2024

Lead States Balanced Mix Design (BMD) Peer Exchange

Outcomes Summary

Chesterfield, MO

September 24–25, 2024

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16. Abstract

On September 24–25, 2024, seven lead States gathered for a peer exchange in Chesterfield, Missouri, and discussed their activities in advancing Balanced Mix Design (BMD) implementation. The peer exchange was sponsored by the Federal Highway Administration (FHWA). The peer exchange provided an opportunity for lead States to share their implementation status, lessons learned, and challenges encountered. The State participants also explored strategies to further enhance BMD adoption. This report summarizes key discussions of selected topics and highlights major outcomes of the peer exchange, including main takeaways, effective practices, and critical challenges identified by the lead States for implementing BMD.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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LIST OF ABBREVIATIONS AND SYMBOLS

Abbreviations

ΔT_c	Delta T_c
AASHTO	Association of State Highway and Transportation Officials
APA	Asphalt Pavement Analyzer
AQC	Acceptance Quality Characteristic
BMD	Balanced Mix Design
CAPRI	Consortium for Asphalt Pavement Research and Implementation
FHWA	Federal Highway Administration
GPC	Gel Permeation Chromatography
HT-IDT	Indirect Tensile Strength Test
HWTT	Hamburg Wheel Tracking Test
IDEAL-CT	Indirect Tensile Asphalt Cracking Test
IDEAL-RT	Indirect Tensile Asphalt Rutting Test
IDOT	Illinois Department of Transportation
I-FIT	Illinois Flexibility Index Test
LaDOTD	Louisiana Department of Transportation and Development
MiST	Moisture Induced Stress Tester
MoDOT	Missouri Department of Transportation
NCHRP	National Cooperative Highway Research Program
OBC	Optimum Binder Content
ODOT	Oregon Department of Transportation
OT	Overlay Test
PAV	Pressure Aging Vessel
PWL	Percent Within Limit
RAP	Reclaimed Asphalt Pavement
RAS	Reclaimed Asphalt Shingle
SCB-J_c	Semi-circular Bend Test
SMA	Stone Matrix Asphalt
TSR	Tensile Strength Ratio
TxAPA	Texas Asphalt Pavement Association
TxDOT	Texas Department of Transportation
VAA	Virginia Asphalt Association
VDOT	Virginia Department of Transportation
WisDOT	Wisconsin Department of Transportation

INTRODUCTION AND PURPOSE

On September 24–25, 2024, seven lead States gathered for a peer exchange on implementation activities to support Balanced Mix Design (BMD). The peer exchange, sponsored by the Federal Highway Administration (FHWA), aimed to sustain momentum in advancing and adopting BMD principles, identify emerging challenges, and foster collaboration among the lead States. The peer exchange was hosted by the Missouri Department of Transportation (MoDOT) in Chesterfield, Missouri. This summary report focuses on lessons learned from the peer exchange, including an overview of BMD implementation status for the lead States, discussions of selected topics for BMD implementation, key takeaways, effective practices, and critical challenges identified by the State participants.

PEER EXCHANGE GENERAL OVERVIEW

BMD focuses on designing asphalt mixtures to meet performance requirements rather than just volumetric requirements. Association of State Highway and Transportation Officials (AASHTO) PP 105-24 Standard Practice for Balanced Design of Asphalt Mixtures[1] describes four approaches for BMD, summarized as follows:

- ***Approach A — Volumetric Design with BMD Verification*** consists of using an existing volumetric mix design along with additional mechanical tests and criteria.
- ***Approach B — Volumetric Design with BMD Optimization*** consists of using an existing volumetric mix design to determine a preliminary optimum binder content (OBC) but allows moderate changes in asphalt binder content to meet mechanical tests criteria. This approach is slightly more flexible than Approach A.
- ***Approach C — BMD-Modified Volumetric Mix Design*** allows some of volumetric properties to be relaxed or eliminated as long as the mechanical test criteria are satisfied. The mechanical test results are used to adjust either the preliminary asphalt binder content or mixture component properties and proportions. This approach is more flexible than Approach A and Approach B.
- ***Approach D — BMD Design Only*** does not use volumetric properties and relies on the mechanical test results to establish and adjust mixture components and proportions. This is considered the most flexible approach.

Participants

States represented at the peer exchange (Figure 1) include:

- Illinois Department of Transportation (IDOT).
- Louisiana Department of Transportation and Development (LaDOTD).
- MoDOT.
- Oregon Department of Transportation (ODOT).
- Texas Department of Transportation (TxDOT).
- Virginia Department of Transportation (VDOT).
- Wisconsin Department of Transportation (WisDOT).

[1]AASHTO PP 105 Standard Practice for Balanced Design of Asphalt Mixtures. American Association of State Highway and Transportation Officials, Washington, D.C., 2020. Use of this AASHTO specification is not a Federal requirement.

Figure 1. U.S. Map showing participating States in the Lead States BMD Peer Exchange.

Agenda

The peer exchange started with reviews of the meeting goal, Guide for Implementing BMD Specifications[2], and national ongoing BMD research and implementation efforts, followed by facilitated discussions on selected topics from the following:

- Starting with the why and benefits.
- Identifying challenges.
- Sharing solutions and best practices.
- Strategies for complex challenges.
- Sustaining momentum.
- Emerging challenges and future outlook.
- Action items and next steps.
- Technical challenges.
- Management challenges.

Questionnaire

Three weeks before the peer exchange, the attendees from the seven participating States were asked to provide information about their BMD implementation status and efforts. Their responses are summarized in Appendix A.

OVERVIEW OF BMD IMPLEMENTATION STATUS

Table 1 presents the BMD implementation status chart of the seven participating lead States, following the eight major tasks identified in the Guide for Implementing BMD Specifications.[2,3] The chart is color-coded, with completed tasks highlighted in green (C), ongoing tasks in diagonal shaded orange (OG), in-progress tasks in vertical shaded yellow (IP), and non-started tasks in red (N). Details on the implementation status of individual subtasks can be found in Appendix B.

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[2]National Cooperative Highway Research Program (NCHRP) 10–107. *Guide for Implementing Balanced Mix Design Specifications*, Report, National Center for Asphalt Technology, April 2023. (Available at https://www.asphaltpavement.org/expertise/engineering/resources/bmd-resource-guide/training-resources)

[3]Hajj, E.Y., Aschenbrener, T., Nener-Plante, D., West, R., Yin, F., and J., Musselman. *Tech Brief: Balanced Asphalt Mix Design: Eight Tasks for Implementation*, Final Report, FHWA-HIF-22-048, U.S. DOT, April 2022.

Table 1. BMD Implementation Status Chart of the Seven Participating States.

Task	Subtask	IDOT	LADOTD	MoDOT	ODOT	TXDOT	VDOT	WisDOT
1-Benefits	–	C	C	C	C	C	C	C
2-Planning	2.1-Champions	C	C	C	C	OG	C	OG
	2.2-Partnership	C	C	C	C	OG	C	OG
	2.3-Homework	C	C	C	OG	OG	C	OG
	2.4-Goals	C	C	C	C	C	C	OG
	2.5-Mapping	C	C	C	C	C	C	OG
	2.6-Support	C	C	C	OG	OG	OG	OG
	2.7-Timeline	C	C	IP	OG	C	OG	OG
3-Tests	3.1-Distresses	C	C	C	C	C	C	OG
	3.2-Selection	C	C	C	C	C	OG	C
	3.3-Validation	C	C	C	OG	OG	OG	OG
4-Equipment	4.1-Acquiring	C	OG[b]	IP	C	IP	C	OG
	4.2-Resources	C	OG[b]	IP	OG	IP	C	OG
	4.3-Training	C	C	IP	C	N	C	OG
	4.4-Evaluation	C	C	OG	OG	IP	OG	OG
	4.5-ILS	C	C	OG	C	IP	IP	OG
5-Baseline Data	5.1-Reviewing	C	C	C	C	C	OG	C
	5.2-Benchmarking	C	C	C	C	C	OG	OG
	5.3-Shadow	C	C	C	C	IP	OG	C
	5.4-Production data	C	C	OG	C	IP	OG	OG
	5.5-Adjusting Mixes	C	C	OG	C	IP	OG	OG
6-Specifications	6.1-Sampling Plans	C	C	C	OG	IP	OG	N
	6.2-Pay Adjustment	N[a]	OG[c]	C	OG	N	N	N
	6.3-Pilot Specs	C	C	C	OG	OG	OG	IP
	6.4-Pilot Projects	C	C	OG	OG	N	OG	IP
	6.5-Spec Revisions	C	C	OG	N	OG	OG	N
7-Training	7.1-Training Programs	C	C	IP	N	N	OG	IP
	7.2-Accreditation	C	C	IP	N	N	OG	N
8-Implementation	–	C	C	IP	N	N	C[d]	N

Notes: –not applicable; C = completed; OG = ongoing (i.e., a task that is regularly being worked on but does not have a completion date); IP = in-progress (i.e., a task that is underway and has a specific completion date); N = non-started; ILS = inter-laboratory study; [a]No current plans to establish pay factors; [b]Outfitting district laboratories for testing; [c]Will be considered when a viable acceptance framework is determined; and [d]Completed for initial implementation of non-polymer modified 9.5mm and 12.5mm surface mixes in maintenance contracts.

DISCUSSION OF SELECT TOPICS FOR BMD IMPLEMENTATION

Task 1. Motivations and Benefits for Implementing BMD

The lead States reported a variety of motivations and anticipated benefits for implementing BMD, including improving pavement performance and lifespan, addressing "dry mix" cracking issues, increasing the use of reclaimed asphalt pavement (RAP), reclaimed asphalt shingle (RAS), and locally available materials. Additionally, some participating States highlighted specific industry-driven factors, such as increased competition and market pressures, which have spurred greater interest in BMD from contractors.

State Highlights

- LaDOTD has published a report[4] demonstrating pavement life extension benefits of asphalt mixtures designed with BMD over Superpave specifications using AASHTOWare Pavement ME Design.

[4] Mayeux, C.R., Akentuna, M. and Salari, S., 2024. *Evaluation of Performance and Life Cycle Cost of Asphalt (8/18 Specifications)* (No. FHWA/LA. 24/670). Louisiana Transportation Research Center.

- VDOT adopted the BMD framework to address challenges related to the performance of surface asphalt mixtures, support the increasing use of innovative materials, and enhance the use of resource responsible materials in pavement systems. Figure 2 summarizes VDOT's motivations for implementing BMD, driven by concerns over cracking performance of asphalt pavements, insufficient asphalt binder in asphalt mixtures, and a growing interest in using high RAP content (>30%). While piloting 50-gyration asphalt mixtures initially aimed at addressing these concerns, it ultimately did not resolve the cracking performance issues, reinforcing VDOT's need for an approach like BMD.

Figure 2. VDOT Motivation and Anticipated Benefits for BMD.

Task 2. Overall Planning for BMD Implementation

All the lead States except one noted that the industry and agency management were supportive of BMD implementation because of the anticipated benefits documented above. Several States noted that leveraging State research programs with academia, research institutions, and consultants was beneficial to accelerating the implementation process. The lead States emphasized the importance of developing a clear, comprehensive, yet realistic implementation plan at the beginning of the BMD implementation process. The lead States also found that engaging the industry and district laboratories is important throughout the implementation process.

State Highlights

- IDOT offered free BMD testing services to the industry, which helped get buy-in from the industry. These testing services allowed asphalt contractors to start collecting performance test data before the acquisition of test equipment, which was often expensive and had a long lead time for delivery.
- ODOT leveraged successful BMD implementation experiences from other States to help get buy-in from agency management and the industry.

Task 3. Selecting Performance Tests

Rutting Tests

The lead States reported using the Hamburg Wheel Tracking Test (HWTT) or Asphalt Pavement Analyzer (APA) to evaluate rutting resistance for mix design. Some States are exploring using a surrogate test with a shorter turnaround on test results for production, such as the High-temperature Indirect Tensile Strength Test (HT-IDT) and Indirect Tensile Asphalt Rutting Test (IDEAL-RT). These tests have exhibited reasonable correlations to HWTT and APA, allowing the State DOT and contractors to use the results for quality control and acceptance decisions during production.

Cracking Tests

The lead States reported using different tests to evaluate cracking resistance for mix design, including the Illinois Flexibility Index Test (I-FIT), Semi-circular Bend Test (SCB-J_c), Indirect Tensile Asphalt Cracking Test (IDEAL-CT), and Overlay Test (OT). They reported different rationales for selecting the tests but agreed that the test must correlate to field cracking performance. They also expressed the desire to use a "simple" test during production to allow a quick turnaround of test results. For instance, LaDOTD is considering alternative tests for production, while maintaining SCB for mix design. Similarly, TxDOT has also been exploring the use of IDEAL-CT to assess the cracking resistance of plant-produced mixtures while requiring the OT for mix design. In another example, MoDOT started with the I-FIT for cracking resistance evaluation but later transitioned to the IDEAL-CT for its practicality and ease of implementation for plant-produced mixtures.

The lead States recognized the necessity of addressing long-term aging when evaluating surface cracking resistance, especially for asphalt mixtures containing additives (e.g., recycling agents). The lead States use different long-term aging procedures. For example, IDOT uses compacted specimen aging for 3 days at 95°C.[5] LaDOTD uses compacted specimen aging for 5 days at 85°C

[5]More information on long-term aging can be found in Al-Qadi, I.L., Ozer, H., Zhu, Z., Singhvi, P., Mohamed Ali, U., Sawalha, M., Espinoza Luque, A.F., Garcia Mainieri, J.J. and Zehr, T.G., 2019. *Development of long-term aging protocol for implementation of the Illinois flexibility index test (I-FIT)*. FHWA-ICT-19-009.

following the former AASHTO R 30-22 but is exploring accelerated aging methods that are less time-consuming and, consequently, more suitable for production testing. WisDOT uses loose mix aging for 6 hours at 135°C.[6]

Moisture Damage Tests

The lead States reported varied levels of success with the HWTT and Tensile Strength Ratio (TSR) test for evaluating the moisture damage of asphalt mixtures. Initially, some participating States believed that adopting the HWTT would be sufficient to address both rutting and moisture damage in asphalt mixtures. Despite improvements, persistent moisture damage problems suggested that HWTT might not fully capture all aspects of moisture damage, depending on factors like aggregate properties and climate.

Asphalt Binder Tests

The lead States recognized the need to adopt an asphalt binder test, like Delta T_c (ΔT_c),[7] as a potential screening tool for BMD performance tests to improve the efficiency of the mix design process. For example, ΔT_c can help identify asphalt binders and additives with poor relaxation properties and high susceptibility to aging, which may result in asphalt mixtures with inadequate long-term cracking resistance. Therefore, asphalt contractors can utilize the ΔT_c results to guide the selection of asphalt binders and additives before conducting the BMD performance tests as part of the mix design process.

The discussion indicated that cracking tests in general depend on the base binder used, requiring correlation to field performance. For instance, the IDEAL-CT uses a single testing temperature, while a variety of binder grades are employed. Therefore, an examination of the test temperature in relation to the intermediate binder grade used (or intermediate environmental temperature) may be warranted.

State Highlights

- IDOT specifies a limit for ΔT_c with 40-hour pressure aging vessel (PAV) aging to avoid the use of virgin asphalt binders that may cause cracking issues in asphalt mixtures due to excessive susceptibility to aging.
- LaDOTD reported that HWTT was not effective in discriminating moisture-resistant versus moisture-susceptible mixes. To address this issue, LaDOTD is considering using TSR in combination with HWTT, conditioning HWTT specimens with freeze and thaw cycles before testing, or conditioning HWTT specimens with the Moisture Induced Stress Tester (MiST) before testing. LaDOTD uses Gel Permeation Chromatography (GPC) to fingerprint virgin asphalt binders, effectively detecting changes in asphalt binder suppliers or sources from mix design to production or during production. LaDOTD also specifies meeting the ductility test on asphalt binders that showed a strong correlation with SCB-J_c test results.
- TxDOT considers increasing HWTT temperature to better assess the rutting resistance of highly modified asphalt mixtures. TxDOT specifies ΔT_c testing of virgin asphalt binders

[6]More information on long-term aging can be found in Bahia, H.U., Sadek, H., Rahaman, M.Z., Lemke, Z., Swiertz, D., Reichelt, S. and Bitumix Solutions, L.L.C., 2018. *Field aging and oil modification study (No. 0092-17-04)*. Wisconsin. Dept. of Transportation.

[7]G. Baumgardner. *Tech Brief: Delta Tc Binder Specification Parameter*, Final Report, FHWA-HIF-21-042, U.S. DOT, September 2021.

while currently exploring the use of the Poker Chip test.[89]

- VDOT uses the Cantabro test to evaluate the durability of asphalt mixtures. VDOT reported that the Cantabro test appears to perform as a screening test for IDEAL-CT. Nonetheless, VDOT has recognized that the Cantabro test is temperature-sensitive and unsuitable for testing field cores.
- WisDOT reported that IDEAL-CT could not appropriately capture the benefits of polymer-modified asphalt binders in mixture cracking resistance. WisDOT has had a successful experience using TSR (without freeze or thaw cycles) to eliminate moisture-susceptible mixes but is exploring the possibility of replacing it with HWTT in the future. WisDOT is also assessing the applicability of the HWTT for rutting and moisture resistance evaluation of asphalt mixtures for low-volume roads.

Task 3. Validating Performance Tests and Criteria

The lead States recognized the need to validate the selected performance tests and criteria for BMD using field test sections to ensure their ability to discriminate between good-performing and poor-performing mixtures under various traffic and climate conditions. The test sections can be new construction or overlay projects on open roadways, accelerated pavement testing facilities, and test tracks.[10] The lead States also acknowledged the need to initiate performance validation efforts early in the BMD implementation process to facilitate the collection of field performance data.

The discussion indicated a few important points: it is essential to validate the test using both good- and poor-performing asphalt mixtures in the field to establish test criteria. Validation takes time and should begin immediately to ensure timely results. Additionally, the test temperature may need to be adjusted based on climate conditions, while the number of passes may need to be modified to reflect traffic conditions.

State Highlights

- TxDOT conducted BMD field validation test sections through change orders without penalties or additional costs to asphalt contractors.
- VDOT constructed a BMD accelerated pavement testing experiment with six asphalt mixtures, including various RAP contents, two binder grades, and two asphalt additives. The results from BMD testing of these mixtures aligned well with the field performance.[11]
- WisDOT built a BMD field validation experiment in 2022 with six test sections on open highways and has been monitoring their field performance. Despite successfully constructing the test sections, WisDOT encountered challenges with site selection due to unexpected variations in underlying pavement structures and materials.

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[8]Hajj, R.M., 2016. *Fatigue characterization of asphalt binders using a thin film poker chip test* (Doctoral dissertation).

[9]Mohanraj, K., Filonzi, A., Mahmoud, E. and Bhasin, A., 2023. *Field validation on the use of poker-chip test to predict cracking in flexible pavements*. Journal of Transportation Engineering, Part B: Pavements, 149(2).

[10]West, R., Tran, N., Yin, F., Rodezno, C., and T., Harman. *Guidelines and Recommendations for Field Validation of Test Criteria for Balanced Mixture Design (BMD) Implementation*, Report No. CAPRI-23-001-R, Consortium for Asphalt Pavement Research and Implementation (CAPRI), October 2023.

[11]Habbouche, J., Tong, B., Flintsch, G.F., Diefenderfer, S.D., Diefenderfer, B.K., Urbaez Perez, E. (2025) "*Evaluation of BMD Surface Mixtures with Conventional and High RAP Contents Under Laboratory-Scale and Full-Scale Accelerated Testing*." Virginia Transportation Research Council, Charlottesville, VA, in edit.

Task 4. Performance Testing Equipment and Staffing

The lead States reported that the lack of staffing resources (including turnover of staffing) was a significant challenge to implement BMD. To address this, several States have had success hiring consultants or research institutions to assist with performance testing needs. The lead States also reported that initial training on sample preparation, equipment calibration, test procedure standardization, and data analysis was necessary to ensure data quality and reduce within-laboratory and between-laboratory variability of test results. The lead States suggested regularly checking and calibrating test equipment, especially when they initially arrive, to ensure compliance with test standard requirements.

Task 5. Shadow and Pilot Projects

All lead States have constructed BMD shadow and pilot projects. These projects were helpful in familiarizing State DOT and industry personnel with conducting performance tests during production, recognizing the difference in test results from mix design to production, and understanding the impact of production variability on the test results.

State Highlights

- IDOT completed at least one pilot project in each of its nine districts in 2016, followed by approximately fifty additional pilot projects from 2017 to 2019. In 2020, all projects with mainline asphalt paving were constructed as shadow projects.
- LaDOTD conducted shadow projects between 2014 and 2016 and plans to conduct pilot projects with performance testing requirements for quality control and acceptance.
- MoDOT conducted pilot projects in 2017 and 2018. Since 2019, roughly 15 pilot projects have been completed annually, which all included incentives and disincentives, as well as QC and acceptance requirements for performance test results.
- ODOT implemented 500-foot test sections for five shadow projects and has secured funding for conducting pilot projects in 2025.
- TxDOT has conducted shadow and pilot projects over the last 7 to 8 years. The initial focus of these projects was on multiple short test sections with varying mix design variables, but the focus has recently shifted to constructing long test sections to assess production variability. TxDOT is working with academia to collect field performance data and laboratory test results at the project level.
- VDOT conducted research pilot projects in 2019 and 2020 using no-cost change orders. In 2021 and 2022, production pilot projects were incorporated into maintenance plant mix schedule contracts by applying BMD mixtures to specified routes and counties. The performance of pilot projects from 2019 through 2021 is being monitored for validation efforts.
- WisDOT has completed 5 to 6 shadow projects, with production data collected for informational purposes. WisDOT plans to conduct more shadow projects in the future.

Task 6. Specifications and Program Development

The lead States reported different approaches (and anticipated approaches) to handling acceptance for BMD.

- IDOT conducts mix design verification and production BMD testing at the district laboratory. Using percent within limit (PWL) specifications for volumetrics and density has helped IDOT minimize the need for “remove and replace” actions. IDOT plans to

conduct more regular production performance testing in the future. Current production testing is typically limited to the start of production.

- LaDOTD requires the contractor to develop the mix design in the laboratory and produce the mixture through the plant for design verification. If the plant asphalt mixture meets the specification requirements, the verification results become the target for the rest of production.
- MoDOT handles mix design approval primarily based on paper review but requires performance testing during production for acceptance and pay adjustments.
- ODOT currently requires IDEAL-CT during production on a pilot basis, but the results are collected for informational purposes only.
- TxDOT requires performance testing for mix design verification at the beginning of production. TxDOT has not established a clear path for acceptance but may consider using IDEAL-CT and IDEAL-RT for acceptance on a sublot basis in the future. Go/No-Go may not work because of reluctance by TxDOT to stop paving operations.
- VDOT handles mix design verification based on paper review due to staff and resource limitations but requires performance testing on a Go/No-Go basis during production. VDOT is evaluating the current production testing frequency. VDOT indicated that Go/No-Go may not work because of reluctance to stop paving and that handling discrepancies between agency and contract test results could be challenging due to mix storage limitations. VDOT may continue to use asphalt content and gradation as acceptance quality characteristics (AQCs) for acceptance. Analyzing the AQCs with a Quality Measure that includes variability (e.g., PWL), may help ensure consistency of the produced mixture and consistency of performance test results.
- WisDOT has successful experience with using test strips for acceptance under Superpave specifications. WisDOT raised questions about the necessity of conducting performance testing on laboratory-prepared materials for mix design approval and verification, suggesting that performance testing on plant-produced materials seemed more essential to ensure end-product quality.

The lead States indicated that dispute resolution was needed when using performance test results beyond the Go/No-Go decision for BMD. The lead States reported different approaches to handling asphalt binder source or supplier changes for BMD. IDOT requires compliance with ΔTc requirements. LaDOTD uses GPC to fingerprint asphalt binders sampled daily. TxDOT requires a new mix design if the asphalt binder supplier changes. The other lead States allow changes in asphalt binder source or supplier provided that the PG requirements can be met.

Task 7. Training, Qualifications, and Accreditations

The lead States suggested conducting training regularly for State DOT and industry personnel. They also noted that the training materials should cover technician responsibilities with performance testing, equipment calibration, and verification.

State Highlights

- TxDOT has established a proficiency program for HWTT and is developing a similar program for OT, with potential plans to add IDEAL-CT and IDEAL-RT. TxDOT hired the Texas Asphalt Pavement Association (TxAPA) to manage the training and certification programs.

- VDOT collaborates with the Virginia Asphalt Association (VAA) to provide BMD training and certification. VDOT has conducted two rounds of interlaboratory studies for IDEAL-CT and developed guidelines for assessing IDEAL-CT data quality.

Task 8. Initial Implementation

The lead States recommended continuously monitoring the performance of existing field projects and using the data to make appropriate adjustments to BMD test criteria beyond initial implementation.

Role of BMD in LCTM Grant Program

The lead States noted that the FHWA LCTM grant program provided State DOTs an excellent opportunity to start or accelerate BMD implementation by procuring equipment, developing training and certification programs, and revising asphalt mixture specifications. Since the LCTM program is specifically looking at the cradle-to-gate stage of production, BMD is critical for ensuring long-term performance of LCTM, as it provides the safeguard to ensure the durability and longevity of asphalt mixtures throughout their service life.

For States interested in starting from scratch, the lead States offered the following suggestions for success:

- IDOT: Understand the issues and limitations of the current mix design system.
- LaDOTD: Define the motivations and objectives of implementing BMD and identify key State DOT and industry personnel for major tasks.
- MoDOT: Communicate with industry partners to establish buy-in for collaboration and ensure industry alignment.
- ODOT: Form a working group with industry members and establish a process for continuous feedback.
- TxDOT: Engage the right stakeholders, including those who may resist BMD implementation.
- VDOT: Begin with solid communication, collaboration, and coordination among stakeholders. Establish a clear path after understanding the why and goals. Start implementing BMD for mixtures with the most pressing performance issues and high-tonnage mixtures.
- WisDOT: Conduct workshops and educational initiatives to bring stakeholders up to speed.

For States interested in accelerating an existing BMD program, the lead States offered the following suggestions for success:

- LaDOTD: Communicate how LCTM materials can deliver comparable or improved performance under BMD. If central laboratories handle mix design approvals, assess the need to establish district laboratories for LCTM compliance.
- VDOT: Define State goals to align with LCTM program requirements.

SUMMARY OF PEER EXCHANGE OUTCOMES

Key Takeaways by State Participants

- ODOT: develop training and certification programs; establish a formal agency-industry working group; and develop a detailed implementation plan.

- WisDOT: develop a detailed implementation plan; establish a formal agency-industry working group; and organize a BMD workshop.
- IDOT: document historical efforts, rationales, and decisions for major implementation tasks; continue to collect performance test results on stone matrix asphalt (SMA) mixtures; keep track of implementation progress; and integrate BMD into the LCTM program.
- LaDOTD: develop a more practical long-term aging procedure for production testing; explore surrogate cracking tests for production testing; integrate BMD into the LCTM program; and continue data collection through other funding opportunities.
- TxDOT: address equipment calibration and compliance verification requirements and implement an accelerated long-term aging procedure for BMD cracking tests.
- VDOT: progress with actionable steps to further advance BMD implementation.
- MoDOT: document historical efforts, rationales, and decisions for major implementation tasks and develop a blueprint for full BMD specifications.

Key Takeaways by State Participants Grouped by Topic

- Start an agency-industry working group.
- Document the "why" behind the specifications, options, and background.
- Create an implementation plan with a timeline and keep it updated.
- Document the process used to create the specifications. There may be staffing turnover or there may be a desire to change the specification in the future.
- Technical topics:
    - Check equipment calibration regularly.
    - Implement a surrogate cracking test for production testing.
    - Adopt an aging procedure for use with the cracking test.
    - Create a training and certification program.
    - Host a BMD Implementation Workshop.
    - Build on momentum from the workshop and keep progress going by meeting with internal stakeholders.
    - Consider participating in the Consortium for Asphalt Pavement Research and Implementation (CAPRI).

Effective Practices Identified by the State Participants for Implementing BMD

Getting Started

- Define and document the motivations and goals for implementing BMD.
- Develop a clear, comprehensive, and realistic implementation plan with anticipated timelines for incremental progress and milestones throughout the implementation process.

Communication and Training

- Be proactive with getting the industry and district laboratories involved from the beginning of the BMD implementation process.
- Conduct regular training with State DOT and industry personnel responsible for conducting BMD tests.

Laboratory Data Collection

- Standardize mix sampling and storage, sample preparation, equipment calibration, performance testing, and data analysis procedures.

- Leverage performance testing support from consultants and academia.
- Conduct interlaboratory studies to assess test variabilities between agency and industry laboratories.
- Consider long-term aging in evaluating surface cracking resistance, especially for asphalt mixtures containing additives.
- Consider using an asphalt binder test as a screening tool for mixture performance tests to improve the efficiency of the mix design process.
- Include both laboratory-prepared and plant-produced materials in benchmarking efforts.

Field Data Collection

- Plan BMD field validation experiments as soon as possible to allow timely collection of field performance data to validate BMD tests and criteria.
- Closely monitor the field performance of shadow and pilot projects and assess their correlations with laboratory test results from mix design and production.
- Evaluate and document production variability to refine BMD test methods and criteria.

Critical Challenges in Implementing BMD

The following critical challenges identified by lead States highlight hurdles to the successful implementation and adoption of BMD that need to be overcome or addressed.

- Understanding the motivations for implementing BMD and getting buy-in from agency management and industry stakeholders. This requires understanding the opportunities and challenges of BMD compared to the current mix design and acceptance system, and aligning the goals and expectations of involved stakeholders.
- Lack of clear guidance for developing an implementation plan, including well-defined milestones, timelines, resource allocations, and performance metrics. Without a structured approach, it becomes challenging to track progress, ensure proper activities, and make adjustments as needed to achieve successful implementation.
- Challenges in demonstrating and quantifying the benefits of BMD. While BMD may extend pavement performance life, concerns exist regarding potential impacts on project bid prices and the added effort required from States DOTs for implementation.
- Limited staffing resources and skilled technicians for handling performance testing. This directly impacts the structure of the acceptance program and the frequency of testing during production.
- Long duration and high variability of certain BMD tests that limit integration into standard laboratory routines. In particular, extended testing times during production hinder timely decision-making.
- Discrepancies in test results between agency and industry laboratories. Thus, highlighting the need for standardized testing procedures and protocols, as well as a better understanding of interlaboratory variability.
- Insensitivity or counterintuitive sensitivity of some BMD tests to mix design variables, such as polymer modification and air voids.
- Insufficient validation of moisture damage tests.
- Lack of standardization with sample preparation and handling for performance testing, uncertainty in addressing long-term aging for surface cracking evaluation, and the unknown impacts of lag and dwell time on performance test results and lack of guidance on how to handle them in mix design and acceptance decisions (Note: lag time refers to the

period between sampling and fabrication, while dwell time refers to the period between fabrication and testing).

- Inadequate training in sample preparation, equipment calibration and verification, and data analysis. Thus, emphasizing the need for a comprehensive, agency-specific training program.
- Lack of guidance on relaxing material properties and volumetrics when adding performance test requirements.
- Absence of clear procedures for handling production acceptance, including dispute resolution.

CONCLUSION

To maintain momentum, participating States have expressed a willingness to share data and reports, which will help foster collaboration and keep the initiative progressing. Additionally, the lead States have expressed interest in holding a follow-up virtual or in-person meeting. This meeting will offer an opportunity to address new challenges and developments that have emerged during BMD implementation.

APPENDICES

Appendix A: Questionnaire Responses

Illinois

Implementation Status Chart

Task	Sub Task	Description	Status	Additional Comments
1. Motivations and Benefits of Performance Specifications	n/a		Complete	
2. Overall Planning	2.1	Identification of Champions	Complete	
	2.2	Establishing a Stakeholders Partnership	Complete	
	2.3	Doing Your Homework	Complete	
	2.4	Establishing Goals	Complete	
	2.5	Mapping the Tasks	Complete	
	2.6	Identifying Available External Technical Information and Support (periodically)	Complete	
	2.7	Developing an Implementation Timeline	Complete	
3. Selecting Performance Tests	3.1	Identifying Primary Modes of Distress	Complete	
	3.2	Identifying and Assessing Performance Test Appropriateness.	Complete	
	3.3	Validating the Performance Tests	Complete	
4. Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment	Complete	
	4.2	Managing Resources	Complete	
	4.3	Conducting Initial Training	Complete	
	4.4	Evaluating Performance Tests	Complete	
	4.5	Conducting Inter-Laboratory Studies	Complete	
5. Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System	Complete	
	5.2	Conducting Benchmarking Studies	Complete	
	5.3	Conducting Shadow Projects	Complete	
	5.4	Analyzing Production Data	Complete	
	5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials	Complete	
6. Specifications and Program Development	6.1	Sampling and Testing Plans	Complete	
	6.2	Pay Adjustment Factors (If Part of the Goals)	Not Started	No plans to establish pay factors
	6.3	Developing Pilot Specifications and Policies	Complete	
	6.4	Conducting Pilot Projects	Complete	
	6.5	Final Analysis and Specification Revisions	Complete	
7. Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs	Complete	
	7.2	Establishing or Updating Laboratory Accreditation Program Requirements	Complete	
8. Initial Implementation	n/a		Complete	

Question 1: What does your State consider to be the primary benefits of BMD?

Response: Improve the performance and lower the life-cycle cost of asphalt pavements. Prevent the use of mix designs that are susceptible to premature deterioration due to rutting, cracking, and stripping.

Question 2: What hurdles and/or gaps need to be addressed for mix design approval implementation?

Response: Implementation is complete, but a few significant questions that needed to be addressed during the implementation process were: (1) Who (Contractor, District, Central Office) runs the performance tests of record? It was decided that the Districts run the tests. (2) Do all mixtures go through all performance tests? High ESAL (≥ 0.3M ESAL's) mixtures are tested in I-FIT, Hamburg Wheel, and Tensile Strength/TSR. Low ESAL (< 0.3M ESAL's) mixtures are tested in I-FIT and Tensile Strength/TSR. (3) What is the frequency of mix design re-verification? Previously, we used a 3 year re-verification timeframe. We now use a "perpetual" mix design process where the mix designs have no re-verification timeframe as long as the combined aggregate Gsb has not changed by more the 0.020 (with additional caveats). This allows Contractors more time to learn, adjust, and innovate with respect to meeting performance test criteria.

Question 3: Do you currently use or plan to use performance tests for acceptance in the future? If no, skip to question 6.

Response: Yes, IDOT uses I-FIT as a cracking test, Hamburg Wheel as a rutting test, and Tensile Strength/TSR as a moisture sensitivity test.

Question 4: What hurdles and/or gaps need to be addressed for plant mix verification?

Response: Implementation is complete, but a few significant questions that needed to be addressed during the implementation process were: (1) When and where is the sample taken? Only required during start of production (test strip) with individual mixture quantities ≥ 3,000 tons. Samples are taken at the jobsite using plates or material transfer device sampling devices. (2) Do all mixtures go thru all tests? Same as response to Q2. Additionally, Tensile Strength/TSR is only required for the first use of a mix design annually. (3) Who runs the performance tests of record? Same as response to Q2. (4) How are failures handled? A failure requires resampling and testing. Paving can continue as long as all other mixture criteria (volumetrics) are being met. If the second set of performance tests fail, no additional mixture is

produced until the Contractor makes a mixture modification leading to passing results. In some cases after failing results following modifications, a mix design may be rejected.

Question 5: What hurdles and/or gaps need to be addressed for mixture acceptance implementation?

Response: Most Districts lack the resources, primarily personnel, to sample and test throughout production. We currently sample for performance tests during start of production (≥ 3,000 tons for individual mixture quantities) and typically do not collect additional samples unless resampling and testing is required due to a failure.

Question 6: What challenges have you overcome in the path to implementation?

Response: Buy-in from industry was mixed. In some ways, we were successful in working with specific contractors and the industry association as a whole, which supported implementation overall. The challenges ended up being related to a small number of contractors who had not prepared for implementation and wanted additional time to test their mixes.

Question 7: What are your expectations for the lead States peer-exchange? What do you hope to learn?

Response: I hope to learn how the lead States are adapting specifications, procedures, and collaboration with industry as implementation progresses. How are failing results managed? Are you considering providing more flexibility in other areas, such as mix design parameters, as implementation progresses?

Louisiana

Implementation Status Chart

Task	Sub Task	Description	Status	Additional Comments
1. Motivations and Benefits of Performance Specifications	n/a		Complete	
2. Overall Planning	2.1	Identification of Champions	Complete	
	2.2	Establishing a Stakeholders Partnership	Complete	
	2.3	Doing Your Homework	Complete	
	2.4	Establishing Goals	Complete	
	2.5	Mapping the Tasks	Complete	
	2.6	Identifying Available External Technical Information and Support (periodically)	Complete	
	2.7	Developing an Implementation Timeline	Complete	
3. Selecting Performance Tests	3.1	Identifying Primary Modes of Distress	Complete	
	3.2	Identifying and Assessing Performance Test Appropriateness.	Complete	
	3.3	Validating the Performance Tests	Complete	
4. Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment	Ongoing	Outfitting district labs for testing
	4.2	Managing Resources	Ongoing	Outfitting district labs for testing
	4.3	Conducting Initial Training	Complete	
	4.4	Evaluating Performance Tests	Complete	
	4.5	Conducting Inter-Laboratory Studies	Complete	
5. Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System	Complete	
	5.2	Conducting Benchmarking Studies	Complete	
	5.3	Conducting Shadow Projects	Complete	
	5.4	Analyzing Production Data	Complete	
	5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials	Complete	
6. Specifications and Program Development	6.1	Sampling and Testing Plans	Complete	
	6.2	Pay Adjustment Factors (If Part of the Goals)	Ongoing	Will be considered when a viable QC/QA framework is determined
	6.3	Developing Pilot Specifications and Policies	Complete	
	6.4	Conducting Pilot Projects	Complete	
	6.5	Final Analysis and Specification Revisions	Complete	
7. Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs	Complete	
	7.2	Establishing or Updating Laboratory Accreditation Program Requirements	Complete	
8. Initial Implementation	n/a		Complete	

Question 1: What does your State consider to be the primary benefits of BMD?

Response: The ability to assess the quality of modern asphalt mixtures containing additives and materials that were not considered in traditionally volumetric mixture design methods.

Question 2: What hurdles and/or gaps need to be addressed for mix design approval implementation?

Response: Little to no gaps regarding implementation for mixture design. A number of gaps regarding implementation for QC/QA. Namely questions regarding: aging protocol, sampling location, lag/dwell, sampling frequency.

Question 3: Do you currently use or plan to use performance tests for acceptance in the future? If no, skip to question 6.

Response: Ideally yes.

Question 4: What hurdles and/or gaps need to be addressed for plant mix verification?

Response: Methods for appropriate sample conditioning, i.e. adequate and timely long-term aging protocol for a cracking test. Verification of test parameter for plant produced material.

Question 5: What hurdles and/or gaps need to be addressed for mixture acceptance implementation?

Response: Similar gaps as for plant mix verification. Timely conditioning protocol. Sampling frequency and location. Relationship between field core and gyratory specimen.

Question 6: What challenges have you overcome in the path to implementation?

Response: Louisiana was lucky to have 10+ years of forensic testing regarding the use of the LWT and SCB tests. The science was there. Biggest hurdle of industry buy-in still persists. initially, industry buy-in was there because allowed for increased RAP content and innovation. More recently, the introduction of "quicker" tests is creating push back on current specification. Producers are not looking to be responsible for more testing. As an agency, we are evaluating the production phase independent of the design phase. This may manifest through the use of parameter prediction models, aging shift factors, or surrogate tests.

Question 7: What are your expectations for the lead States peer-exchange? What do you hope to learn?

Response: interested to learn what other States are considering regarding aging protocols, moving to QC/QA, field validation and consistency of test protocols, etc. Louisiana DOTD is on an island with the current specification and have been implemented since 2016. Looking for ways to continue progressing rather than stay stagnant. LADOTD is happy with the design specification but want to make progress in production.

Missouri

Implementation Status Chart

Task	Sub Task	Description	Status	Additional Comments
1. Motivations and Benefits of Performance Specifications	n/a		Complete	
2. Overall Planning	2.1	Identification of Champions	Complete	
	2.2	Establishing a Stakeholders Partnership	Complete	
	2.3	Doing Your Homework	Complete	
	2.4	Establishing Goals	Complete	
	2.5	Mapping the Tasks	Complete	
	2.6	Identifying Available External Technical Information and Support (periodically)	Complete	
	2.7	Developing an Implementation Timeline	In Progress	Plan to fully implement in 2026
3. Selecting Performance Tests	3.1	Identifying Primary Modes of Distress	Complete	
	3.2	Identifying and Assessing Performance Test Appropriateness.	Complete	
	3.3	Validating the Performance Tests	Complete	
4. Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment	In Progress	All equipment should be acquired by the end of the year
	4.2	Managing Resources	In Progress	
	4.3	Conducting Initial Training	In Progress	
	4.4	Evaluating Performance Tests	Ongoing	
	4.5	Conducting Inter-Laboratory Studies	Ongoing	Hope to complete this in spring of 2025
5. Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System	Complete	
	5.2	Conducting Benchmarking Studies	Complete	
	5.3	Conducting Shadow Projects	Complete	
	5.4	Analyzing Production Data	Ongoing	
	5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials	Ongoing	
6. Specifications and Program Development	6.1	Sampling and Testing Plans	Complete	
	6.2	Pay Adjustment Factors (If Part of the Goals)	Complete	
	6.3	Developing Pilot Specifications and Policies	Complete	
	6.4	Conducting Pilot Projects	Ongoing	
	6.5	Final Analysis and Specification Revisions	Ongoing	Plan to make final spec revisions at the end of 2025
7. Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs	In Progress	Certification class with be through State-Tech similar to current superpave certification class
	7.2	Establishing or Updating Laboratory Accreditation Program Requirements	In Progress	
8. Initial Implementation	n/a		In Progress	Pilot projects with final specification for performance incintives have been awarded to contractors already

Question 1: What does your State consider to be the primary benefits of BMD?

Response: Increase quality of asphalt mixtures. Reduced cracking while still ensuring mixtures do not rut.

Question 2: What hurdles and/or gaps need to be addressed for mix design approval implementation?

Response: Need to implement critical aging of mixtures. With all the rejuvenator products, MoDOT needs to ensure long term benefits of flexibility and not just short-term.

Question 3: Do you currently use or plan to use performance tests for acceptance in the future? If no, skip to question 6.

Response: Yes, currently use performance tests for acceptance in pilot projects and plan to use for acceptance for all Superpave in the near future.

Question 4: What hurdles and/or gaps need to be addressed for plant mix verification?

Response: Consistent sampling, handling, and precise fabrication methods so that mix can be verified.

Question 5: What hurdles and/or gaps need to be addressed for mixture acceptance implementation?

Response: Same as No. 4 QC/QA results must be comparable when testing the same mixtures.

Question 6: What challenges have you overcome in the path to implementation?

Response: Specification changes and buy-in by industry. Testing backlogs for material in the central lab, which led to purchasing equipment for the districts. Getting comfortable with moving away from consensus and volumetric tests for acceptance.

Question 7: What are your expectations for the lead States peer-exchange? What do you hope to learn?

Response: Lessons learned from other States. Testing and aging procedures for consistent results for better comparison.

Oregon

Implementation Status Chart

Task	Sub Task	Description	Status	Additional Comments
1. Motivations and Benefits of Performance Specifications	n/a		Complete	
2. Overall Planning	2.1	Identification of Champions	Complete	
	2.2	Establishing a Stakeholders Partnership	Complete	
	2.3	Doing Your Homework	Ongoing	
	2.4	Establishing Goals	Complete	
	2.5	Mapping the Tasks	Complete	
	2.6	Identifying Available External Technical Information and Support (periodically)	Ongoing	
	2.7	Developing an Implementation Timeline	Ongoing	
3. Selecting Performance Tests	3.1	Identifying Primary Modes of Distress	Complete	
	3.2	Identifying and Assessing Performance Test Appropriateness.	Complete	
	3.3	Validating the Performance Tests	Ongoing	
4. Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment	Complete	
	4.2	Managing Resources	Ongoing	
	4.3	Conducting Initial Training	Complete	
	4.4	Evaluating Performance Tests	Ongoing	
	4.5	Conducting Inter-Laboratory Studies	Complete	
5. Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System	Complete	
	5.2	Conducting Benchmarking Studies	Complete	
	5.3	Conducting Shadow Projects	Complete	
	5.4	Analyzing Production Data	Complete	
	5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials	Complete	
6. Specifications and Program Development	6.1	Sampling and Testing Plans	Ongoing	
	6.2	Pay Adjustment Factors (If Part of the Goals)	Ongoing	
	6.3	Developing Pilot Specifications and Policies	Ongoing	
	6.4	Conducting Pilot Projects	Ongoing	
	6.5	Final Analysis and Specification Revisions	Not Started	
7. Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs	Not Started	
	7.2	Establishing or Updating Laboratory Accreditation Program Requirements	Not Started	
8. Initial Implementation	n/a		Not Started	

Question 1: What does your State consider to be the primary benefits of BMD?

Response: Better performing, cost-effective ACP mixes. Reduction or balance of the primary modes of distress.

Question 2: What hurdles and/or gaps need to be addressed for mix design approval implementation?

Response: Establish performance tests requirements. Develop training for technicians and updating laboratory accreditation requirements.

Question 3: Do you currently use or plan to use performance tests for acceptance in the future? If no, skip to question 6.

Response: Yes, we currently require Hamburg testing for ACP mixes that use a liquid anti-strip additive in place of lime treatment. ODOT also collects production mix and performs performance testing (Hamburg and IDEAL-CT).

Question 4: What hurdles and/or gaps need to be addressed for plant mix verification?

Response: Develop training for technicians and updating laboratory accreditation requirements. Better understanding of effects of lag/dwell time on sample preparation.

Question 5: What hurdles and/or gaps need to be addressed for mixture acceptance implementation?

Response: Establish performance tests requirements and BMD specification(s). Update QA/QC requirements.

Question 6: What challenges have you overcome in the path to implementation?

Response: Challenges related to tasks 1-5.

Question 7: What are your expectations for the lead States peer-exchange? What do you hope to learn?

Response: Hoping to learn from other States in regard to tasks 6-8; specifically on the production mixture acceptance.

Texas

Implementation Status Chart

Task	Sub Task	Description	Status	Additional Comments
1. Motivations and Benefits of Performance Specifications	n/a		Complete	
2. Overall Planning	2.1	Identification of Champions	Ongoing	TxDOT Industry BMD Working Group
	2.2	Establishing a Stakeholders Partnership	Ongoing	TxDOT Industry BMD Working Group
	2.3	Doing Your Homework	Ongoing	FHWA Mega-States, BMD IWG (NAPA)
	2.4	Establishing Goals	Complete	
	2.5	Mapping the Tasks	Complete	
	2.6	Identifying Available External Technical Information and Support (periodically)	Ongoing	FHWA Mega-States, BMD IWG (NAPA)
	2.7	Developing an Implementation Timeline	Complete	
3. Selecting Performance Tests	3.1	Identifying Primary Modes of Distress	Complete	
	3.2	Identifying and Assessing Performance Test Appropriateness.	Complete	
	3.3	Validating the Performance Tests	Ongoing	Annual Field Performance Monitoring
4. Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment	In Progress	Contractor package evaluation complete
	4.2	Managing Resources	In Progress	Tracking with 2024 construction
	4.3	Conducting Initial Training	Not Started	
	4.4	Evaluating Performance Tests	In Progress	Specimen type, fabrication, conditioning
	4.5	Conducting Inter-Laboratory Studies	In Progress	CTIS complete; NCAT, contractor/agency
5. Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System	Complete	
	5.2	Conducting Benchmarking Studies	Complete	TX complete; WesTrack
	5.3	Conducting Shadow Projects	In Progress	2024 construction
	5.4	Analyzing Production Data	In Progress	
	5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials	In Progress	Strategies in draft AASHTO practice
6. Specifications and Program Development	6.1	Sampling and Testing Plans	In Progress	
	6.2	Pay Adjustment Factors (If Part of the Goals)	Not Started	
	6.3	Developing Pilot Specifications and Policies	Ongoing	Revisions to SS
	6.4	Conducting Pilot Projects	Not Started	
	6.5	Final Analysis and Specification Revisions	Ongoing	Revisions to SS
7. Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs	Not Started	
	7.2	Establishing or Updating Laboratory Accreditation Program Requirements	Not Started	
8. Initial Implementation	n/a		Not Started	

Question 1: What does your State consider to be the primary benefits of BMD?

Response: The primary expected benefits of BMD in TX include enhanced pavement longevity, and increased opportunities for innovation. By focusing on performance testing, BMD should lead to longer-lasting pavements. The intention is to allow higher proportions of recycled materials and other alternative materials. Additionally, BMD opens more opportunities for contractors to innovate in the pavement industry while ensuring that the performance of the pavement is equivalent to or better than traditional mix design methods.

Question 2: What hurdles and/or gaps need to be addressed for mix design approval implementation?

Response: Test variability. Field validation data.

Question 3: Do you currently use or plan to use performance tests for acceptance in the future? If no, skip to question 6.

Response: Yes.

Question 4: What hurdles and/or gaps need to be addressed for plant mix verification?

Response: Differences between mix design and production. Cracking test variability.

Question 5: What hurdles and/or gaps need to be addressed for mixture acceptance implementation?

Response: A better understanding of test variability and how to handle dispute resolution is needed. Training on handling and running BMD tests. Test equipment availability.

Question 6: What challenges have you overcome in the path to implementation?

Response: not answered.

Question 7: What are your expectations for the lead States peer-exchange? What do you hope to learn?

Response: not answered.

Virginia

Implementation Status Chart

Task	Sub Task	Description	Status	Additional Comments
1. Motivations and Benefits of Performance Specifications	n/a		Complete	
2. Overall Planning	2.1	Identification of Champions	Complete	
	2.2	Establishing a Stakeholders Partnership	Complete	
	2.3	Doing Your Homework	Complete	
	2.4	Establishing Goals	Complete	
	2.5	Mapping the Tasks	Complete	
	2.6	Identifying Available External Technical Information and Support (periodically)	Ongoing	Will be necessary indefinitely as process evolves
	2.7	Developing an Implementation Timeline	Ongoing	Will be performed for each additional mix type added to BMD spec
3. Selecting Performance Tests	3.1	Identifying Primary Modes of Distress	Complete	
	3.2	Identifying and Assessing Performance Test Appropriateness.	Ongoing	Will be performed for each additional mix type added to BMD spec
	3.3	Validating the Performance Tests	Ongoing	Will be performed for each additional mix type added to BMD spec
4. Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment	Complete	
	4.2	Managing Resources	Complete	
	4.3	Conducting Initial Training	Complete	
	4.4	Evaluating Performance Tests	Ongoing	Will be performed for each additional mix type added to BMD spec
	4.5	Conducting Inter-Laboratory Studies	In Progress	For Cantabro and APA testing
5. Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System	Ongoing	As part of validation process, and for additional mix types
	5.2	Conducting Benchmarking Studies	Ongoing	Will be performed for each additional mix type added to BMD spec
	5.3	Conducting Shadow Projects	Ongoing	Will be performed for each additional mix type added to BMD spec
	5.4	Analyzing Production Data	Ongoing	Will be performed for each additional mix type added to BMD spec
	5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials	Ongoing	Will be performed for each additional mix type added to BMD spec
6. Specifications and Program Development	6.1	Sampling and Testing Plans	Ongoing	Being adjusted as more data is obtained
	6.2	Pay Adjustment Factors (If Part of the Goals)	Not Started	Under consideration and discussion, no action started
	6.3	Developing Pilot Specifications and Policies	Ongoing	Will be performed for each additional mix type added to BMD spec
	6.4	Conducting Pilot Projects	Ongoing	Will be performed for each additional mix type added to BMD spec
	6.5	Final Analysis and Specification Revisions	Ongoing	Will continue to update and revise as more data and experience are gained
7. Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs	Ongoing	Will be updated if different tests are required for additional mix types
	7.2	Establishing or Updating Laboratory Accreditation Program Requirements	Ongoing	Will be updated if different tests are required for additional mix types
8. Initial Implementation	n/a		Complete	Initial implementation of non-PMB 9.5mm & 12.5mm surface mixes in maintenance contracts is complete

Question 1: What does your State consider to be the primary benefits of BMD?

Response: Primary - potential for increasing mixture durability and lifespan.

Secondary - ability to address the use of additive/new technologies/different materials that volumetric design did not address.

Question 2: What hurdles and/or gaps need to be addressed for mix design approval implementation?

Response: These are more gaps than hurdles, as we already have a mix design approval process in use for 9.5mm & 12.5mm non-PMB surface mixes.

Differences in source materials from design to production - particularly binder and RAP, but also changes in aggregate properties.

Differences between lab-mixed design material and plant-produced production material.

Question 3: Do you currently use or plan to use performance tests for acceptance in the future? If no, skip to question 6.

Response: Yes - currently use Cantabro mass loss, CT-index, APA rut depth, and TSR as go/no-go tests. Anticipate eventual use of testing in acceptance.

Question 4: What hurdles and/or gaps need to be addressed for plant mix verification?

Response: Reheat/non-reheat material differences, lag/dwell time influence.

Question 5: What hurdles and/or gaps need to be addressed for mixture acceptance implementation?

Response: Test time, test variability (including factors leading to that variability)

Determination of what characteristics/properties should used for pay.

Approach to acceptance - strict pass/fail or variable penalty.

Question 6: What challenges have you overcome in the path to implementation?

Response: Initial resistance to concept; test selection to be scientifically appropriate yet practical; training; improvement of test variability through training and experience; transferring research results into viable specifications; addressing mix changes and impacts on test results; lack of links between materials information and pavement performance and structure

information; need for making decisions before information is available, while overall picture has not come into focus; assessing risk and cost/benefit of moving forward with various aspects of implementation.

Question 7: What are your expectations for the lead States peer-exchange? What do you hope to learn?

Response: I am looking forward to seeing how other States are approaching implementation. Where exactly are the other States - outside of discussion at these meetings, information is nearly always somewhat outdated. Why are they taking their approach? Are there better ways to address various aspects and challenges? What approaches/issues seem to be universally applicable versus what aspects need to be more localized? What unusual or challenges have others addressed and can those solutions be applied in our efforts?

Wisconsin

Implementation Status Chart

Task	Sub Task	Description	Status	Additional Comments
1. Motivations and Benefits of Performance Specifications	n/a		Complete	
2. Overall Planning	2.1	Identification of Champions	Ongoing	
	2.2	Establishing a Stakeholders Partnership	Ongoing	
	2.3	Doing Your Homework	Ongoing	
	2.4	Establishing Goals	Ongoing	
	2.5	Mapping the Tasks	Ongoing	
	2.6	Identifying Available External Technical Information and Support (periodically)	Ongoing	
	2.7	Developing an Implementation Timeline	Ongoing	
3. Selecting Performance Tests	3.1	Identifying Primary Modes of Distress	Ongoing	
	3.2	Identifying and Assessing Performance Test Appropriateness.	Complete	
	3.3	Validating the Performance Tests	Ongoing	
4. Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment	Ongoing	
	4.2	Managing Resources	Ongoing	
	4.3	Conducting Initial Training	Ongoing	
	4.4	Evaluating Performance Tests	Ongoing	
	4.5	Conducting Inter-Laboratory Studies	Ongoing	
5. Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System	Complete	
	5.2	Conducting Benchmarking Studies	Ongoing	
	5.3	Conducting Shadow Projects	Complete	
	5.4	Analyzing Production Data	Ongoing	
	5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials	Ongoing	
6. Specifications and Program Development	6.1	Sampling and Testing Plans	Not Started	
	6.2	Pay Adjustment Factors (If Part of the Goals)	Not Started	
	6.3	Developing Pilot Specifications and Policies	In Progress	
	6.4	Conducting Pilot Projects	In Progress	
	6.5	Final Analysis and Specification Revisions	Not Started	
7. Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs	In Progress	
	7.2	Establishing or Updating Laboratory Accreditation Program Requirements	Not Started	
8. Initial Implementation	n/a		Not Started	

Question 1: What does your State consider to be the primary benefits of BMD?

Response: Use available resources such as more RAM and local aggregates. Better quality measure than our current volumetrics specifications. Increase pavement life. Promotes innovation through new design techniques and materials.

Question 2: What hurdles and/or gaps need to be addressed for mix design approval implementation?

Response: Training for all contractors' mix designers and regional testers. Reduce interlaboratory variability and design to field variability. Procurement of equipment to the regional DOT labs. Determination of production acceptance criteria.

Question 3: Do you currently use or plan to use performance tests for acceptance in the future? If no, skip to question 6.

Response: We plan to use performance testing for acceptance in the future.

Question 4: What hurdles and/or gaps need to be addressed for plant mix verification?

Response: We need to agree on limits, and we need contractor buy in. Lab to field validation of the performance data.

Question 5: What hurdles and/or gaps need to be addressed for mixture acceptance implementation?

Response: We need to agree on limits, and we need contractor buy in. Region's ability to do performance testing.

Question 6: What challenges have you overcome in the path to implementation?

Response: We have developed a sample handling procedure to ensure all parties are doing the testing the same. Contractor buy in. Determining which test methods to move forward with. Develop surrogate tests for acceptance.

Question 7: What are your expectations for the lead States peer-exchange? What do you hope to learn?

Response: Learn how to set performance parameters correctly. Ensure the performance tests are going to show improved performance. Learn where other States are at and lessons learned.