5.51
Sa_2 (m^2/kg)	5.89
Sa_{ave} (m^2/kg)	5.70

= Calculation being conducted (Do not change cell)
= Data/decision needed

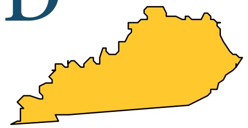
Adjustments to Asphalt Mixture Components to Satisfy BMD – **Advanced Materials Services** -

- ## Rutting:
- Use a polymer modified binder to improve rutting resistance
- Increase angularity of sand-sized particles

- ## Cracking:
- Add more binder & increase VMA
- Increase VFA to improve overall cracking performance
- Reduce air voids (as low as 2% with reasonable amount of RAP and polymer modified binder)
- Customize cracking test for needs
  - Overlay Tester for composite pavements
  - Flexural beam for flexible pavements (although high variability makes it challenging to interpret for BMD)

To balance performance, reduce air voids to as low as allowed while using RAP and/or polymer to maintain stability

Adjustments to Asphalt Mixture Components to Satisfy BMD – **Blankenship Asphalt Tech -**



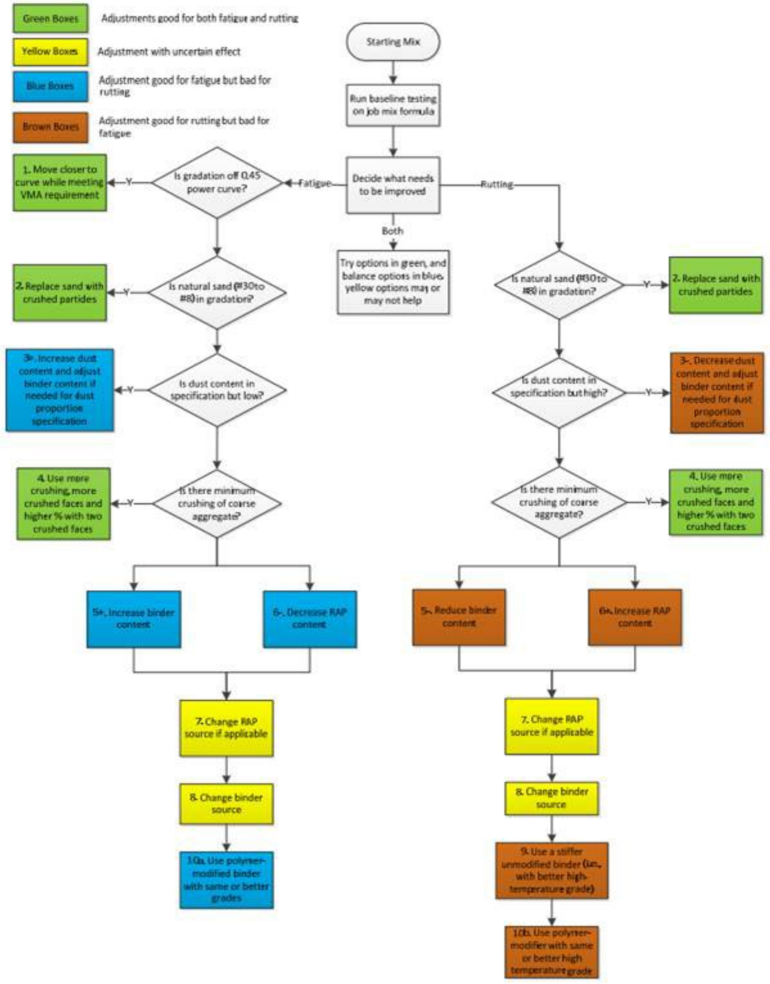
- ## Rutting:
- Evaluate gradation combinations based on VMA and optimize JMF based on rutting mechanical test outcome
- Lower natural sand and/or increase manufactured (angular) sand
- Look at dust particle size – dust type matters

- ## Cracking:
- Add more binder
- Aggregates may need to be washed (high fines content)
- Adjust binder type – use a softer binder
- Personal experience has shown IDEAL-CT may not capture full benefit of polymer, rubber, fibers and other additives – need to investigate your own materials

Lower design air void requirements when traffic conditions not major concern (i.e. – lower volumes)

Adjustments to Asphalt Mixture Components to Satisfy BMD – **Granite Construction** -

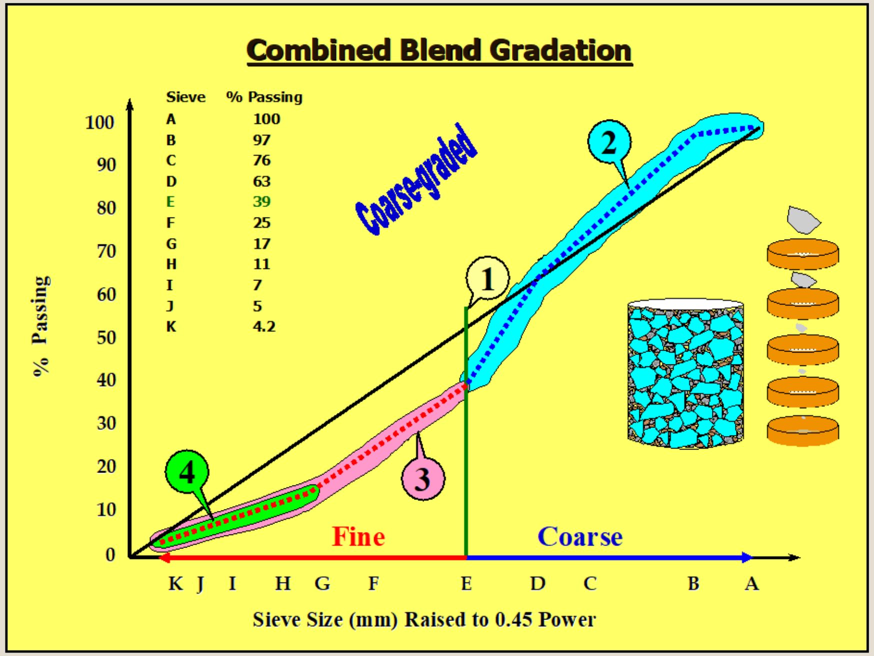
- Utilizes a flowchart framework developed by UC-Davis for CalTrans
  - Change one parameter at a time to minimize confusion
  - Found some adjustments have benefitted BMD performance but was out of specification for gradation tolerances. More flexibility by agencies necessary for successful implementation
  - **Experience has shown that volumetrics are not impacted by stiffness changes (i.e. – binder grade, RAP binder grade, etc.) to the same degree as mechanical tests**



Rongzong, Wu., Harvey, J., Buscheck, J, and Mateos, A., *UCPRC-RR-2017-12*. 1-112.

Adjustments to Asphalt Mixture Components to Satisfy BMD – **Similar Comments by Interviewees -**

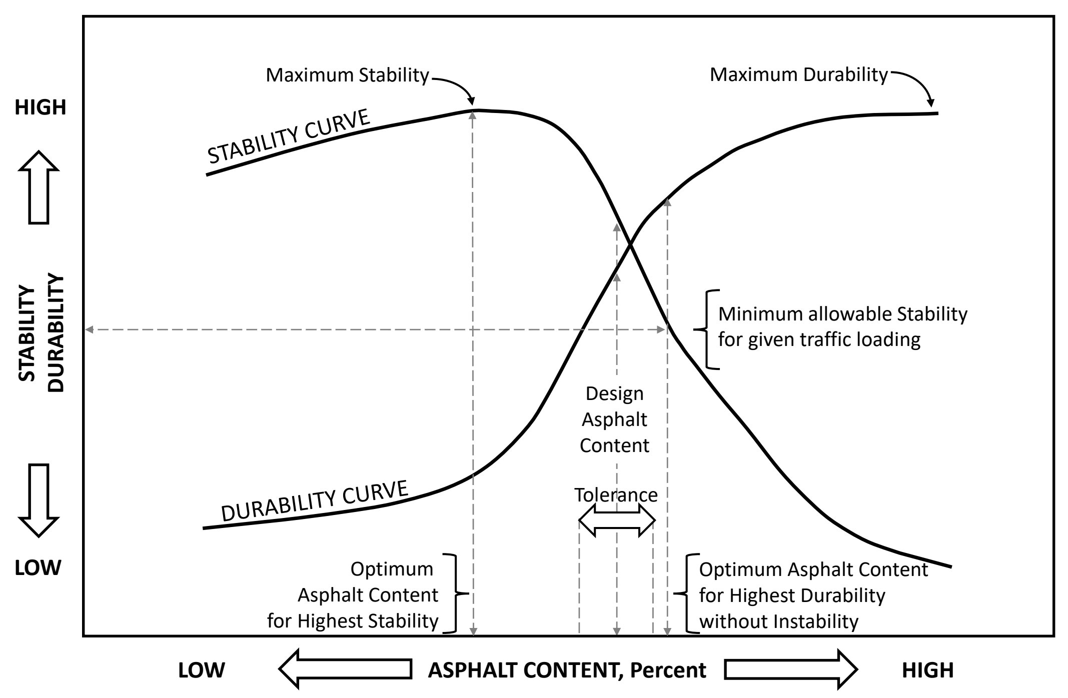
- General Considerations when Making Adjustments
  - Follow a systematic approach for making changes. One change at a time to understand impact
    - Produce sufficient mixture after adjustment to make accurate determination of impact (drum plant requires 50 to 100 tons minimum)
  - Look into Bailey method concepts to define the impact on aggregate properties on effective asphalt content
    - Aggregate shape, surface texture, and packing/structure



Bill Pine, Heritage Construction & Materials, IN

Adjustments to Asphalt Mixture Components to Satisfy BMD – **Similar Comments by Interviewees -**

- General Considerations when Making Adjustments
  - Reduce the focus on strict air void range or reduce the low-end tolerance of the air void
    - Traditional 3 to 5% plant voids; allow 2 to 5% as long as rutting passes
  - Balance the use of volumetric properties and mechanical testing. Don't focus solely on mechanical testing to solve issues
  - Simple consideration – get as much asphalt in the mix until you have stability/rutting issues
    - Can counteract rutting issues with stiffer binder at high temperatures (PMA and/or recycled asphalt)



Suggestions for Improvements Going Forward

(WITH SOME EXAMPLES OF RECENT WORK)

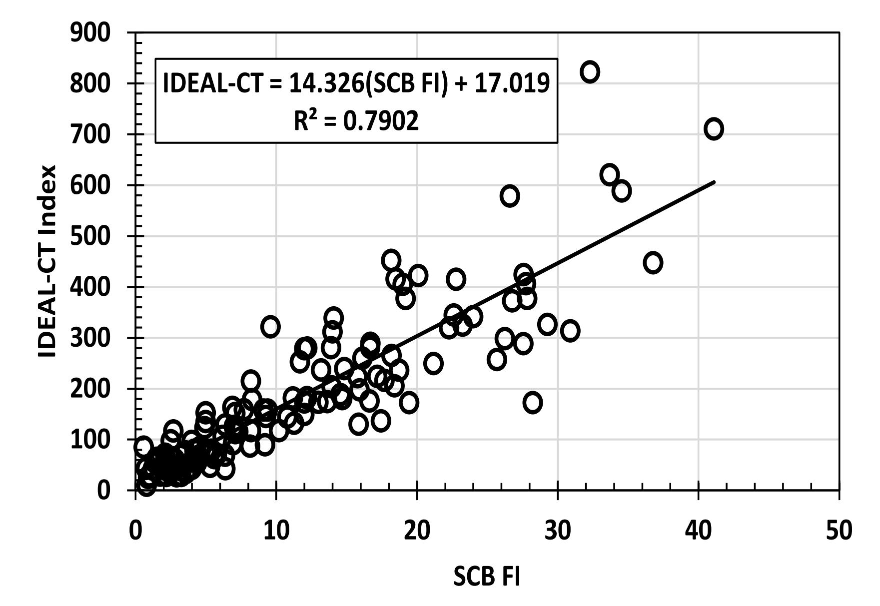
Suggestions to Improvements Moving Forward

- Research and Training Needs
  - A coordinated national effort to develop some type of regional/national training program
    - FHWA Balanced Mixture Design
    - NCAT BMD Guide/Lab Training
    - NAPA BMD Working Group
    - Virginia Education Center for Asphalt Technology (VECAT)
      - Current Youtube channel
- A need for established training program for technicians running the mechanical tests
  - Initiate/develop State DOT certification programs with periodic renewal
  - Encourage external training by State DOTs
  - Initiate work-force training programs at Universities

https://www.youtube.com/watch?v=5UEndoMNdGc

Suggestions to Improvements Moving Forward

- Importance of training (industry and State level)
  - Accreditation program for mechanical testing needed
    - AASHTO Re:source availability
      - Hamburg Wheel Tracking (AASHTO T324)
      - Asphalt Pavement Analyzer (AASHTO T340) – new for 2023
      - IDEAL-CT Index (ASTM D8225) – new for 2023
- Which test? Impact on suppliers/contractors working in multiple states
  - Can test relationships be established and used interchangeably?
  - Ex. Mathy Construction supplies to WI (HWT; SCB FI; IDEAL-CT), IA (HWT; DCT), MN (HWT, DCT), and IL (HWT, SCB FI)



Suggestions to Improvements Moving Forward

- If BMD adds mechanical test criteria without adding additional benefit, wh bother?
  - Pay adjustments?
- Criteria must consider pavement conditions – tied back to structural design
  - Layer specific
  - Traffic specific
  - Similar to Superpave material selection criteria

Test	NJDOT High RAP Requirement			
	Surface Course		Intermediate/Base Course	
	PG64-22	PG76-22	PG64-22	PG76-22
APA Rutting	< 7 mm	< 4 mm	< 7 mm	< 4 mm
Overlay Tester	> 200 cycles	> 275 cycles	> 100 cycles	> 150 cycles

Conclusion

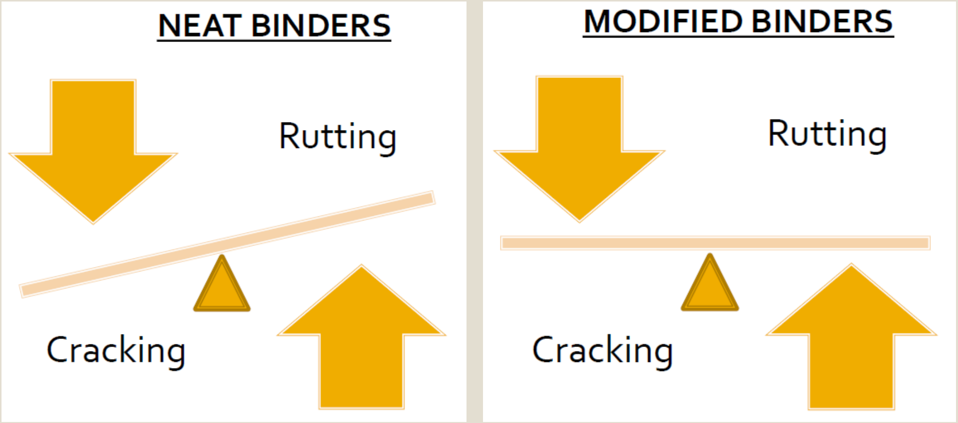
A FEW SUMMARY COMMENTS…

Summary

- Although interviewees had significant experience in BMD, responses to questions identified areas where work may be needed
  - Handling variability from contractor to State DOT
  - Validating lab produced vs plant produced
  - Accuracy vs practicality
  - Training on proper specimen fabrication and testing
  - Training on impact of mixture component changes to mechanical test response (plant production)
  - Accreditation program
  - Round robin programs to aid in training & equipment/technician checks
  - Where to collect necessary information for support

Summary

- Adjustments to meet Mechanical tests
  - Rutting
    - Minimize effective asphalt content (low end of VMA spec)
    - Increase high temp binder grade (PMA and/or recycled asphalt)
    - Increase angular/textured aggregates
  - Cracking
    - Increase effective asphalt content (VMA)
    - Increase VFA (increase in VMA with decrease in AV)
    - Watch impact of recycled binder
    - Binder source can impact performance with same binder grade



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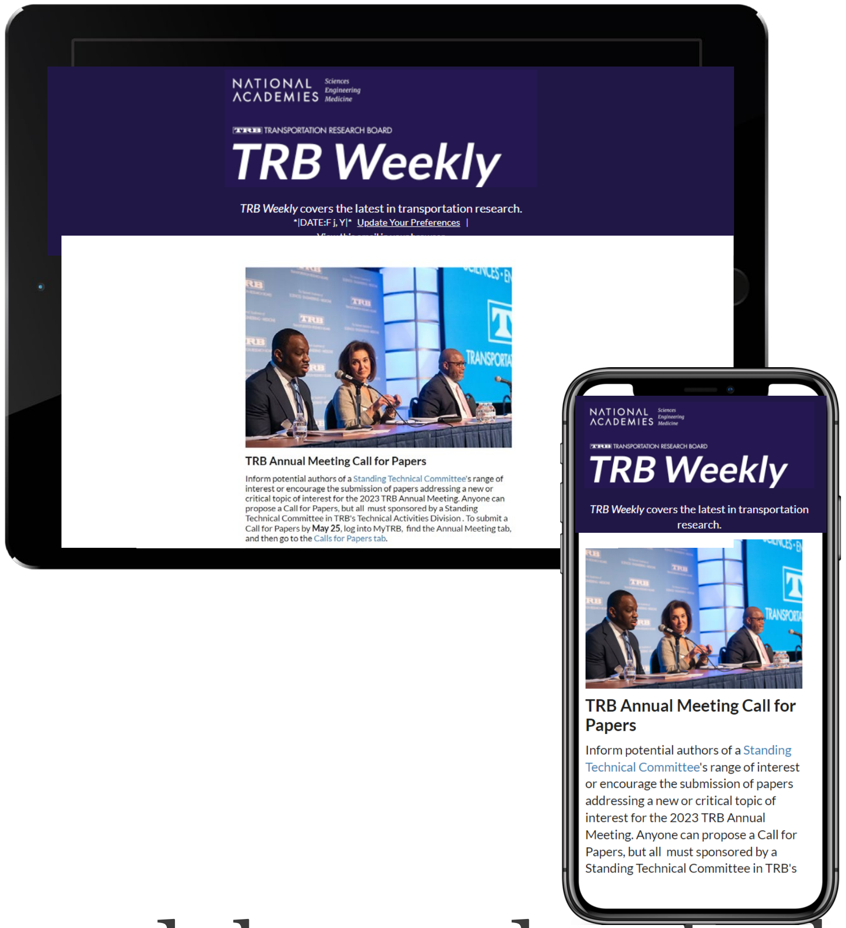

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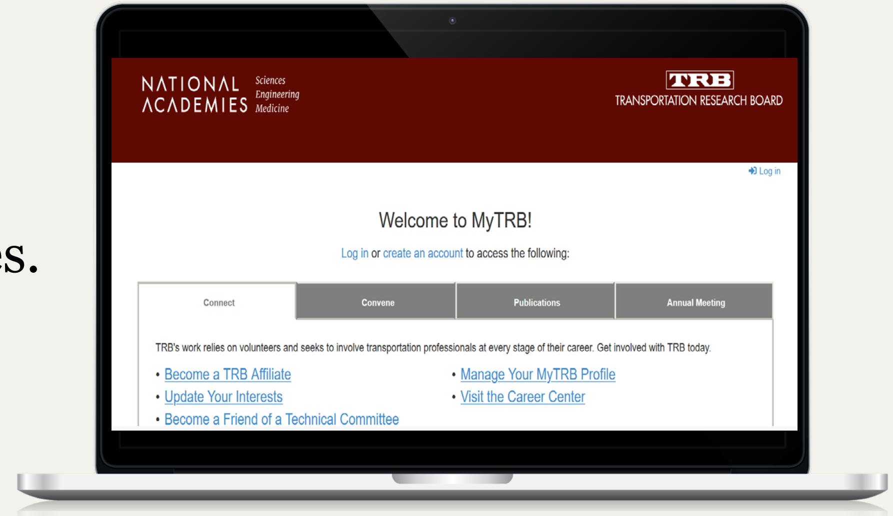

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