Eight Tasks Towards Implementation of Balanced Mix Design for Asphalt Mixtures

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"DEVELOPMENT AND DEPLOYMENT OF INNOVATIVE ASPHALT PAVEMENT TECHNOLOGIES" COOP AGREEMENT WITH UNIVERSITY OF NEVADA, RENO

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Presentation Overview

Presentation Overview

I. **Introduction**
II. Definitions
III. Tasks for BMD Implementation
IV. Conclusions

Introduction (1 of 2)

Case Studies of Key State DOTs.

- **Purpose:** Obtain detailed understanding of agency practices & lessons learned.
- **How?**
  - Review of agency documents (policy, specs, reports, etc.).
  - Conduct virtual site visits.
- **Products**
  - State DOT site visit reports (https://www.unr.edu/wrsc/tools/asphalt/dapt-publications).
  - Summary report (https://scholarworks.unr.edu/handle/11714/8127).
  - Tech Brief (https://www.fhwa.dot.gov/pavement/pub_details.cfm?id=1144).

TechBrief

The Asphalt Pavement Technology Program is an integrated national effort to improve the long-term performance and cost effectiveness of asphalt pavements. Managed by the Federal Highway Administration working with State highway agencies, industry and academia, the program's primary goals are to reduce congestion, improve safety, and foster technology innovation. The program was established to develop and implement guidelines, methods, procedures, and other tools for use in asphalt pavement materials selection, mix design, testing, construction, and quality control.

Office of Preconstruction, Construction, and Pavements
FHWA-HIF-22-048
Date: April 2022

U.S. Department of Transportation
Federal Highway Administration

Balanced Asphalt Mix Design: Eight Tasks for Implementation

Introduction

Balanced Mix Design (BMD) is described as 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."[1] Goals for implementation of BMD may differ among State Departments of Transportation (DOTs). Initially, some may wish only to add performance tests as part of mix design approval, whereas others may want to replace many existing criteria with new performance test criteria for mix design approval as well as for quality assurance (QA). To learn more regarding the details of BMD and implementation efforts, FHWA conducted virtual site visits between April and September 2020 and interviews of seven early adopter State DOTs, along with material producers, consultants and paving contractors that serviced the agencies. The participating State DOTs were California DOT (Caltrans); Illinois DOT (IDOT); Louisiana DOT and Development (LaDOTD); Maine DOT (MaineDOT); New Jersey DOT (NJDOT); Texas DOT (TxDOT); and Virginia DOT (VDOT).

Successful practices documented from these virtual site visits were collected and synthesized into an overall process of implementing BMD as part of mix design approval and QA. This effort suggested eight major tasks based on concurrent activities (e.g., BMD regional workshops[3], BMD implementation guide[4]). The tasks and the associated subtasks are presented in Table 1. These tasks are meant to summarize the suggested activities that a State DOT may need to undertake to implement a BMD program. Not all tasks may be applied or considered by a State DOT depending on its organizational structure, staffing level, workspace, annual asphalt tonnage, as well as industry experiences and practices. Use of the tasks is not a Federal requirement.

Although there are logical sequences for some of the tasks, there are some cases where tasks may be conducted in parallel or in a different order without any negative consequences. For instance, several activities can occur in multiple inter-related tasks or subtasks. The following sections describe the various tasks for BMD implementation.

Scan to get the link!

Introduction (2 of 2)

Webinar Outcomes

- Understand the why and overall benefits of BMD.
- Recognize the overall planning and coordination effort associated with the implementation process of BMD.
- Identify the tasks that need to be completed for the development and implementation of BMD.
- Recognize successful key State DOTs practices and experiences related to BMD.
- Recognize available external technical information and support.

What don’t you see here?
How to perform BMD tests, best test parameters, research results, etc.

Presentation Overview

Definitions (1 of 5)

- **What is BMD?**
  - BMD is defined as an asphalt mix design framework using *mechanical tests correlated to field performance* on appropriately conditioned specimens that address multiple modes of asphalt layer distress taking into consideration mixture aging, traffic, climate, and location within the pavement structure.

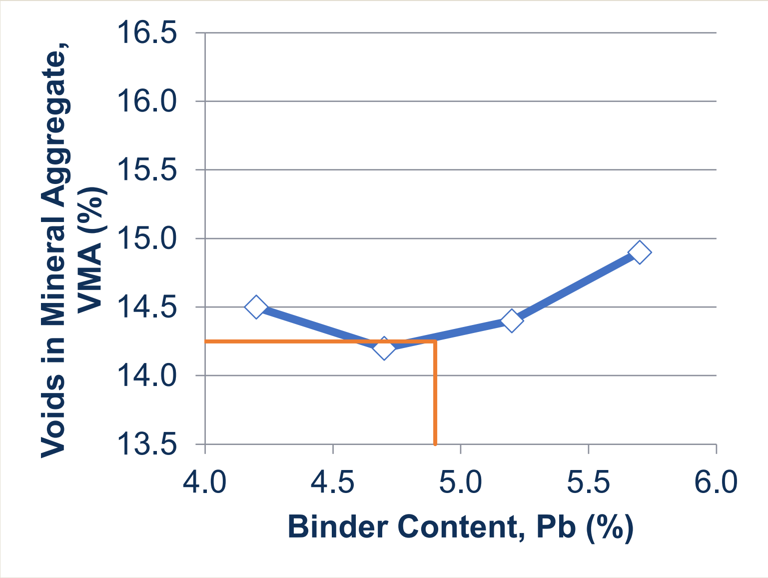
Design "philosophy" used to optimize asphalt mixture performance against distresses pertinent to the climate & traffic specific to the region where it will be placed.

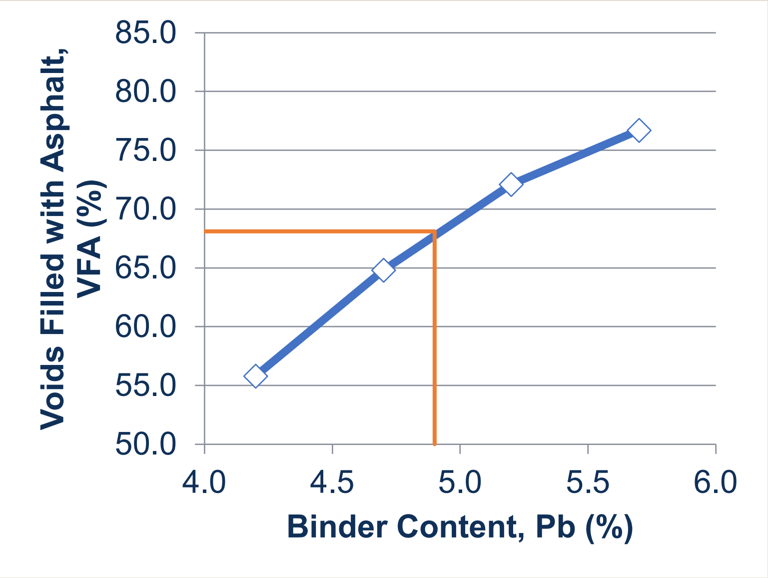
TRB's *Transportation Research Circular E-C280: Glossary of Terms for Balanced Design of Asphalt Mixtures* provides a reference document for usage of Balanced Mix Design terminology by the asphalt mixtures community in the United States.

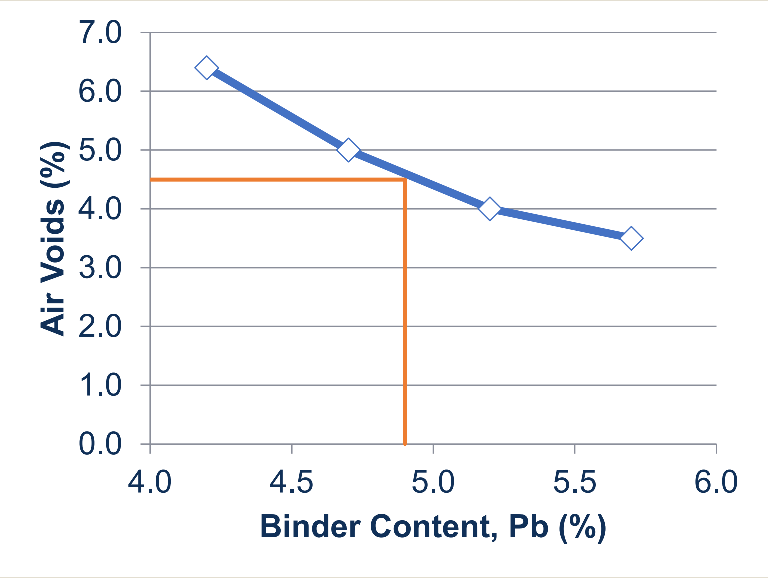
Scan to get the link!

Definitions (2 of 5)

- **Current Volumetric-based Mix Design Procedures**
  - Design of aggregates and combined gradation.
  - Air void level to determine target binder content = 4%, regardless of traffic level.
  - Change in gyrations, gradation, volumetrics to determine mix design.

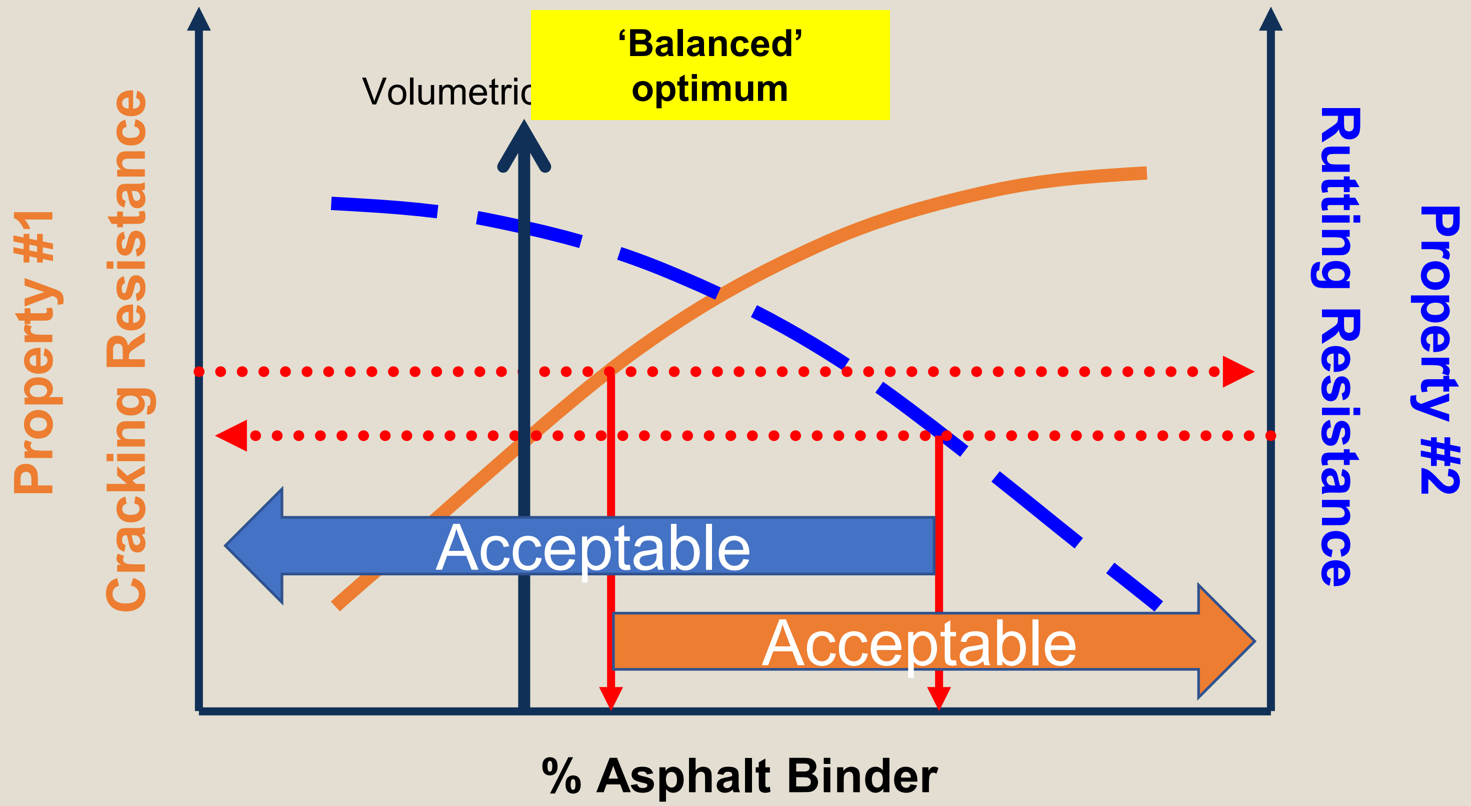






Definitions (3 of 5)

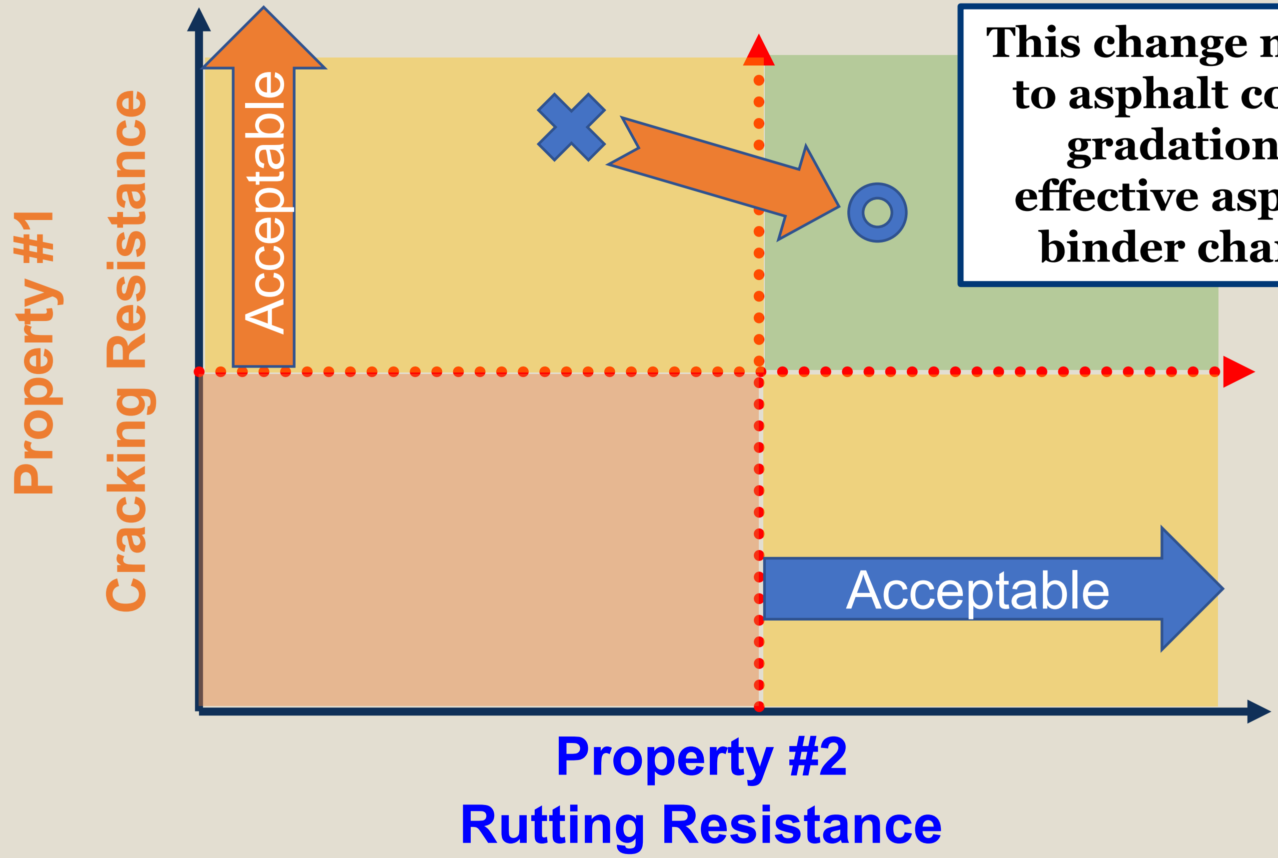
- **Initial BMD Concept**



BMD Concept
Initial concepts of BMD had mix designers altering asphalt binder content to 'balance' the mixture between rutting and cracking.

Definitions (4 of 5)

- **Reality of BMD Approach**



This change may be due to asphalt content, or gradation (more effective asphalt), PG binder change, etc.

BMD Concept

Current practice and work recognizes that DOT's will not require a fully 'balanced' mixture – must meet certain criteria for performance. Other strategies available to achieve performance.

BMD is not solely about achieving the 'right' quantity of asphalt!

Definitions (5 of 5)

- **What are the Alternate BMD Approaches?**

BMD Approach	Volumetric Requirements	Mixture Mechanical Testing Requirements	Flexibility	Innovation Potential
A: Volumetric Design with BMD Verification	Full compliance.	Full compliance.	Most conservative.	Lowest.
B: Volumetric Design with BMD Optimization	Full compliance at preliminary OBC.	BMD optimization through moderate changes in asphalt binder content.	Slightly more flexible than Approach A.	Limited.
C: BMD-Modified Volumetric Design	Some requirements relaxed or eliminated.	BMD optimization by adjusting preliminary asphalt binder content or mixture component properties or proportions.	Less conservative than Approach A and Approach B.	Medium degree.
D: BMD Design Only	Limited or no requirements.	BMD optimization by adjusting mixture components and proportions.	Least conservative.	Highest degree.

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I. Introduction

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IV. Conclusions

Tasks for BMD Implementation

Task		Sub Task	Description	-1	1	2	3	4	5	6	7
1	Understanding the why and benefits of Performance Specifications			●							
2	Overall Planning	2.1	Identification of Champions		●						
		2.2	Establishing a Stakeholders Partnership		●						
		2.3	Doing Your Homework		●						
		2.4	Establishing Goals		●						
		2.5	Mapping the Tasks		●						
		2.6	Identifying Available External Technical Information and Support (periodically)		●	●	●	●	●	●	
		2.7	Developing an Implementation Timeline		●	●	●	●	●	●	
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	Managing Resources				●	●	●	●	
		4.3	Conducting Initial Training			●	●				
		4.4	Evaluating Performance Tests				●	●	●		
		4.5	Conducting Inter-Laboratory Studies					●	●		
5	Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System			●	●				
		5.2	Conducting Benchmarking studies				●	●			
		5.3	Conducting Shadow Projects					●	●		
		5.4	Analyzing Production Data					●	●		
		5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials					●	●	●	
6	Specifications and Program Development	6.1	Sampling and Testing Plans						●	●	
		6.2	Pay Adjustment Factors (If Part of the Goals)						●	●	
		6.3	Developing Pilot Specifications and Policies						●	●	
		6.4	Conducting Pilot Projects						●	●	
		6.5	Final Analysis and Specification Revisions							●	●
7	Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs						●	●	●
		7.2	Establishing or Updating Laboratory Accreditation Program Requirements					●	●	●	●
8	Initial 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.

Tasks for BMD Implementation

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
1	Understanding the why and benefits of Performance Specifications			●							
2	Overall Planning	2.3	Doing Your Homework								
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8	Initial Implementation										

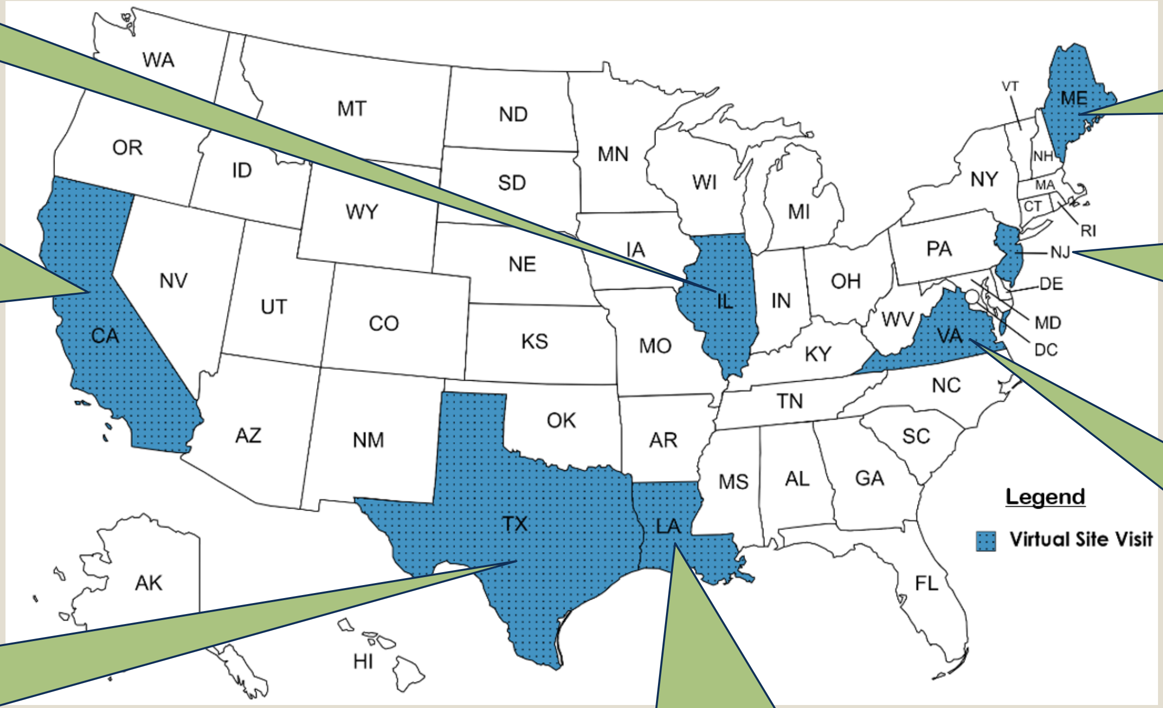
Tasks for BMD Implementation:

Task 1 Motivation and Benefits of BMD

- Immediate need to address premature failures from use of recycled materials.

- Building long-life asphalt pavements (LLAPs) that can last >30 years (tie mixture & thickness design).
- Simplifying BMD approach to allow higher recycled content that could be applied to standard projects statewide.

- Immediate need to address premature failures from use of recycled materials.
- Use higher quantities of RAP for economics & environment.



- Address premature failures.
- Allow innovative and recycled materials.

Address raveling and durability issues even though PWL volumetric properties were acceptable.

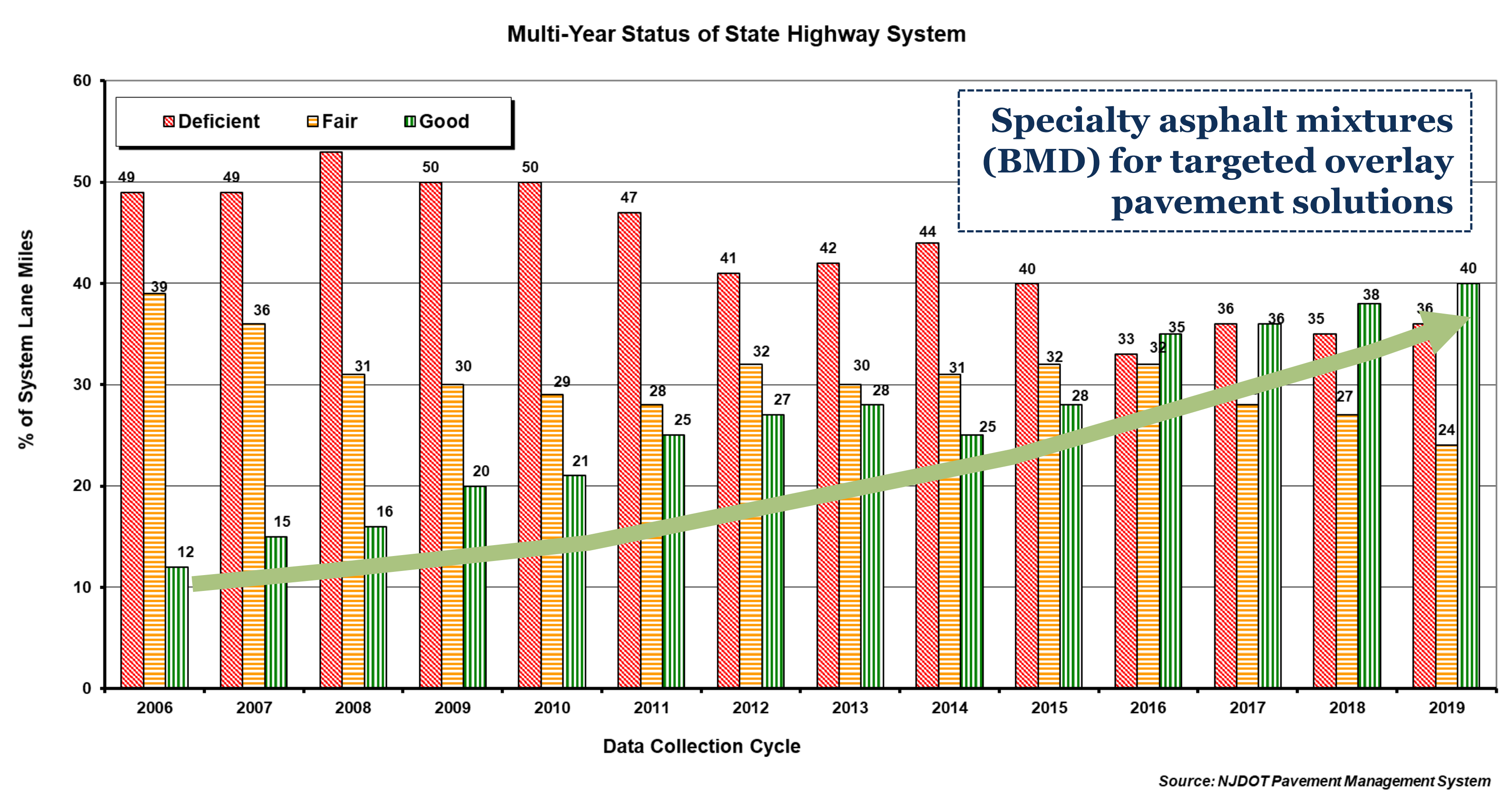
- Superpave implementation led to durability and cracking distresses.
- Adjusting gyrations & volumetric properties did not improve performance.

- Superpave implementation led to durability and cracking distresses.
- Adjusting volumetric did not improve performance especially mixtures with RAP.

Task 1 Motivation and Benefits of BMD

Benefits

- Personal testimony was a powerful way to document benefits of implementing mechanical tests (IDOT).
- Fewer cases of premature failure observed resulting in estimated cost savings of $7.5 million per year (Maine DOT).
- Use of mechanical tests with specialty mixtures was a significant reason for overall improvement of road network (NJDOT).
- Cost savings from increasing RAP use was a motivation to implement BMD (TxDOT).



Tasks for BMD Implementation (Cont'd)

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
2	**Overall Planning**	2.1	Identification of Champions		●						
		2.2	Establishing a Stakeholders Partnership		●						
		2.3	Doing Your Homework		●						
		2.4	Establishing Goals		●						
		2.5	Mapping the Tasks		●						
		2.6	Identifying Available External Technical Information and Support (periodically)		●	—	—	—	—	●	
		2.7	Developing an Implementation Timeline		●	—	—	—	—	●	

Task		Sub Task	Description
4	**Equipment: Acquiring, Managing Resources, Training, and Evaluating**	4.2	Managing Resources
		4.3	Conducting Initial Training
		4.4	Evaluating Performance Tests
		4.5	Conducting Inter-Laboratory Studies
5	**Establishing Baseline Data**	5.1	Reviewing Historical Data & Information Management System
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7	**Training, Certifications, and Accreditations**	7.1	Developing and/or Updating Training and Certification Programs
		7.2	Establishing or Updating Laboratory Accreditation Program Requirements
8	**Initial Implementation**		

Task 2 Overall Planning (1 of 6)

- **Champions.**

Champion	Activity	Example
Caltrans, IDOT, LaDOTD, MaineDOT	Acquired Upper Management/ Leadership Support/ Commitment.	Research, equipment, lab space, staffing, pilot projects, training, etc.
NJDOT	Established internal partnership.	Materials / Design / Management

- **Formation of a joint Task Force.**
  - **Agency.**
  - **Industry.**
  - **Academia (as suitable).**

State DOT	Stakeholder Partnership
IDOT	Implementation Task Force
VDOT	BMD Task Force BMD Technical Subcommittee

Task 2 Overall Planning (2 of 6)

- **Doing your Homework**

Identifying The Issues

- Perf. of high-traffic mixtures.
- Recycled materials.
- Premature failure.
- High-performance & specialty mixtures.

Identifying Resources

- Initial equipment purchase, associated supplies, maintenance/ calibration, training.
- High-level assessment (organizational structure, readiness levels, workspace, tonnage, experiences/practices)

Reviewing Literature

- Long history of using performance tests.
- Historical database.
- Review of other State DOTs specs.
- Knowledge exchange.

Task 2 Overall Planning (3 of 6)

Establishing Goals

Goals defined with considerations to:

- State DOT's organizational structure, staffing level, workspace, annual asphalt tonnage, etc.
- Industry experiences and practices.

Scope for the application of the BMD program onto projects:

- Varies by State DOTs.
- Most significant factors observed: mixture quantity & roadway/corridor classification.

State DOT	Project Scope	Goal: Design	Goal: Acceptance
Caltrans	High-traffic projects with ≥100,000 tons of asphalt mixture produced.	X	X
IDOT, LaDOTD	All projects (phased approach).	X	X
MaineDOT	All interstate & high investment projects.	X	
NJDOT	Evolving from: specialty mixture design/ specialty acceptance/ BMD for dense-graded mixtures.	X	(X)
TxDOT	All mixtures / phased implementation.	X	X
VDOT	Standard well-graded surface mixtures projects with the intent for all projects to be eventually included.	X	X

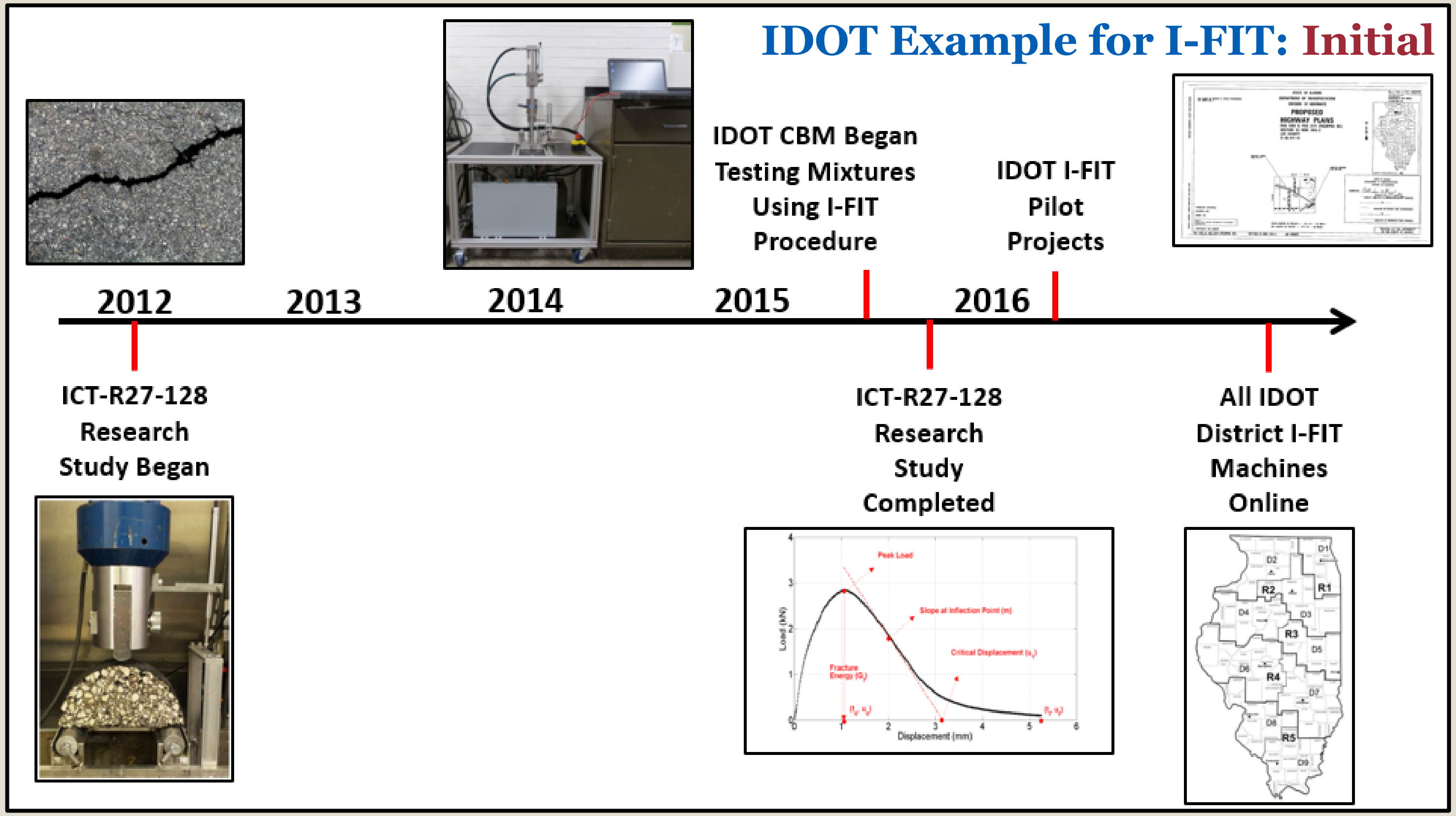
Task 2 Overall Planning (4 of 6)

- **Establishing Goals: Potential Implications of Goals Selection**
  - **Goals can result in different level of changes to how mix designs, verification, & acceptance are being normally handled.**
  - **Questions to be answered:**
    - Who's responsibility is the mix design & performance testing?
    - Is a State DOT going to accept contractor results for performance tests?
    - How a State DOT going to verify & accept mix designs?
    - How to plan for additional workload, cost, and time involved?
    - Is performance testing handled by central or District lab?
    - How production testing is going to be handled & at what frequency?
    - What to do with and how to address failing performance test results?
    - How will dispute resolution be handled?
    - Do State DOT/Industry have the necessary skilled workforce?
    - Etc.

Task 2 Overall Planning (5 of 6)

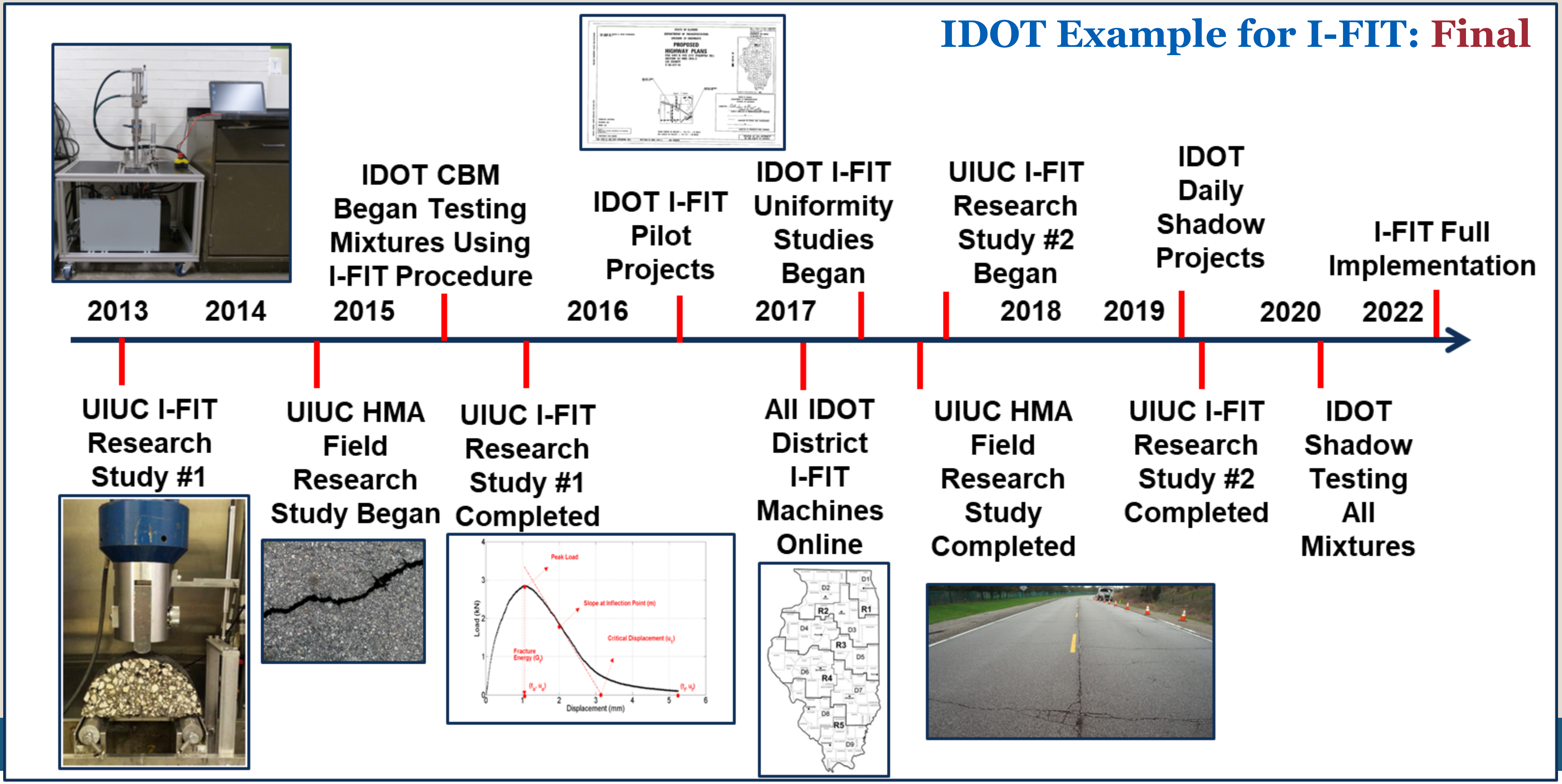
- **Developing an Implementation Timeline**
  - Set timelines.
  - Consider resources.
  - Define scope.
  - Phase activities / milestones.

These timelines **can shift** given future changes but setting a target is **important**.



Task 2 Overall Planning (6 of 6)

- **Developing an Implementation Timeline**



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		3.2	Identifying and Assessing Performance Test Appropriateness.								
		3.3	Validating the Performance Tests								

Task 3 Selecting Performance Tests (1 of 4)

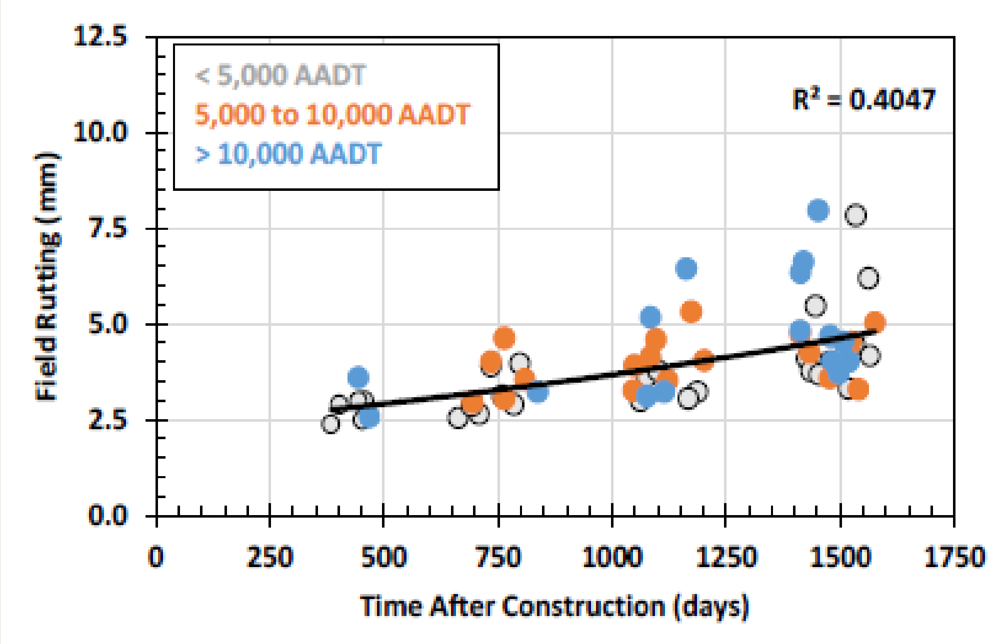
- Identify primary modes of distress (e.g., PMS data).
- Match candidate performance tests.
- Assess routine use.

Considerations to available resources including factors such as:

- Sample preparation.
- Specimen conditioning & testing.
- Training needs & applicability.
- Equipment cost.
- Repeatability.
- Material sensitivity.
- Field validation.

Considerations to asphalt mixture acceptance during production:

- Volumetric properties.
- Surrogate performance tests correlated to asphalt mixture design approval tests.
- Actual performance tests used during mixture design.
- Performance tests with pay adjustment factors.



Source: NETC 18-2
https://www.newenglandtransportationconsortium.org/projects/netc-18-2/

Task 3 Selecting Performance Tests (2 of 4)

- Additional considerations: test variability.

Cracking Test	Procedure	Coefficient of Variation (COV)
DCT	ASTM D7313	10–15%
Flexural Bending Beam Fatigue	AASHTO T 321	40–50%
IDT Creep	AASHTO T 322	7–11%
IDEAL-CT	ASTM D8225	10–25%
I-FIT	AASHTO T 124	Single-operator 27.1% Multi-lab 34.1%
SCB	ASTM D8044	20%
Overlay Tester (CFE & CRI)	Tex-248-F	10–25%
Nflex	AASHTO TP 141	10–25%
TSR - IDT	AASHTO T 283	10%

https://www.asphaltpavement.org/expertise/engineering/resources/bmd-resource-guide

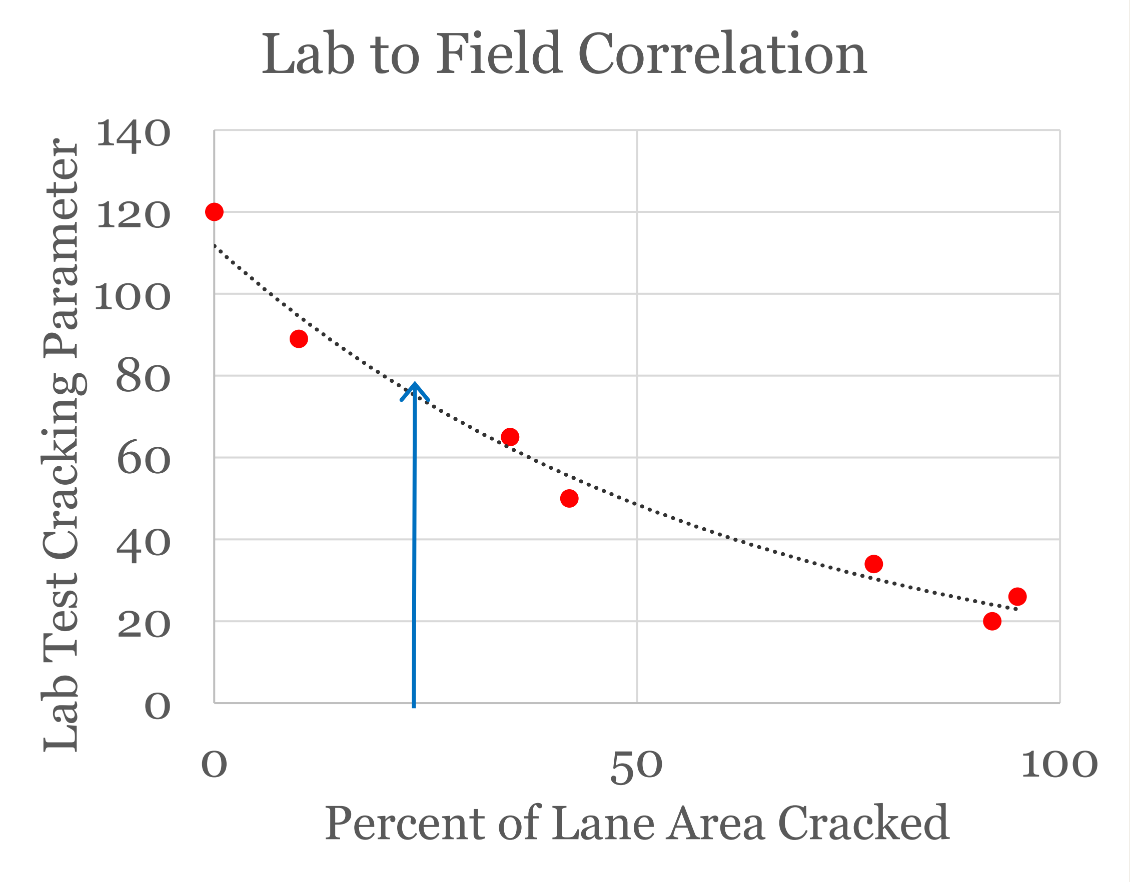
Task 3 Selecting Performance Tests (3 of 4)

- State DOTs top 3 factors.

Factor	Caltrans	IDOT	LaDOTD	MaineDOT	NJDOT		TxDOT	VDOT
					Design/ Verification	Acceptance		
Sample preparation						↔	↔	↔
Specimen conditioning & testing					↔	↔	↔	↔
Training needs & applicability								
Equipment cost						↔		
Repeatability & Reproducibility	↔	↔	↔	↔	↔		↔	↔
Material sensitivity	↔	↔	↔	↔				
Field validation	↔	↔	↔	↔	↔			

Task 3 Selecting Performance Tests (4 of 5)

- *<u>Primary goal:</u>* Make sure that the performance test results have a strong relationship to field performance.
- Critical for proper test selection and supporting the development of specification criteria.
- **Benchmarking ≠ Validation**



Must confirm relationship in order to develop criteria!

Task 3 Selecting Performance Tests (5 of 5)

- Validating Performance Tests (relationship to field performance).

TxDOT Example (HWTT & OT)

Robust Validation of BMD Test Criteria

Selection of Initial Criteria
- Historical database of test results & related field performance.
- HWTT (2004) & OT (2014) for an array of mixtures.

Validation of Initial Criteria
- Research comparing HWTT & OT to field pavement performance.
- Analysis of Hamburg Wheel Tracking Device Results in Relation to Field Performance (0-4185).

Ongoing Database
- Improve analysis methods.
- Update criteria.

Additional Validation Studies
- ALF.
- Field test sections.
- NCAT test track

Having a large database of test results for typical mixtures along with their respective history of field pavement performance are key for TxDOT's implementation efforts of BMD.

Tasks for BMD Implementation (Cont'd)

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		2.4	Establishing Goals		●						
		2.5	Mapping the Tasks		●						
		2.6	Identifying Available External Technical Information and Support (periodically)		●	—	—	—	—	●	
		2.7	Developing an Implementation Timeline		●	—	—	—	—	●	
5	Data	5.3	Conducting Shadow Projects								
		5.4	Analyzing Production Data					●	●		
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8	Initial Implementation										●

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4	Performance Testing Equipment: Acquiring, Managing Resources, Training, and Evaluating	4.1	Acquiring Equipment			●	—	—	●		
		4.2	Managing Resources				●	—	—	●	
		4.3	Conducting Initial Training			●	●				
		4.4	Evaluating Performance Tests				●	—	●		
		4.5	Conducting Inter-Laboratory Studies					●	●		

Task 4 Performance Testing Equipment (1 of 2)

- **Acquiring Equipment**
  - Contractor vs. agency, central vs. district lab, new vs. modify, etc.

Workspace Labs

Rearrange

- To improve efficiency in district labs (IDOT).

Reorganize

- Laundry room to fit equipment (NJDOT).

Convert

- Stairwell to house new equipment (MaineDOT).
- janitor's closet for coring & sawing specimens (MaineDOT).

Lab/Staffing Capabilities

Consider current staffing & equipment (VDOT)

Meet current workload & transition to new needs (NJDOT, VDOT)

Hire additional & dedicated staff (MaineDOT)

Maintain an active material producer list (MPL) for labs approved to perform HWTT (TxDOT)

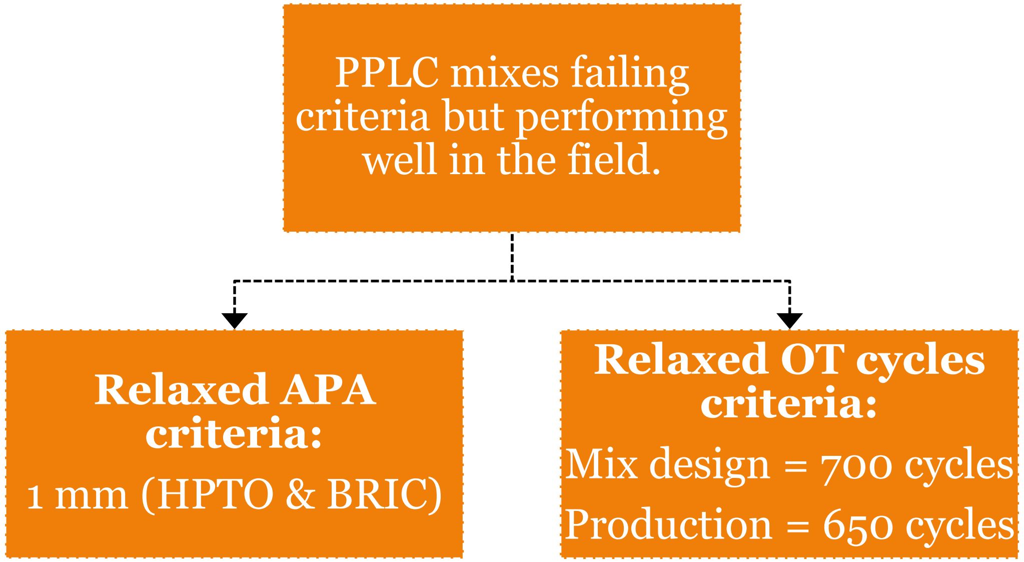
Task 4 Performance Testing Equipment (2 of 2)

Evaluating Performance Tests & Conducting ILS

IDOT
- I-FIT **LTOA protocol**
  - For LPLC & PPLC specimens.
  - 72 hours at 95°C (IDOT).

LaDOTD
- SCB **aging scaling factor** to estimate test results.

NJDOT
- LPLC vs PPLC



ILS
- Refinement of test procedure.
- Refinement of fabrication procedure.
- Keeping uniformity with existing & new labs.

Tasks for BMD Implementation (Cont'd)

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
1	Understanding the why and benefits of Performance Specifications			●							
2	Overall Planning	2.1	Identification of Champions		●						
		2.2	Establishing a Stakeholders Partnership		●						
		2.3	Doing Your Homework		●						
		2.4	Establishing Goals		●						
		2.5	Mapping the Tasks		●						
		2.6	Identifying Available External Technical Information and Support (periodically)		●	●	●	●	●	●	
		2.7	Developing an Implementation Timeline		●	●	●	●	●	●	
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			●	●	●	●		
	Performance Testing	4.1	Acquiring Equipment			●	●	●	●		
		4.2	Managing Resources				●	●	●	●	
	Program Development	6.4	Conducting Pilot Projects						●	●	
		6.5	Final Analysis and Specification Revisions							●	●
7	Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs						●	●	●
		7.2	Establishing or Updating Laboratory Accreditation Program Requirements					●	●	●	●
8	Initial Implementation										●

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
5	Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System			●	●				
		5.2	Conducting Benchmarking studies				●	●			
		5.3	Conducting Shadow Projects					●	●		
		5.4	Analyzing Production Data					●	●		
		5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials					●	●	●	

Task 5 Establishing Baseline Data (1 of 6)

How Validation is Different from Benchmarking?

- **Validation.**
  - *Primary goal:* Make sure that the performance test results have a strong relationship to field performance.
  - Critical for proper test selection, and supporting the development of specification criteria.
- **Benchmarking.**
  - *Primary goal:* Determine how existing asphalt mixture designs perform using the selected performance tests.
  - Benchmark of existing asphalt mixture designs.

Task 5 Establishing Baseline Data (2 of 6)

- Reviewing Historical Data & Information Management System: LaDOTD Example.

Long record of test results.

- +20 years HWTT
- +18 years SCB
- Allowed to tie asphalt mixture properties to their related field performance.

Identify correlations between field & lab measured mixture performance indicators.

- HWTT rut depth related to MEPDG projected terminal rutting (calibrated using field distress data from PMS).
- SCB *Jc related* to 20-year projected combined cracking indices (alligator cracking & random cracking).

Establish Initial test criteria for HWTT & SCB based on traffic level.

- HWTT measured rut depths for Level 2 & Level 1 asphalt mixtures.
- Minimum SCB *Jc* values of 0.6 & 0.5 kJ/m^2 established for Level 2 & Level 1 asphalt mixtures.

Propose a draft sampling & testing plan of the specs.

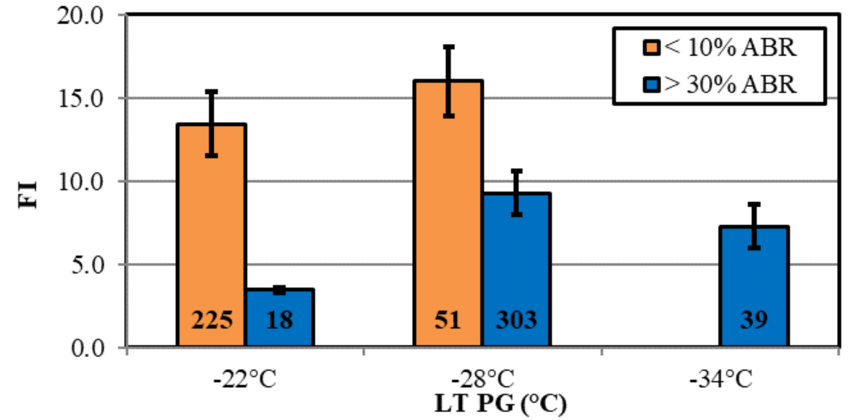
- Further validate the initial performance test criteria.
- Continue to collect field & lab performance data.

Development of Performance-based Specifications for Louisiana Asphalt Mixtures

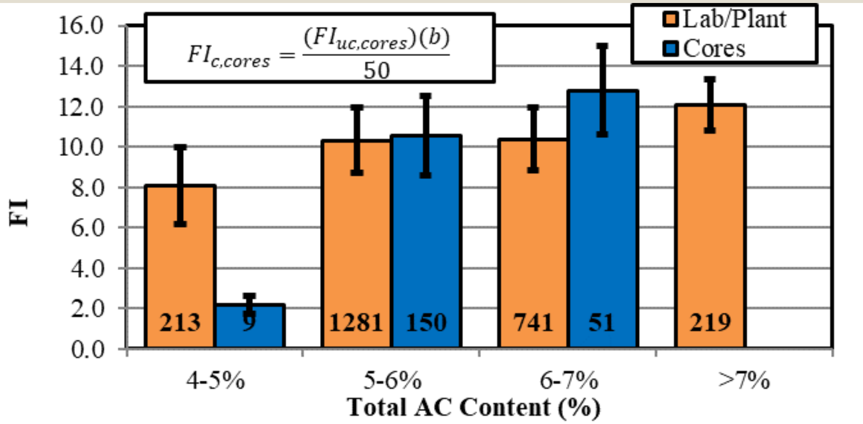
Task 5 Establishing Baseline Data (3 of 6)

- Conducting Benchmarking Studies: IDOT (+3,000 test sets)

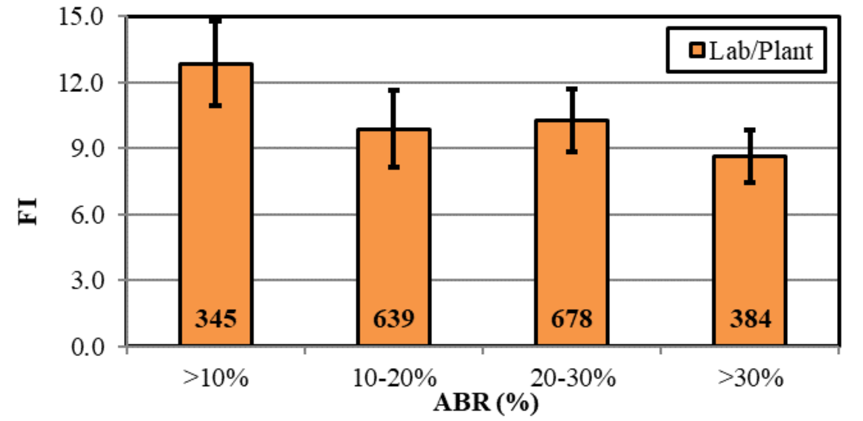
Effect of virgin binder low temp PG



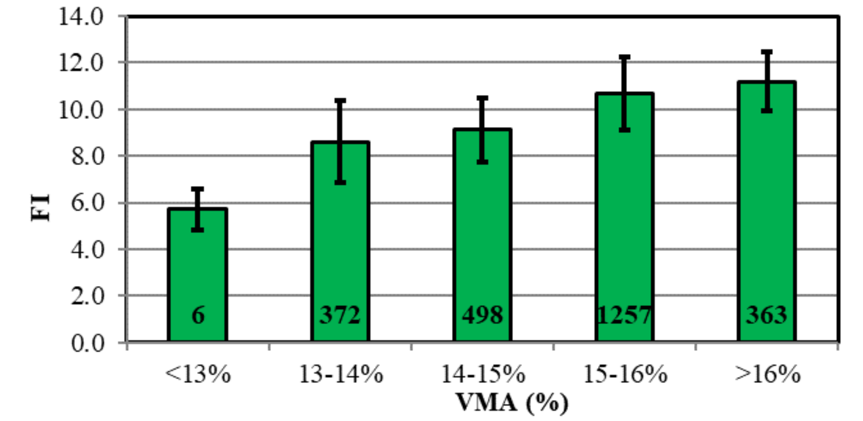
Effect of Total AC Content



Effect ABR



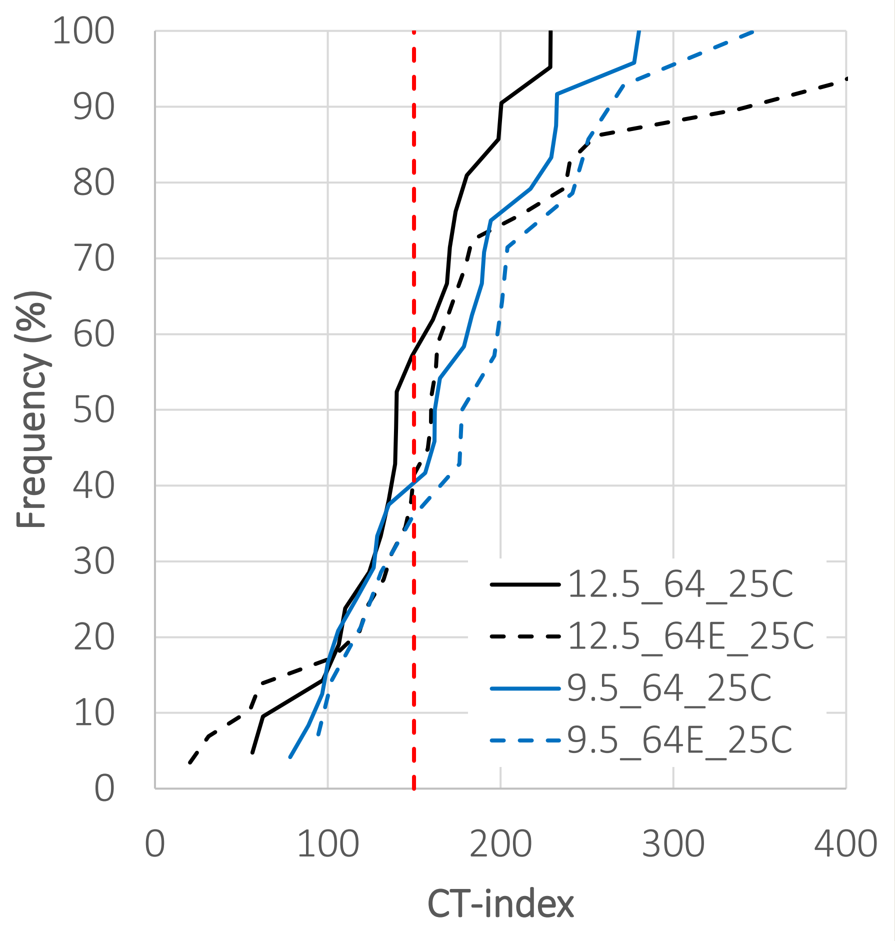
Effect of Design VMA



Task 5 Establishing Baseline Data (4 of 6)

- Conducting Benchmarking Studies: MaineDOT.
  - Database used to compare:
    - Tests from splits of Acceptance samples
    - Compared to volumetric properties
  - Results appear to reflect benefit of polymers (i.e., PG 64E-28) & finer gradations (i.e., smaller NMAS) on crack resistance.

NMAS	Binder PG	CT-index			
		n	Average of Mean	Average of SDev	Average of COV
12.5mm	PG 64-28	20	147.6	20.7	14.4%
12.5mm	PG 64E-28	27	185.0	25.6	15.3%
9.5mm	PG 64-28	23	167.1	20.3	11.7%
9.5mm	PG 64E-28	14	190.1	27.6	13.3%
Weighted Average			**172.0**	**23.3**	**13.8%**



Task 5 Establishing Baseline Data (5 of 6)

- Conducting Shadow Projects: test results are informational.
  - Gain familiarity with selected tests.
  - Add to the database.
  - Understand production variability.

Scope:
No. of shadow projects.
Type of projects (project selection guidelines).

Careful selection of projects & contractors/ producers for shadow projects.

Careful documentation of construction process to know if any field issues occurred that may cause premature distress issues in the field.

Example of Lessons Learned & Challenges

Accelerate turnaround time

- Prioritization.
- Oven solely dedicated to performance tests.
- Additional water bath with scale.
- Full-time technician for performance testing (likely).

Challenges

- Dealing with >1 project at a time.
- Getting samples from contractor promptly.
- Having performance test failure.
  - Re-verify after mixture adjustment.
- Meeting air voids tolerances.
  - Cutting & preparing additional samples if out of tolerance.

Task 5 Establishing Baseline Data (6 of 6)

- Determining How to Adjust Mixtures: Lessons Learned.
  - Adjustments are material specific.
  - Binder selection based on stiffness (not just meeting PG).
  - Gradation & bin percentages adjustments to increase effective binder.
  - Minimization in/exclusion of natural sand.
  - Benefits in volumetric adjustments (e.g., decrease in N_{design}, increase in VMA).
  - Increase in mastic (fines & binder)—improved cracking resistance.
  - Understanding differences between coldfeed & post plant gradations.
  - Calibration of the plant's weigh bridges became more important.

Tasks for BMD Implementation (Cont'd)

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
1	Understanding the why and benefits of Performance Specifications			●							
2	Overall Planning	2.1	Identification of Champions		●						
		2.2	Establishing a Stakeholders Partnership		●						
		2.3	Doing Your Homework		●						
		2.4	Establishing Goals		●						
		2.5	Mapping the Tasks		●						
		2.6	Identifying Available External Technical Information and Support (periodically)		●	●	●	●	●	●	
		2.7	Developing an Implementation Timeline		●	●	●	●	●	●	
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	Managing Resources				●	●	●	●	
		4.3	Conducting Initial Training			●	●				
		4.4	Evaluating Performance Tests				●	●	●		
		4.5	Conducting Inter-Laboratory Studies					●	●		
7	Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs								
		7.2	Establishing or Updating Laboratory Accreditation Program Requirements					●	●	●	●
8	Initial Implementation										●

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
6	Specifications and Program Development	6.1	Sampling and Testing Plans						●	●	
		6.2	Pay Adjustment Factors (If Part of the Goals)						●	●	
		6.3	Developing Pilot Specifications and Policies						●	●	
		6.4	Conducting Pilot Projects						●	●	
		6.5	Final Analysis and Specification Revisions							●	●

Task 6 Specs & Program Development (1 of 2)

- **Acceptance & QC options**

State DOT	Acceptance
Caltrans, LaDOTD, VDOT	Volumetric properties with performance tests for information.
NJDOT, TxDOT	Surrogate performance tests correlated to mix design approval tests.
IDOT, NJDOT, MaineDOT	Actual performance tests (same used during mix design).
NJDOT	Performance tests with pay adjustment factors.

- **Setting Criteria**
  - Critical item.
    - requires input from many previous tasks (doing your homework, benchmarking, PMS data, Production variability analysis, etc.).

Caution when using criteria from other States or research organizations–differences in conditions:

- Mix types & properties
- Climate
- Aging conditions
- Quality assurance programs
- Others

Task 6 Specs & Program Development (2 of 2)

Subtasks	Examples
Developing Pilot Specifications & Policies.	• Specifications & policies for the HWTT were created & reviewed prior to using them on pilot projects (MaineDOT). • Detailed specifications were prepared, which included the use of a test strip and field-testing frequencies (NJDOT). • BMD for dense-graded asphalt mixtures was implemented on a voluntary basis. The goal was to have 20 projects over 2 years (TxDOT). • BMD pilot projects were optional for the contractor. The contractor would select Approach A or D (VDOT). • The specification calls for a minimum of 40% RAP and allows for RAs (VDOT).
Conducting Pilot Projects.	• Pilot projects were introduced gradually & started with one per district (IDOT). • A pilot project was conducted in 6 of the 9 districts. Full implementation followed 3 years later (LaDOTD).
Final Analysis & Specification Revisions.	• The specification addresses performance testing during mix design and production (IDOT). • Performance testing was successfully implemented for mix design & there is now interest in using them for acceptance (NJDOT). • There is interest in exploring the use of surrogate performance testing (NJDOT, TxDOT).

Tasks for BMD Implementation (Cont'd)

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
1	Understanding the why and benefits of Performance Specifications			●							
2	Overall Planning	2.1	Identification of Champions		●						
		2.2	Establishing a Stakeholders Partnership		●						
		2.3	Doing Your Homework		●						
		2.4	Establishing Goals		●						
		2.5	Mapping the Tasks		●						
		2.6	Identifying Available External Technical Information and Support (periodically)		●	●	●	●	●	●	
		2.7	Developing an Implementation Timeline		●	●	●	●	●	●	
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	Managing Resources				●	●	●	●	
		4.3	Conducting Initial Training			●	●				
		4.4	Evaluating Performance Tests				●	●	●		
		4.5	Conducting Inter-Laboratory Studies					●	●		
5	Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System			●	●				
		5.2	Conducting Benchmarking studies				●	●			
		5.3	Conducting Shadow Projects					●	●		
		5.4	Analyzing Production Data					●	●		
		5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials					●	●	●	
6	Specifications and	6.1	Sampling and Testing Plans						●	●	
		6.2	Pay Adjustment Factors (If Part of the Goals)						●	●	
		6.3	Developing Pilot Specifications and Policies						●	●	
7	Training, Certifications, and Accreditations	7.1	Developing and/or Updating Training and Certification Programs						●	●	●
		7.2	Establishing or Updating Laboratory Accreditation Program Requirements					●	●	●	●

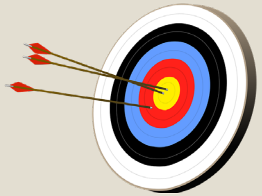
Task 7 Training, Certifications, & Accreditations

Subtasks	Examples
Developing Training and Certification Programs.	• Performance tests are part of the standard technician certification program (IDOT, TxDOT). • Training contractor staff on their own equipment in their own laboratory environment was extremely helpful (Caltrans).
Establishing Laboratory Accreditation.	• Central laboratories are accredited and as a local practice district laboratories may be accredited. Technicians doing acceptance testing are required to participate in an annual proficiency program (LaDOTD).

Tasks for BMD Implementation (Cont'd)

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
1	Understanding the why and benefits of Performance Specifications			●							
2	Overall Planning	2.1	Identification of Champions		●						
		2.2	Establishing a Stakeholders Partnership		●						
		2.3	Doing Your Homework		●						
		2.4	Establishing Goals		●						
		2.5	Mapping the Tasks		●						
		2.6	Identifying Available External Technical Information and Support (periodically)		●	—	—	—	—	●	
		2.7	Developing an Implementation Timeline		●	—	—	—	—	●	
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	Managing Resources				●	—	—	●	
		4.3	Conducting Initial Training			●	●				
		4.4	Evaluating Performance Tests				●	—	●		
		4.5	Conducting Inter-Laboratory Studies					●	●		
5	Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System			●	●				
		5.2	Conducting Benchmarking studies				●	●			
		5.3	Conducting Shadow Projects					●	●		
		5.4	Analyzing Production Data					●	●		
		5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials					●	—	●	
6	Specifications and Program Development	6.1	Sampling and Testing Plans						●	●	
		6.2	Pay Adjustment Factors (If Part of the Goals)						●	●	
		6.3	Developing Pilot Specifications and Policies						●	●	
		6.4	Conducting Pilot Projects						●	●	
		6.5	Final Analysis and Specification Revisions							●	●
8	Initial Implementation										●

Task 8 Initial Implementation (1 of 7)



- Establish scope for project selection prior to implementation.
  - Function of BMD program target goals.
- Communicate changes & new requirements to both industry & agency personnel.
  - Technology transfer using webinars, face-to-face meetings, workshops.
  - "Implementation teams" to help both contractors & State DOT personnel address problems, interpret specification requirements, etc.
- Integrate a feedback loop into the process.
  - Regularly evaluate/update process based on feedback loop & available resources.

Task 8 Initial Implementation (2 of 7): IDOT Example

2019

- Implemented I-FIT on all interstate projects with additional projects approved by Central Office
- Total of 27 projects statewide.

2020

- Original plan: full Implementation of I-FIT
- Postponed in order for contractors to gain more experience & become reasonably comfortable with performance test (based on contractors' feedback).

2021

- Implemented I-FIT thresholds in design & production for short-term aged specimens
- Including higher thresholds for SMA and IL-4.75 mixtures.

2022

- Fully implemented I-FIT thresholds in design and production for short-term and long-term aged specimens.

Task 8 Initial Implementation (3 of 7): IDOT Example

• Mix Design & Acceptance

Approach A *Volumetric Design with Performance Verification*

→ **Contractor Design**
Conduct lab mix design (AASHTO M 323 or M 325).

→ **Contractor Submittal**
Submit JMF & SGC specimens for TSR, HWT, & I-FIT.

→ **State DOT Verification**
Verify Mix Design for volumetrics & performance testing.

→ **State DOT Approval**
Approved mix JMF may be used in the plant.
Mix approved indefinitely.

→ **PRODUCTION**

→ **Contractor Test Strip**
At beginning of production.
Mixture sampled, prepared/ compacted & sent to State District lab.

→ **State DOT Verification**
Mixture has to meet HWT & I-FIT requirements.

→ **Contractor Adjustments to Mixture Production (Failing Results)**
Made prior to restarting production & submit to IDOT for I-FIT & HWT testing.

Production

Re-design
If combined agg. bulk SG changes by more than +/- 0.020 from original mix design.

Verification (including performance testing)
If aggregate producer changes production practices or ledges prior/during construction season.

Failing HWT or I-FIT

Consecutive failing
No additional mixture produced until passing tests criteria.

State DOT Additional Testing
May conduct additional HWT & I-FIT on production mixtures.

Task 8 Initial Implementation (4 of 7): IDOT Example

• Specs for performance testing

T 393-21

Mixture Type		HWTT (Illinois Modified AASHTO T 324), ≤ 12.5 mm Rut Depth at a Minimum Number of Wheel Passes				FI (Illinois Modified AASHTO T 124)		TS (Illinois Modified AASTO T 283), psi			
								Conditioned TS		Uncon-ditioned TS	TSR
		PG 58-xx (or lower)	PG 64-xx	PG 70-xx	PG 76-xx (or higher)	Short-Term Aging	Long-Term Aging#	Non-Polymer PG	Polymer modified PG$		
High ESAL	IL-19.0	≥ 5,000	≥ 7,500	≥ 15,000	≥ 20,000	8.0	4.0*	≥ 60	≥ 80	≤ 200	≥ 0.85
	IL-9.5					8.0	4.0*				
	IL-4.75			≥ 10,000^	≥ 15,000^	12.0	–				
Low ESAL	IL-19.0L	–	–	–	–	8.0	4.0*				
	IL-9.5L	–	–	–	–	8.0	4.0*				
SMA	≤ 10 MESALs	≥ 5,000	≥ 7,500	≥ 15,000	≥ 20,000	16.0	10.0				
	> 10 MESALs					16.0	10.0				

–indicates not applicable.
^beginning in 2021.
#required for surface courses only beginning in 2022.
*production mixture requirement. Mixture design long term aging FI is minimum of 5.0.
$except polymer modified PG XX-28 or lower binders shall have a minimum TS of 70 psi.

Removed in 2022 Spec Book

VFA limits Removed in 2022 Spec Book

Task 8 Initial Implementation (5 of 7): IDOT Example

- Many contractors chose to invest in equipment, especially those operating in remote areas.
  - Some contractors partnered in equipment purchasing & ownership.
- Lab workspace can be challenging.
  - Contractor converted a storage room into a temp-controlled room to house equipment.
  - A contractor had to acquire interchangeable table jigs due to space limitation.
- Contractors have challenges in acquiring qualified technicians.
  - Having to run performance tests added to that challenge.
  - Additional training on equipment and test result calculations needed.
- No issues or challenges in meeting in-place density requirements.

key for success: partnership & continuous discussion between IDOT, industry, IAPA, & universities.

Tasks for BMD Implementation

Task 8 Initial Implementation (6 of 7): TxDOT Example

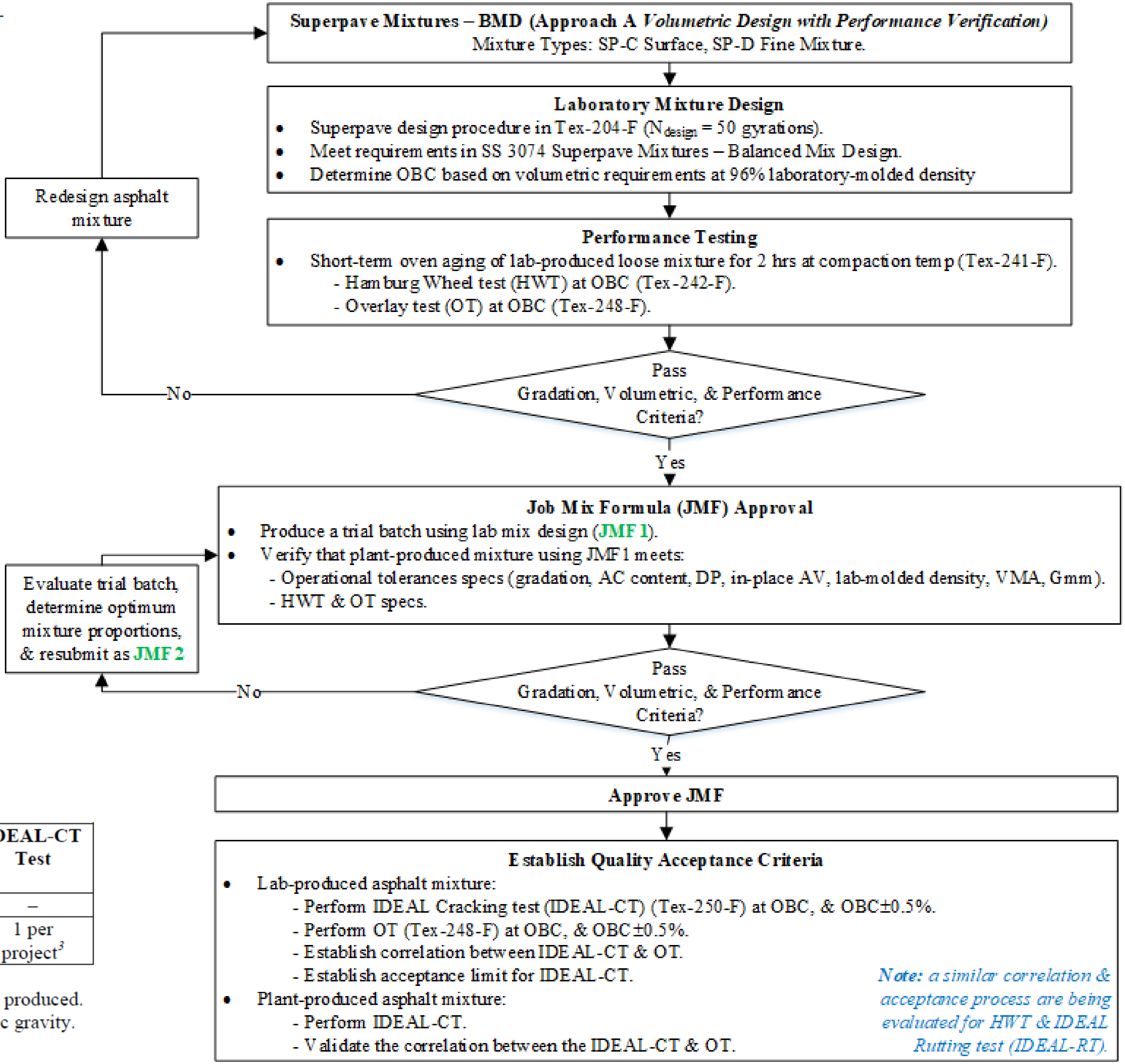


Table 8. Minimum Production Testing Frequency.

Entity	Gradation	Volumetrics[2] and In-place Air voids	Asphalt Binder Content	HWT	OT	IDEAL-CT Test
Contractor	1 per sublot	–	1 per sublot	–	–	–
TxDOT	1 per 12 sublots[1]	1 per sublot[1]	1 per lot[1]	1 per project[3]	1 per project[3]	1 per project[3]

–Not applicable.
[1]1 per day if 100 tons or more are produced. No testing is required when less than 100 tons are produced.
[2]Laboratory-molded density and bulk specific gravity, VMA, and theoretical maximum specific gravity.
[3]Testing performed by MTD or designated laboratory.

Task 8 Initial Implementation (7 of 7): TxDOT Example

- Specs for performance testing

Mixture Type		High-Temperature Asphalt Binder PG	HWTT at 50°C		OT$			IDT (dry), psi$
			Passes at 12.5 mm Rut Depth	Rut Depth at 20,000 passes	Number of Cycles	CFE, inch-psi	CPR	
DG HMA (Item 341)	A (Coarse Base), B (Fine Base), C (Coarse Surface), D (Fine Surface), F (Fine Mixture)	PG 64 or lower	≥ 10,000	–	–*	–	–	85–200
		PG 70	≥ 15,000	–	–*	–	–	85–200
		PG 76 or higher	≥ 20,000	–	–*	–	–	85–200
SP Mixtures (Item 344)	SP-B (Intermediate), SP-C (Surface), or SP-D (Fine Mixture)	PG 64 or lower	≥ 10,000	–	–*	–	–	85–200
		PG 70	≥ 15,000	–	–*	–	–	85–200
		PG 76 or higher	≥ 20,000	–	–*	–	–	85–200
PFC (Item 342)	Fine (PFC-F)	PG 76	≥ 10,000	–	≥ 200	–	–	–
	Coarse (PFC-C)	PG 76	Report only	–	Report only	–	–	–
	Fine (PFCR-F)	A-R	Report only	–	Report only	–	–	–
	Coarse (PFCR-C)	A-R	Report only	–	Report only	–	–	–
SMA (Item 346)	SMA	–	–	≤ 12.5 mm	≥ 200	–	–	–
	SMAR	–	–	≤ 12.5 mm	≥ 200	–	–	–
TOM (Item 347)	Coarse (TOM-C) or Fine (TOM-F)	PG 70	≥ 15,000	–	≥ 300	–	–	≤ 200
		PG 76	≥ 20,000	–	≥ 300	–	–	≤ 200
TBFC (Item 348)	Fine (PFC-F)	PG 76	≥ 10,000	–	≥ 200	–	–	–
	Coarse (PFC-C)	PG 76	Report only	–	Report only	–	–	–
	Coarse (PFCR-C)	A-R	Report only	–	Report only	–	–	–
	Thin Bonded Wearing Course (TBWC)	Type A	Report only	–	Report only	–	–	–
		Type B	Report only	–	Report only	–	–	–
		Type C	Report only	–	Report only	–	–	–
CAM (SS 3000)	Fine Mixture	PG 64 or lower	≥ 10,000	–	≥ 750	–	–	85–200
		PG 70	≥ 15,000	–	≥ 750	–	–	85–200
		PG 76 or higher	≥ 20,000	–	≥ 750	–	–	85–200
SP – BMD (SS 3074)#	SP-C (Surface) or SP-D (Fine Mixture)	PG 64 or lower	≥ 10,000	–	–	≥ 1.0	≤ 0.45	85–200
		PG 70	≥ 15,000	–	–	≥ 1.0	≤ 0.45	85–200
		PG 76 or higher	≥ 20,000	–	–	≥ 1.0	≤ 0.45	85–200

–Not applicable.
$CFE= Critical Fracture Energy; CPR=Crack Progression Rate, IDT=Indirect Tensile Strength (Tex-226-F).
*For informational only when requested or shown in the plans during the first week of production.
#When HWTT and OT meet the requirements, a correlation is established between OT and IDEAL-CT (Tex-250-F).

Presentation Overview

Conclusions

FEEDBACK LOOP

- Partnering with & collaboration between State DOT, industry, & academia.
- Having test procedures available.
- Funding research studies to evaluate the sensitivity of performance tests to material properties.
- Conducting and participating in inter-laboratory studies.
- Having a certification program in-place for testing and evaluating asphalt mixtures.
- Having statewide shadow and pilot projects and an incremental implementation over several years.

Remember It is called *Initial Implementation*.
The process will evolve & requires continuous updates, improvements, & refinements over time

Balanced Mix Design Case Studies Workshop

- https://www.fhwa.dot.gov/pavement/asphalt/

- https://www.fhwa.dot.gov/pavement/asphalt/pubs/20210722_bmd_workshop_flyer_508c_finalv3.pdf

Scan to get the link!

U.S. Department of Transportation
Federal Highway Administration

RESOURCE CENTER

Balanced Mix Design (BMD) Case Studies Virtual Workshop: Moving Forward with Implementation

Description

This free Federal Highway Administration (FHWA) workshop will provide State DOTs with knowledge on how to get started and/or move forward with the implementation of BMD as learned from in-depth case studies of key State DOTs. It is **customized** to a State DOTs current situation with its BMD implementation program.

This unique workshop includes providing managers and practitioners with knowledge on:

a. the overall BMD process and its benefits;
b. the planning and activities needed for the selection, evaluation, and implementation of performance tests for routine uses in a BMD process; and
c. positive practices and lessons learned by key State DOTs.

The workshop will focus on a BMD implementation process that was developed and conducted from in-depth case studies of key State DOTs.

Location

The **free virtual workshop** will be delivered using Microsoft Teams or any other virtual meeting platform accepted by a State Department of Transportation (DOT).

Length

The workshop is a total of six hours and will include multiple segments with a maximum of three hours per segment. The workshop can be delivered over the course of several days.

Target Audience

The successful implementation of BMD will need to be a team effort. Thus, the target audiences for the workshop are managers and practitioners interested in the implementation of BMD from State DOTs, industry, academia, and consultants. This involves participants from various offices of a State DOT, such as materials, pavement design, construction, and pavement management.

Outcomes

Upon completion of the workshop, participants will be able to:

- Understand the overall benefits of BMD.
- Recognize the planning and coordination effort associate with the implementation process of BMD.
- Identify the tasks that need to be completed for the development and implementation of BMD.
- Recognize successful key State DOTs practices and experiences related to BMD.
- Recognize available external technical information and support.

Register Today

Contact **Derek-Nener-Plante** at derek.nenerplante@dot.gov for more information.