

**Balanced Mix Design (BMD)
Peer Exchanges: Summary of
Challenges**

U.S. Department of Transportation
Federal Highway Administration

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UMaine rises to No. 5 in Latest National Coaches Poll

UMaine hockey continues to rise in national polls

By Larry Mahoney
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Abbreviations and Acronyms

- AASHTO – American Association of State Highway and Transportation Officials
- ABR: Asphalt binder replacement
- AC: Asphalt content
- ALF: Accelerated loading facility
- AQC: Acceptance quality characteristic
- ASTM: American Society for Testing and Materials
- BMD: Balanced Mix Design
- BRIC: Binder-rich intermediate course
- Caltrans: California DOT
- CT₁₉₅₀: Cracking index
- DOT: Department of transportation
- ESAL: Equivalent single axle load
- FHWA: Federal Highway Administration
- FI: Flexibility Index
- HPTO: High performance thin overlay
- HWTT: Hamburg Wheel Tracking Test
- IDEAL-CT: Ideal cracking test
- IDOT: Illinois DOT
- I-FIT: Illinois Flexibility Test
- JMF: Job mix formula
- LaDOTD: Louisiana Department of Transportation and Development
- LPLC: Lab-produced lab-compacted
- MaineDOT: Maine DOT
- MPL: Material producer list
- NCAT: National Center for Asphalt Technology
- N_{design}: Design gyrations
- NJDOT: New Jersey DOT
- NMAS: Nominal maximum aggregate size
- OT: Overlay Test
- P_c: Percent of asphalt binder in mixture
- PG: Performance grade
- PMS: Pavement management system
- PPLC: Plant-produced lab-compacted
- QA: Quality assurance
- RAP: Reclaimed asphalt pavement
- RAS: Reclaimed asphalt shingles
- RBR: Reclaimed binder ratio
- SGC: Superpave gyratory compactor
- SIP: Stripping inflection point
- SMA: Stone matrix asphalt
- TSR: Tensile strength ratio
- TxDOT: Texas DOT
- UNR: University of Nevada, Reno
- VDOT: Virginia DOT
- VFA: Voids filled with asphalt
- VMA: Voids in the mineral aggregate

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What do we want to get out of this?

Hear challenges of Balanced Mix Design implementation as heard from State DOT's and Contractors across the country

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Background

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Definitions

What is BMD?

- AASHTO PP 105-20: "BMD is an 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."

TRB's [Transportation Research Circular E-C280: Glossary of Terms for Balanced Design of Asphalt Mixtures](#) provides a reference document for usage of Balanced Mix Design terminology by the asphalt mixtures community in the United States.

Design "philosophy" used to optimize the mix performance against distresses pertinent to the climate & traffic specific to the region where it will be placed.

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Numerous States Moving to BMD

- APPROACH A: VOLUMETRIC DESIGN WITH PERFORMANCE VERIFICATION
- APPROACH A AND B
- APPROACH A AND D
- APPROACH B: VOLUMETRIC DESIGN WITH PERFORMANCE OPTIMIZATION
- APPROACH C: PERFORMANCE-BASED VOLUMETRIC DESIGN
- APPROACH D: PERFORMANCE DESIGN
- PRE-IMPLEMENTATION

Source: NAPA
<https://www.asphalt pavement.org/wp-content/uploads/2022/08/2022-08-16-Engineering-Resources/BMD-Resource-Guide/Implementation-Efforts>

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Overall BMD Implementation Process 8 Tasks That Can be Undertaken (Schedule Example)

Task	Sub-Task	Description	1	2	3	4	5	6	7	8
1. Understanding the why and benefits of Performance Specifications	1.1	Identification of Objectives								
	1.2	Establishing a Stakeholders Partnership								
	1.3	Long-Term Horizons								
2. Overall Planning	2.1	Establishing Goals								
	2.2	Mapping the Landscape								
	2.3	Identifying Available External Technical Information and Support (periodically)								
3. Selecting Performance Tests	3.1	Identifying Primary Modes of Distress								
	3.2	Identifying and Assessing Performance Test Appropriateness								
	3.3	Validating the Performance Tests								
4. Performance Testing, Equipment Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment								
	4.2	Conducting Initial Training								
	4.3	Evaluating Performance Tests								
5. Establishing Baseline Data	5.1	Conducting Baseline Studies								
	5.2	Identifying Baseline Data & Information Management Systems								
	5.3	Conducting Baseline Projects								
6. Specifications and Program Development	6.1	Developing Test Specifications and Methods								
	6.2	Identifying Baseline Data & Information Management Systems								
	6.3	Conducting Pilot Projects								
7. Training, Certification, and Accreditation	7.1	Developing and Updating Training and Certification Programs								
	7.2	Conducting Baseline Studies								
	7.3	Establishing or Updating Laboratory Accreditation Program Requirements								
8	Final Implementation									

Not all tasks may be applied/considered.

Considerations to:

- Organizational structure, staffing, workspace, asphalt tonnage, etc.
- Industry experiences & practices.

Inter-related tasks or subtasks activities.

Tech Brief: [Balanced Asphalt Mix Design: Eight Tasks for Implementation](#)

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Balanced Mix Design Peer Exchanges

- Meeting Location
- Southeast Peer Exchange, Louisiana, March 1-2, 2023
- North Central Peer Exchange, Illinois, March 22-23, 2023
- Northeast Peer Exchange, Massachusetts, March 29-30, 2023
- Rocky Mountain West Peer Exchange, Utah, November 28-30, 2023
- Midwest Peer Exchange, Illinois, December 13-14, 2023
- Mega-States Peer Exchange

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Critical Challenges

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Critical Challenges for BMD



Its more than just technical items!

Management Challenges



Technical Challenges



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Management Challenges



- Change Management.
- Cost-Benefit Analysis
- Specifications & Risk Management.
- Resource Allocation.
- Implementation Planning.
- Stakeholders Engagement.

Technical Challenges

- BMD Tests Validation
- Testing Procedures & Protocols
- Variabilities
- Database Setup, Collection, Analysis, & Management.
- Pathway for Use in Field Quality Assurance (QA).
- Volumetrics Historical Usage

Integration with Existing Practices.

- Education, Training, & Skill Development.
- Information Sharing & Collaboration Among Peers

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Be Mindful that...

- Not all states are experiencing every challenge listed.
- All raised challenges are listed, even if only mentioned by few states.

Two present statuses for the challenges:


1. The path forward has been identified and implemented.
2. Ongoing efforts are in progress to address and find solutions.

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Be Mindful that...

Similar challenges are heard from contractors.

- Implementation requires resources.
- Resistance to change.
- BMD tests may not be able to fully replace current acceptance testing.
- Variability in BMD tests results.
- Etc.





Source: NAPA

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Management Challenges

- Change Management.
- Cost-Benefit Analysis
- Specifications & Risk Management.
- Resource Allocation.
- Implementation Planning.
- Stakeholders Engagement.

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Management Challenges Change Management

- Resistance to change.
 - Familiar with traditional mix design.
 - Shift culture.
- Change management strategies.
 - Communicate.
 - Describe why.
 - Promote buy-in (what's in it for me).
 - Plan.

Resistance to change
• Inspiring confidence.
• Having competing priorities (relative benefits).
• Facing two opposite situations for innovation?
Shift culture
• Receiving mixed reactions for test selections.
• Having a clear vision.
Communication
• Identifying champions locally (buy-in).
• Communicating the "why" when recent modifications implemented (e.g., regressed AV).
• Understanding/documenting relative benefit.
• Creating a plan with timelines.

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Management Challenges Cost-Benefit Analysis

- Benefits to stakeholders.
- Cost-effectiveness.
- Justify the investment.
 - Improved pavement performance.
 - Longevity.
 - Reduced maintenance costs.
 - Support sustainability efforts.

Management Challenges Specifications & Risk Management

- Mix design and acceptance procedures complying with industry standards.
- Identifying and mitigating risks associated with implementation of BMD (e.g., performance issues, budget overruns).

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Management Challenges Resource Allocation

- Personnel.
- Funding.
- Equipment.
- Initial investments and ongoing operational costs.

Personnel
• Addressing staffing need to implement BMD becomes challenging amid several competing priorities within an agency.
• Considering current staffing resources and additional workload for implementing BMD
• Finding qualified workforce while adding new procedures to existing volumetric approval processes.

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Management Challenges Implementation Planning

- Formal plan.
- Defined goals and scope.
- Avoid missteps and minimize re-work.
 - Time is warranted to develop and document a strategic plan with short and long-term goals.

Plan, goals, scope
• Formalizing BMD approach. <ul style="list-style-type: none"> ◦ Planning with tasks and timelines. ◦ Transitioning from Approach A to D.
• Realizing and seeing a greater focus on strategic planning and timeline.
• Avoid missteps <ul style="list-style-type: none"> • Need not accelerating implementation process (thoughtful planning, lessons learned). • Recognizing that BMD implementation takes time and might face setbacks.

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Management Challenges Stakeholders Engagement

- Clear communication.
- Engage stakeholders.
- Collaboration.

Stakeholders Engagement
• Findings ways to partner with industry for implementation buy-in.
• Formulating a dedicated task force(s) for asphalt stakeholders' engagement.
• Identifying local champions for buy-in at higher levels.
• Leveraging contractors/consultants/academia for testing when State DOT resources are insufficient.
• Communicating and working with industry partners for achieving a feasible version of BMD implementation.

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Technical Challenges

- BMD Tests Validation
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Technical Challenges BMD Tests Validation

- Relationship of mechanical tests to field performance.
- Mechanical tests correlate to the distress of interest.
- Specification criteria for mix design approval and possibly production acceptance.

BMD Tests Validation
• Facing a delay in starting validation efforts early with a documented plan and data collection plan.
• Gaining confidence in mechanical tests and their correlation with distress of interest.
• Integrating asset management frameworks for effective data presentation to decision-makers..
• Short field evaluation period for BMD projects (typically in-service less than 5 years, with most under 3 years).

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Technical Challenges Testing Procedures & Protocols

- Include lab and field produced asphalt mixtures.
- Sample handling and conditioning protocols.
- Define **lag time** (how long after mixing can the specimens be compacted) and **dwelt time** (how long after compaction can the specimens still be tested and get acceptable results).

Testing Procedures & Protocols (1 of 2)

- Achieving sampling and testing consistency.
- Establishing standard protocols for handling, storing, and aging
- Limited information or standards on sample handling, reheating, and conditioning, leading to the loss of significant data.
- Big topics of aging and moisture damage where there are many unknowns

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Technical Challenges Variabilities

- Variability of test results.
 - Variability erodes confidence.
- Sensitivity of test results.
 - Sensitivity is needed.

Variabilities

- Ways to reducing tests variability.
- Concerns with variability in BMD cracking tests undermining the confidence in BMD.
- Concerns about differences in test results with differences in devices
- Sensitivity of BMD tests to change in asphalt binder source.
- Differences in laboratory test results for mix design material and plant-produced material.

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Technical Challenges Database Setup, Collection, Analysis, & Management

- Database setup.
 - Track testing parameters.
 - Track field performance.
- Data management can persuade decision makers.

Database

- Organizing initial BMD database.
 - Needing for a data wish list for validation projects.
 - Needing for templates and format.
 - Maximizing data fields and raw data.
- Linking data for BMD mix design, construction QA, and field performance.
 - e.g., mix design info, mixture type, raw material sources, project location, pre-existing pavement condition, lot and sub-lot numbers, BMD test results, field performance.

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Technical Challenges Pathway for Use in Field QA

- Desire to use BMD principles in mix design.
- BMD for acceptance:
 - Test strips? Go-no-go?
 - Testing frequency?
 - Quality measures?
 - Payment?
 - Thresholds?
- Fear that the focus is too much on BMD tests for pay and lose sight of production control in terms of consistent production, raw materials, and plant operations.

Pathway for Use in Field QA

- Needing for an aging protocol to shorten test time and establish new thresholds for use during production.
- Needing for increased sampling frequency for BMD tests. Testing frequency and lot size are a challenge.
- Finding surrogate BMD tests to provide quicker turnaround of results for QA.
- Assigning BMD test results weight factors for pay – role of volumetrics and density?

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Technical Challenges Volumetrics Historical Usage

- Volumetric properties alone have shortcomings.
- Relaxing volumetric requirements?
 - First, confirm BMD test results to pavement performance (validation).
- Innovation.
 - Ability to have greater access to more resources and responsible use of materials.

Volumetrics Historical Usage (1 of 2)

- Instilling confidence in transitioning from volumetric properties to BMD tests is crucial for implementation.
- Will industry and leadership feel enough confidence in using tests in lieu of volumetric properties given current testing practices?
- Can role of volumetrics in mix design and acceptance stages differ?
- Which volumetric properties to use?
- Which criteria to relax? and by how much?

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Management Challenges

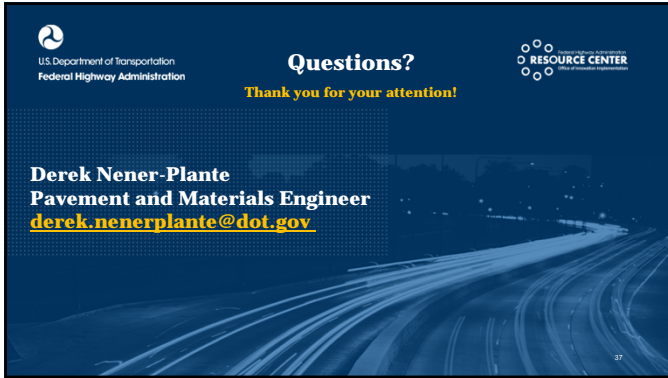
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Questions?
Thank you for your attention!

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