Case Studies on the Implementation of Balanced Mix Design and Performance Tests for Asphalt Mixtures

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NEAUPG

October 27, 2021

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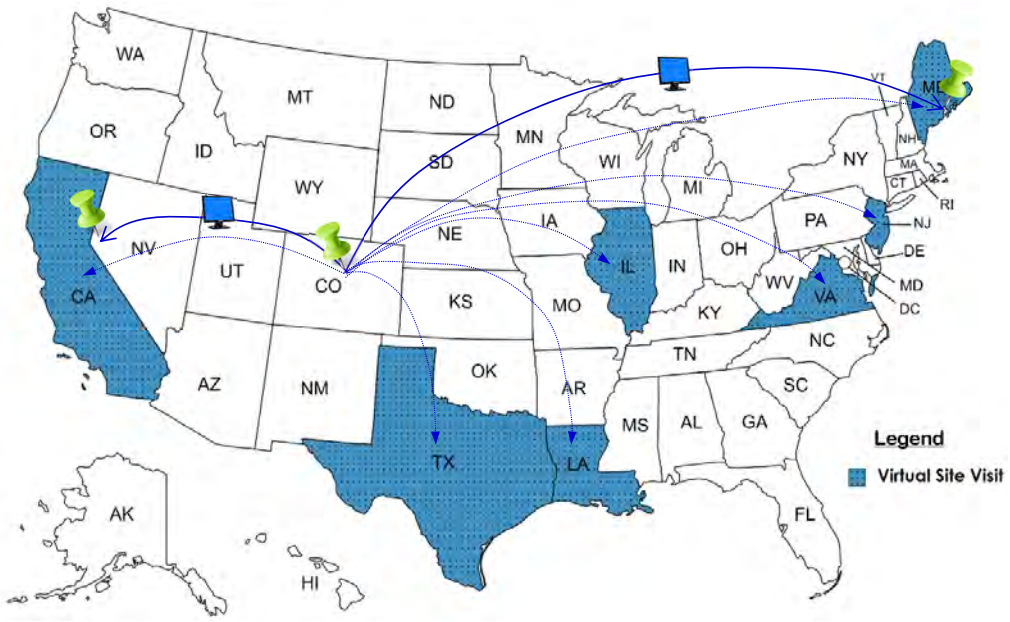
Introduction
Case Studies of Key State DOTs (Virtual Site Visits)

- Pre-visit kickoff & planning web conferences.
- Review of agency documents (policy, specs, reports, etc.).
- 2–4 day virtual site visit.
  - Obtain detailed understanding of agency practices & lessons learned.
- Products
  - Individual State DOT site visit reports.
  - Overall summary report.
  - Tech Brief.



- https://www.unr.edu/wrsc/tools/asphalt/dapt-publications
- https://www.asphaltpavement.org/expertise/engineering/resources/bmd-resource-guide/training-resources

What's BMD

- AASHTO PP 105-20 defines Balanced Mix Design (BMD) 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."

What are the Alternate BMD Approaches?
(AASHTO PP 105-20)

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

[a]State DOT may set minimum requirements for binder quality & aggregate properties. Once the lab test results meet the performance criteria, the mixture volumetric properties may be checked for use in production.

Definitions
What are Positive Practices, Lessons Learned, & Challenges?

Positive Practices	Lessons Learned	Challenges
• Successful efforts that are being used or have been used by a State DOT that could also be considered by other agencies.	• Experiences and efforts from past activities that could be taken into account by a State DOT in future planning and activities.	• Efforts that a State DOT has previously or is still in the process of addressing.

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

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							●	●
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.

Task 1: Understanding the Why and Benefits

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	●							
		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										●

The Why & Benefits of BMD
Primary Considerations for the Why

Traditional Volumetric-Based Mixture Design	May not provide overall optimum performance for asphalt mixtures.
	Can result in dry asphalt mixtures.
	May not adequately evaluate impact of many asphalt mixture components or additives: • RAP, RAS, warm-mix additives, polymers, recycling agents, fibers.
	Lack a performance optimization process for specific applications: • Mixture location within pavement structure. • Special applications (e.g., reflective cracking relief interlayer). • Existing pavement condition for overlay applications.

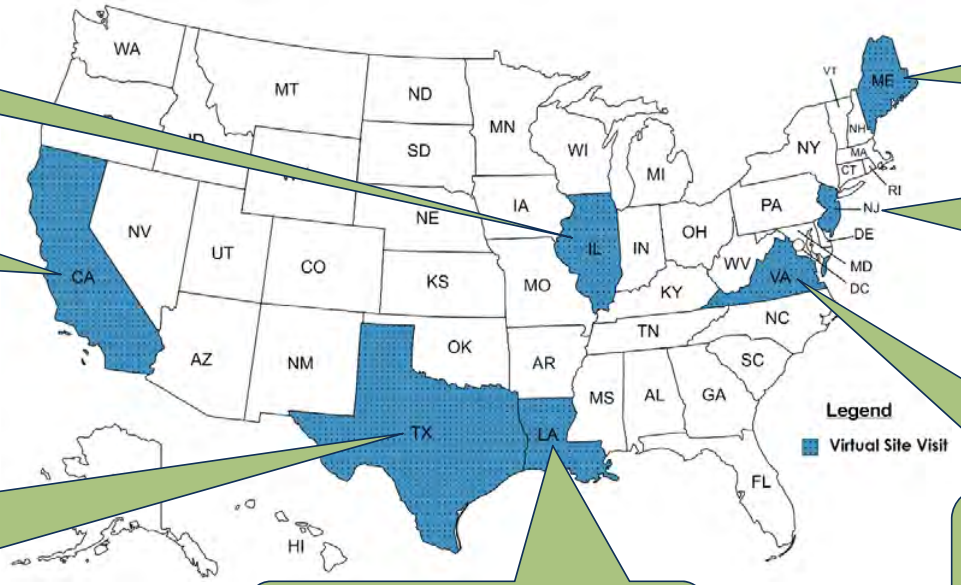
Critical for securing management support & commitment from both State DOT & industry.

The Why & Benefits of BMD
State DOT Examples of the Why/Motivation

- Improve performance.
- Recycled materials

Building long-life asphalt pavements (LLAPs) that can last more than 30 years.

- Immediate need to address the premature failures from the use of recycled materials.
- Use higher quantities of RAP for economics and 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 volumetric properties did not improve performance.

- Superpave implementation led to durability and cracking distresses.
- Recycled materials.

The Why & Benefits of BMD
State DOT Examples of the Benefits

- IDOT: Quality Improvements

Based on past experience & observed benefits from HWTT implementation:
- Full support for I-FIT implementation.
- Adjustments made to mixtures to pass HWTT led to mostly passing I-FIT results.

Issues
- Rutting & tenderness problems with high ESAL mixtures

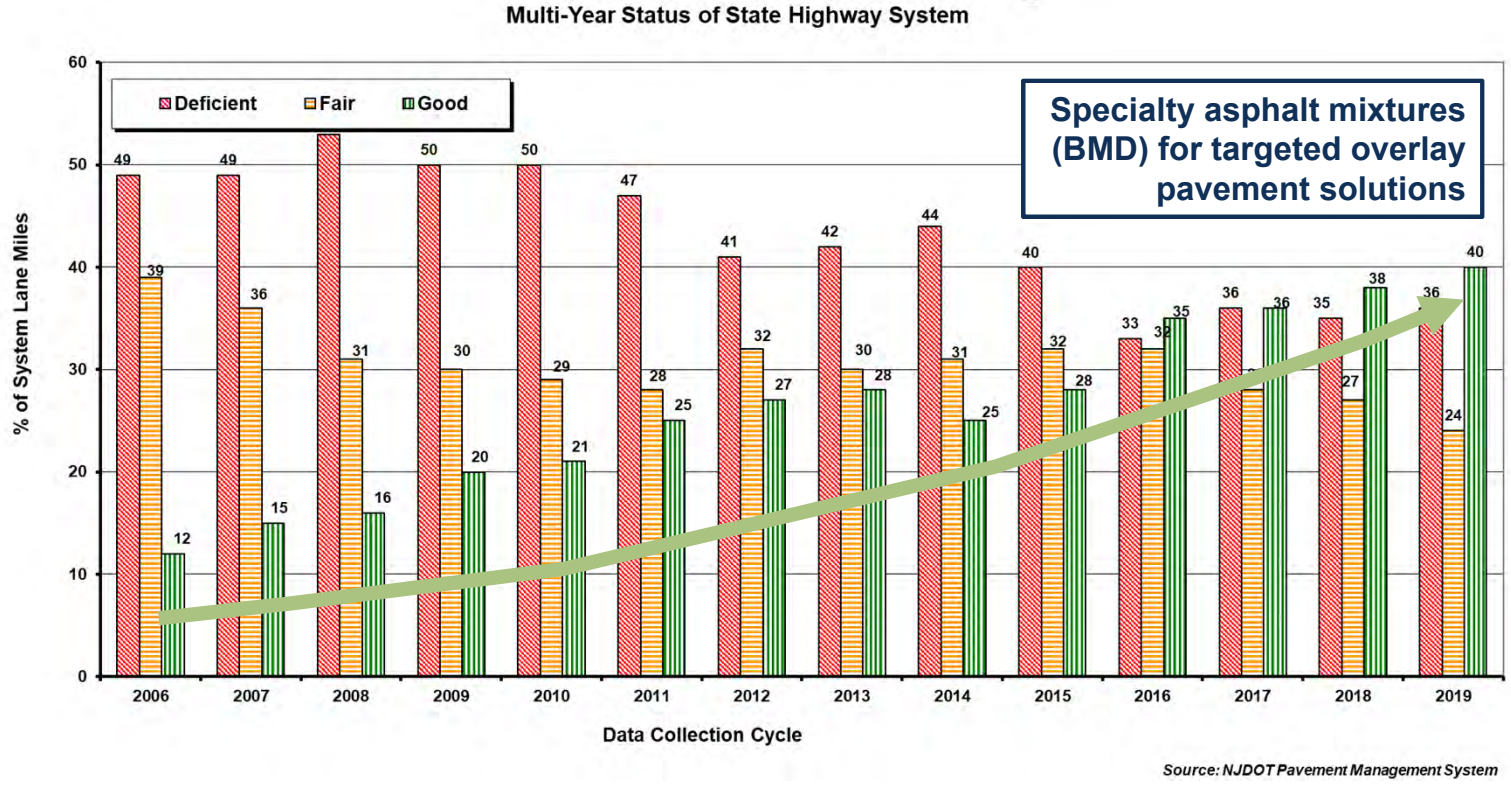
Challenges
- Most mixtures failing HWTT criteria.
- HWTT limited the use of aggregate sources commonly available.
- Concerns with the ability to produce acceptable & economical mixtures.

Ramifications
- Delayed HWTT implementation (2-years grace period).
- Contractors figured out changes needed to pass HWTT criteria.
- Reduced natural sand, increased design VMA, & used more angular fine aggregates.

Results
- No more tender mixtures, very stable mix & a much better field performance.

The Why & Benefits of BMD
State DOT Examples of the Benefits: NJDOT

Overall Pavement Network Improvement



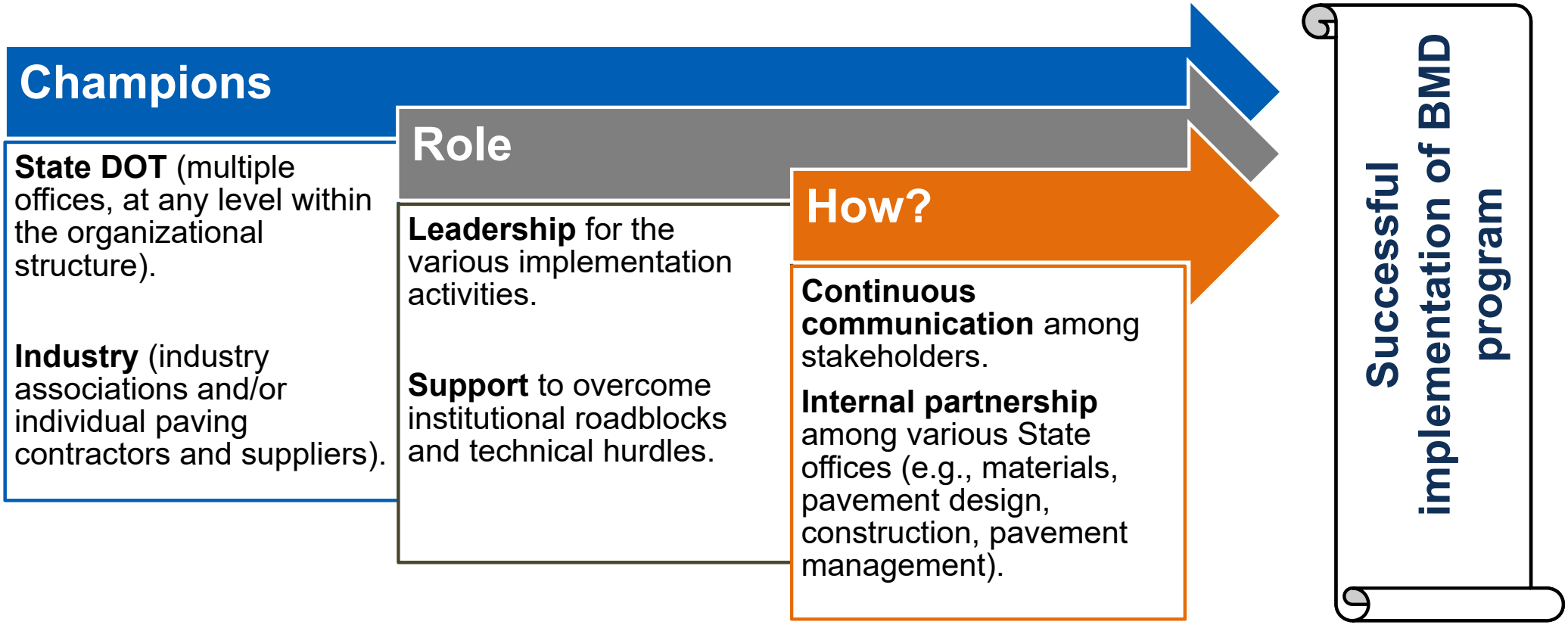
Source: NJDOT Pavement Management System

Task 2: Overall Planning

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		●	—	—	—	—	●	
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								
		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										

► *Task 2*

Overall Planning: Identifications of Champions



Champions & Stakeholder Partnership
State DOT Examples

- **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: 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: Establishing Goals

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

Overall Planning: Developing an Implementation Plan

- IDOT:
  - Planned/undertook research studies.
  - Advanced BMD annually.

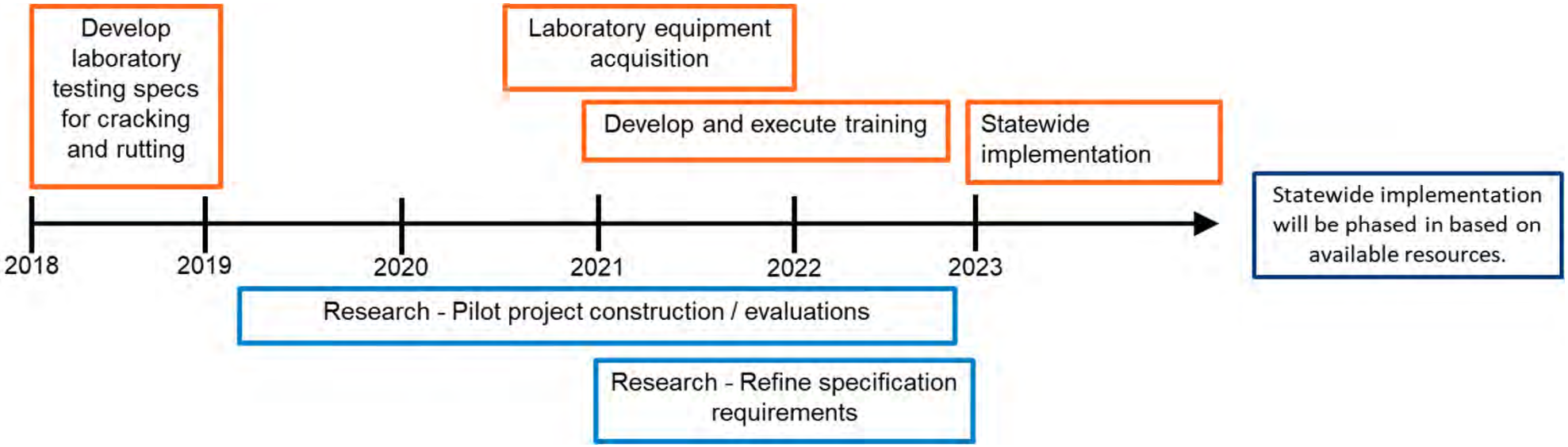
One pilot project per district → Two pilot projects per district → Interstates & statewide implementation

- LaDOTD:

Build-up experience & establish a large database of test results. → Develop necessary BMD pilot specifications. → Carry out a pilot program with field pavement trials. → Make practical adjustments to the test methods. → Assure industry buy-in. → Provide necessary training & support.

Overall Planning: Developing an Implementation Plan

- VDOT:



Task 3: Selecting Performance Tests

Task		Sub Task	Description	Years -1	1	2	3	4	5	6	7
1	Understanding the why and benefits of Performance Specifications			●							
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		2.2	Establishing a Stakeholders Partnership		●						
		2.3	Doing Your Homework		●						
		2.4	Establishing Goals		●						
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	Equipment: Acquiring, Managing Resources, Training, and Evaluating	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										●

► *Task 3*

Selecting Performance Tests

- 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.

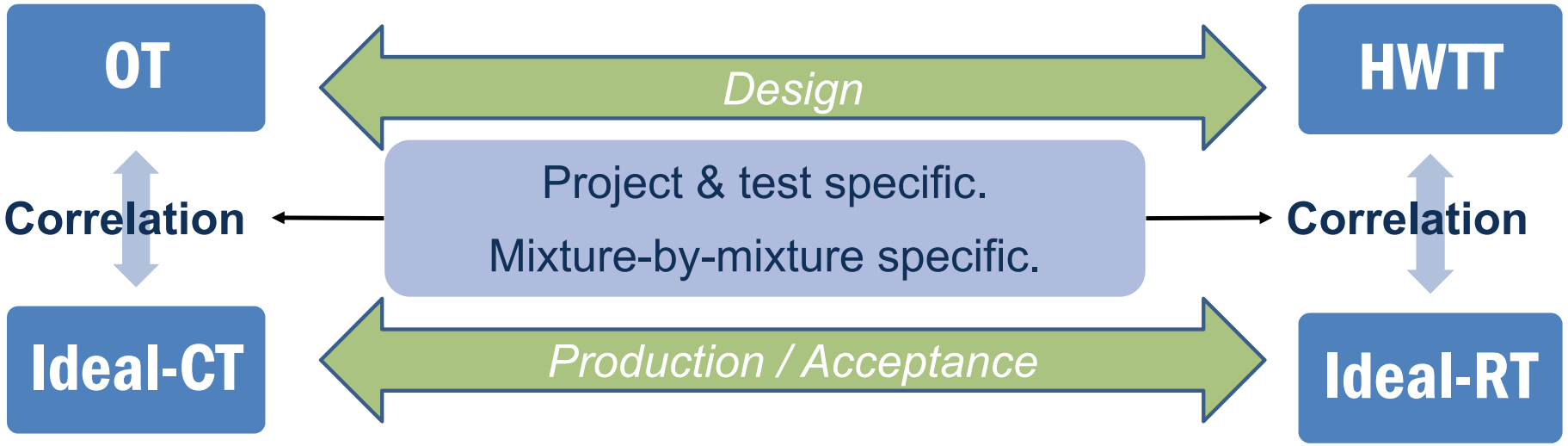
FHWA-HIF-19-103 Index-Based Tests for Performance Engineered Mixture Designs for Asphalt Pavements (https://www.fhwa.dot.gov/pavement/asphalt/pubs/hif19103.pdf).

Selecting Performance Tests

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	◄	►	►	►	►			

Selecting Performance Tests
Surrogate Tests

- Primarily for acceptance (If desired): e.g., NJDOT, TxDOT, VDOT.
- Correlation with more fundamental/truth tests.



Validating the Performance Tests
Relationship to Field Performance

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.

Validating the Performance Tests
Relationship to Field Performance

Review past performance test validation studies.

Assess the validity & applicability of past efforts.

Plan for conducting additional field validation efforts of performance tests under State specific conditions.

► *Task 3*

Validating the Performance Tests: TxDOT (HWTT & OT)

Robust Validation of 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.

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.

Task 4: Performance Testing Equipment

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		●	●	●	●	●	●	
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	Data	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										●

Acquiring Equipment

- For sample preparation, aging/conditioning, fabrication, testing, etc.
  - Table saw, conditioning chamber, water bath, compactor, press machine, etc.
  - Electrical requirements, air requirements, footprint of lab, etc.
- New or modify existing equipment.
  - Likely to happen prior or during shadow or pilot projects.
  - Pooled-fund/bulk equipment purchase

Potential challenges

- Difficulty in finding $$
- Time needed to acquire equipment.
  - Capital equipment justification (State DOT decided not to go with the least offered price).
  - Device shipped from overseas.
- Equipment calibration/ maintenance.

► *Task 4*

Managing Resources
State DOT Examples

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)

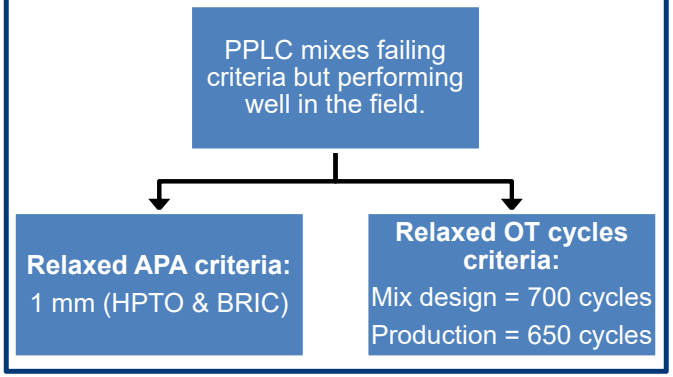
► *Task 4*

Evaluating Performance Tests
Other Test Considerations (Prior to 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



► *Task 4*

Evaluating Performance Tests
Inter-Lab Study (ILS)

State DOT	Inter-Lab Study (ILS)
Caltrans	HWTT round robin. IA program requires testing proficiency samples.
IDOT	Multi-year I-FIT round robin studies: precision statement; improvements to test procedure
LaDOTD	QC form for SCB specimen fabrication to improve COV from 30% to <20%.
MaineDOT	Year 1 to 2 round robins led to improved & prescribed procedures for sample preparation, HWTT set-up, & reporting.
NJDOT	1/year (over 4 years). Each year focusing on a different performance test.
TxDOT	Annual HWTT proficiency program. Improvements made in COV.
VDOT	Participated in NCAT's round robin study. Conduct a round robin on indirect tensile cracking test to establish precision.

Task 5: Establishing Baseline Data

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		●						
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		2.5	Mapping the Tasks		●						
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		2.7	Developing an Implementation Timeline		●	—	—	—	—	●	
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		3.2	Identifying and Assessing Performance Test Appropriateness.		●	●					
		3.3	Validating the Performance Tests			●	—	—	●		
	Performance Testing	4.1	Acquiring Equipment			●	—	—	●		
		4.2	Managing Resources			●	—	—	—	●	
5	Establishing Baseline Data	5.1	Reviewing Historical Data & Information Management System				●	●			
		5.2	Conducting Benchmarking studies				●	●			
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		5.4	Analyzing Production Data					●	●		
		5.5	Determining How to Adjust Asphalt Mixtures Containing Local Materials					●	—	—	●
	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						●	—	●
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8	Initial Implementation										●

► Task 5 Reviewing Historical Data & Information Management System

LaDOTD Example

Long record of test results.	Identify correlations between field performance & lab measured mixture performance indicators.	Establish Initial test criteria for HWTT & SCB based on traffic level.	Propose a draft sampling & testing plan of the specs.
• +20 years HWTT • +18 years SCB • Allowed to tie asphalt mixture properties to their related field performance.	• HWTT rut depth related to MEPDG projected terminal rutting (calibrated using field distress data from PMS). • SCB *Jc related* to the 20-year projected combined cracking indices (alligator cracking index & random cracking index).	• 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.	• 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*

Benchmarking of Existing Mixture Designs

- Conduct performance testing.
  - Benchmark of existing mix designs.
  - State DOT lab or a designated third-party lab.
  - Eliminate between-lab variability in the test results.
- Develop a database.
- Analyze variables on test results.
  - Mixture design differences
  - Production variability
- Evaluate tests for promise.

Primary goal: Determine how existing asphalt mixture designs perform using the selected performance tests.

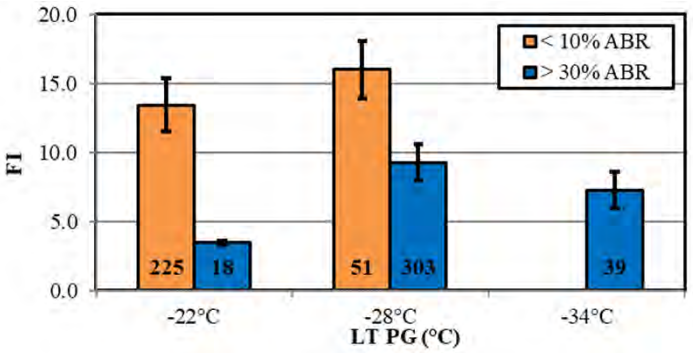
Specimen fabrication:

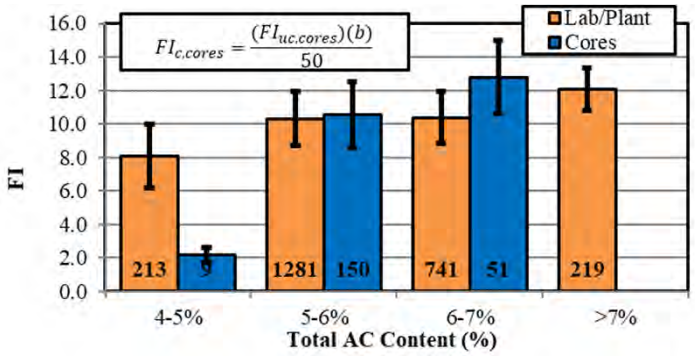
- Has a significant impact on mixture performance test results.
- Provide a standardized step-by-step sample fabrication procedure (developed under Sub-Task 4.4).

► *Task 5*

Benchmarking of Existing Mixture Designs
IDOT: I-FIT database (+3,000 test sets)

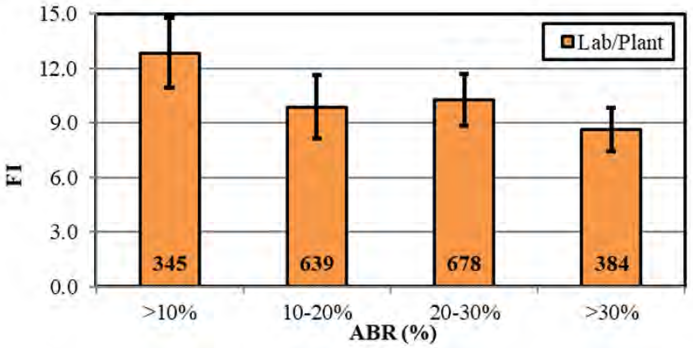
Effect of virgin binder low temp PG

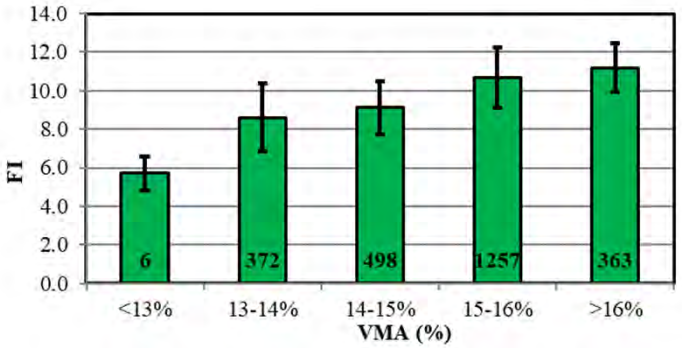




Effect of Total AC Content

Effect ABR





Effect of Design VMA

► *Task 5*

Benchmarking of Existing Mixture Designs LaDOTD: SCB Analysis

Mixtures	% of Mixtures Passing Initial Criteria for Acceptable Cracking Resistance	Notes
PG 64-22	38%	Percentages are irrespective of whether asphalt mixtures are designed to meet HWTT & SCB parameters
PG 70-22M	68%	
PG 76-22M	91%	
PG 82-22CRM	20%	
All BMD Mixtures	**64%**	Mixtures designed according to LaDOTD BMD specs

► *Task 5*

Conducting Shadow Projects

- Existing project using conventional acceptance tests.
  - Performance test results are informational.
  - Data is shared & discussed with contractors & project personnel.

- Goals: 1) Gain familiarity with the selected tests.
  2) Add to the database.
  3) Understand production variability.

- Scope: Number of shadow projects.
  Type of projects (project selection guidelines).

Conducting Shadow Projects
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.

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 Ndesign, increase in VMA).
- Increase in mastic (fines & binder)—improved cracking resistance.

Task 6: Specs & Program Development

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	and Accreditations	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*

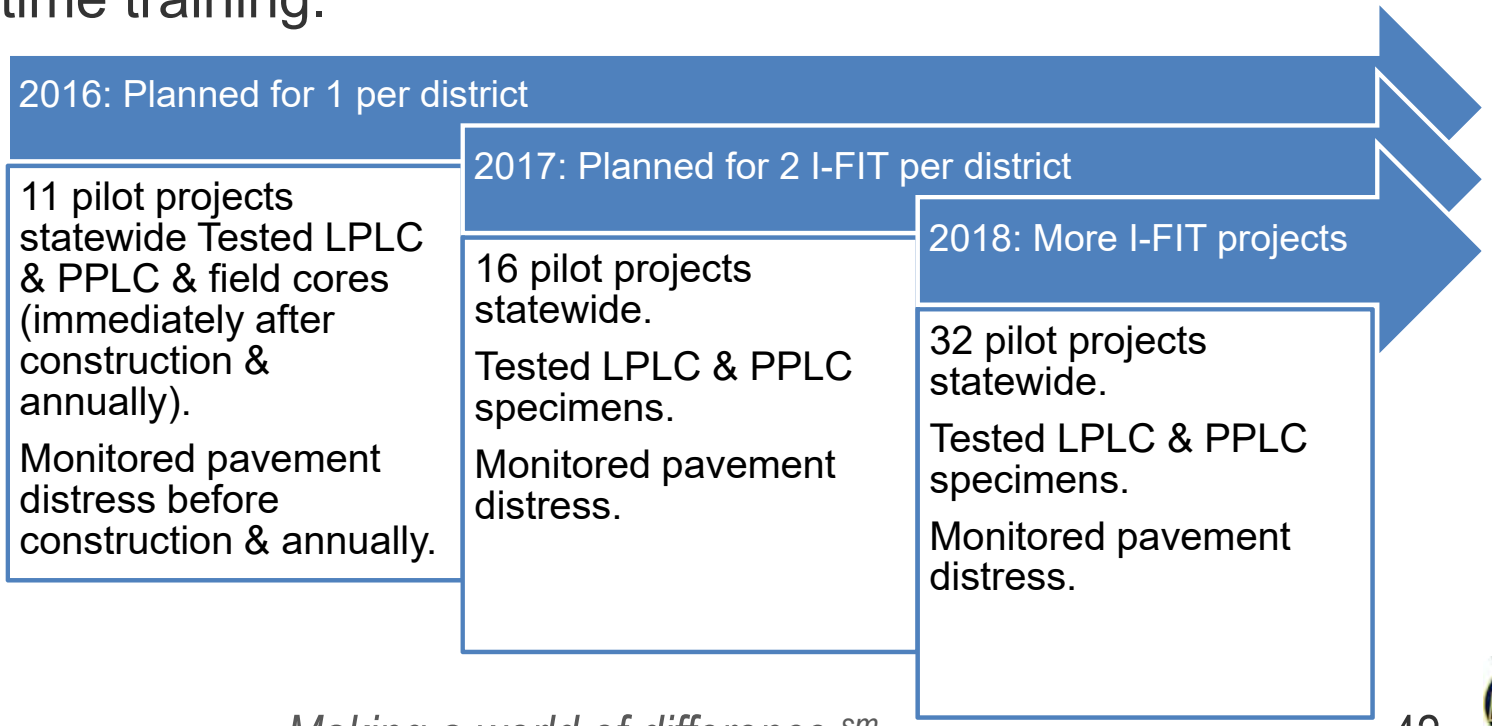
Acceptance and Quality Control

State DOT	Acceptance
Caltrans, LaDOTD	Volumetric properties.
NJDOT, TxDOT	Surrogate performance tests correlated to asphalt mix design approval tests.
IDOT, NJDOT, MaineDOT	Actual performance tests used during mixture design.
NJDOT	Performance tests with pay adjustment factors.

► *Task 6*

Pilot Specifications & Projects

- Typical bidding-contracting process with the new QA requirements applied.
- Performance testing required as part of mix design & acceptance.
- Conduct just-in-time training.



Final Analysis & Specification Revision
NJDOT Example

- Performance testing required adjustments
  - Longer working hours and new schedule for staff.
    - Readiness, approval, & adjustment.
  - Extra sample molds & programmable conditioning ovens.
  - Electricity issues in the aging building.
- Equipment breakdown.
  - No access to backup equipment.
  - No quick repair service.

Task 7: Training, Certifications, & Accreditations

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						●	●	

Task		Sub Task	Description	Years							
				-1	1	2	3	4	5	6	7
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 Establish or Update Program Requirements

Caltrans

- Performance tests in both lab accreditation & tester certification (AASHTO T 321, 324, 378, etc.)
- Just-in-time training from UCPRC.
  - Before the start of project.
  - On performance testing & sample preparation.
  - Included industry & Caltrans.
  - UCPRC staff visited contractors' labs for training.

TxDOT

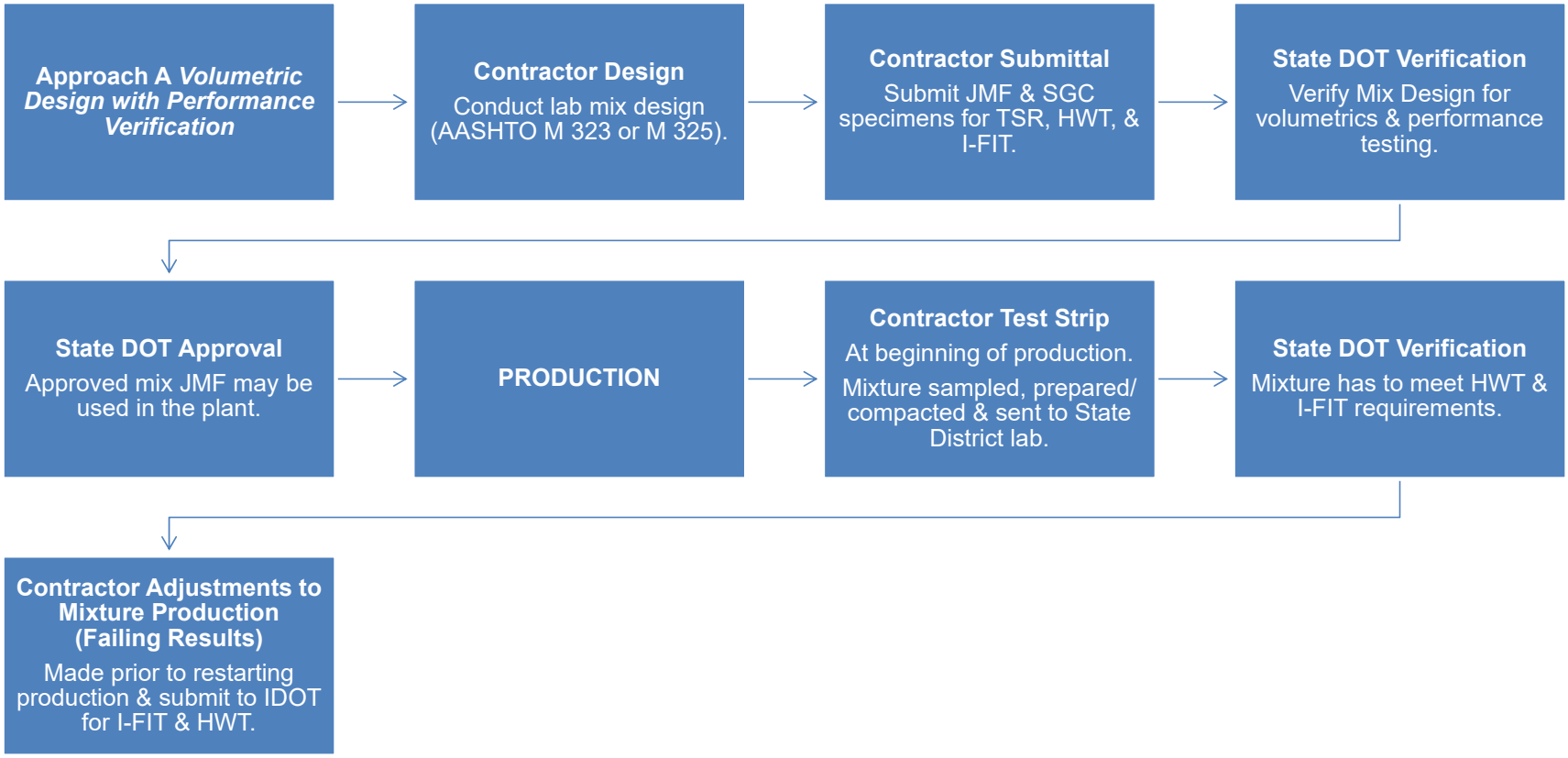
- Hot Mix Asphalt Center (HMAC) certification program –TXAPA.
  - Tex-242-F Hamburg Wheel-Tracking Test.
  - Training videos provided (https://vimeopro.com/user33086364/test-procedure-videos).
- Labs must also participate in the Annual State-wide HWTT proficiency program.

Task 8: Initial 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	2.1	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							●	●

Task		Sub Task	Description	Years							
				-1	1	2	3	4	5	6	7
8	Initial Implementation										●

IDOT: Mix Design & Acceptance



IDOT: Mix Design & Acceptance Specs for Performance Testing

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.

Conclusions

- Partnering with and collaboration between State DOT, industry, and 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.

Balanced Mix Design Case Studies Virtual Workshop

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

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

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U.S. Department of Transportation
Federal Highway Administration

RESOURCE CENTER

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

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.

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.

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.

https://www.unr.edu/wrsc/tools/asphalt