

# **Paving the Way: The Modern Art of Balanced Mix Design**

**Amma Agbedor, Ph.D., P.Eng.**  
Canadian & Research Engineer  
Asphalt Institute

## Balanced Mix Designs

- What is it all about?
- Which tests are being utilized?
- How to implement?

# Objective of the Asphalt Mix Design

To determine the ***combination of asphalt binder and aggregate*** that will result in a mixture that provides ***long-lasting performance*** as part of the pavement structure, that ***meets the governing specifications***.



# Optimizing Desired Performance



- Aggregate gradation
- Asphalt cement content
- Volumetric properties
- Strength properties
- Moisture sensitivity analysis

# Why the Need for a New Mix Design Approach?

- **Volumetric properties** not enough to evaluate new mix variables:
    - Warm mix asphalt (WMA) additives
    - Recycling agents
    - Polymers
    - Fibers
- New Additives***  
***Different Engineering Properties***
- **Premature cracking** in asphalt pavements and **dry mixes** become most common **complaint by owners** for mixes containing RAP



# Refinements to the Superpave Mix Design Procedure

Owners' efforts to improve **durability**:

1. Lowering Gyration Levels ( $N_{\text{design}}$ )
2. Lowering Design Air Voids
3. Increasing Minimum VMA
4. Air Voids Regression Approach
5. Corrected Optimum Asphalt Content



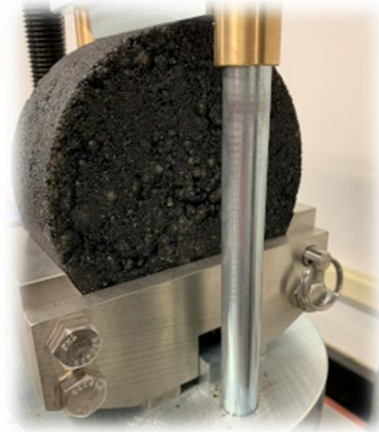
An asphalt mix design using **performance tests** to test appropriately **conditioned specimens** that address multiple **modes of distress** taking into consideration ***mix aging, traffic, climate, and location within the pavement structure.***

Source: NCHRP Project 20-07/Task 406 Development of a Framework for Balanced Mix Design. 2018

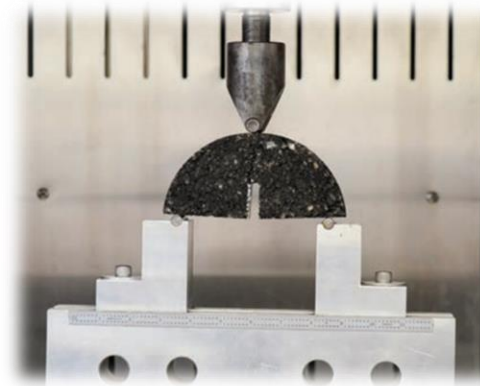
# Common Tests included in BMD



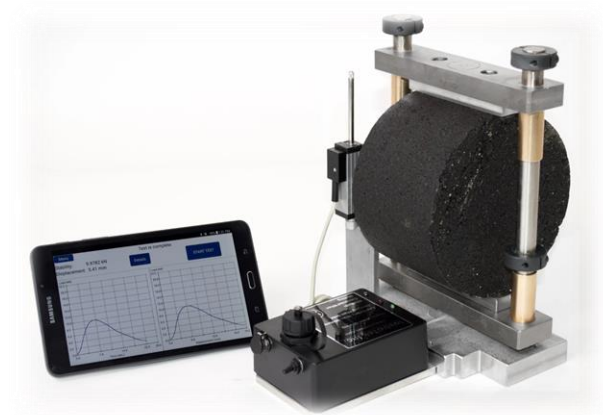
Asphalt Pavement Analyzer



IDEAL-RT Test



Semi Circular Beam Test



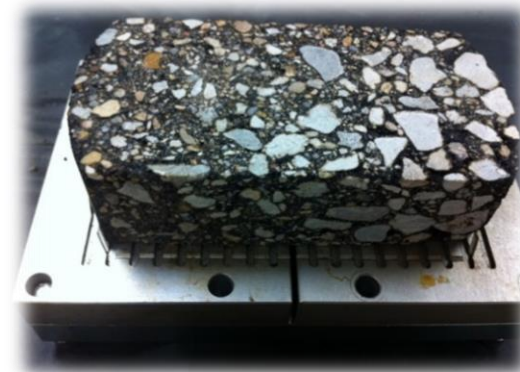
IDEAL-CT Test



Asphalt Mix Performance Test



Hamburg Wheel Tracking Test



Texas Overlay Test



Disk-Shaped Compact Tension Test



## Approach A

- Requires full compliance with the existing volumetric requirements and additional performance requirements.
- This is the most conservative approach and has the lowest innovation potential.

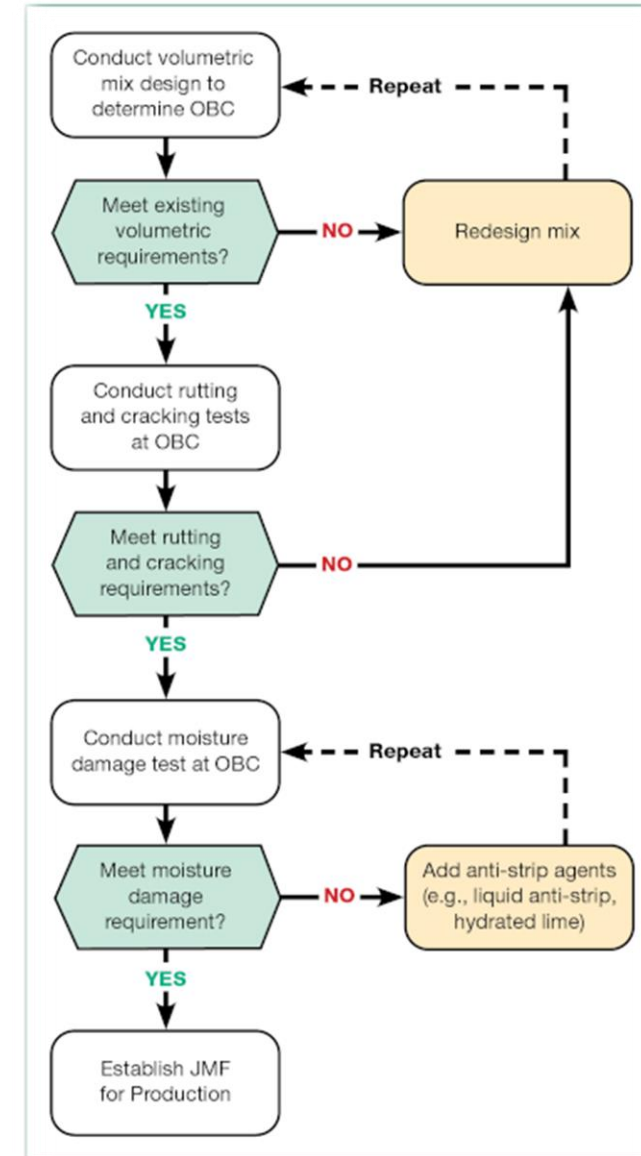


Figure 1. Graphical Illustration of the Volumetric Design with Performance Verification Approach (Approach A)

## Approach B

- Requires full compliance with the existing volumetric requirements at the preliminary OBC.
- Allows moderate changes in asphalt binder content for performance optimization based on mixture performance test results.

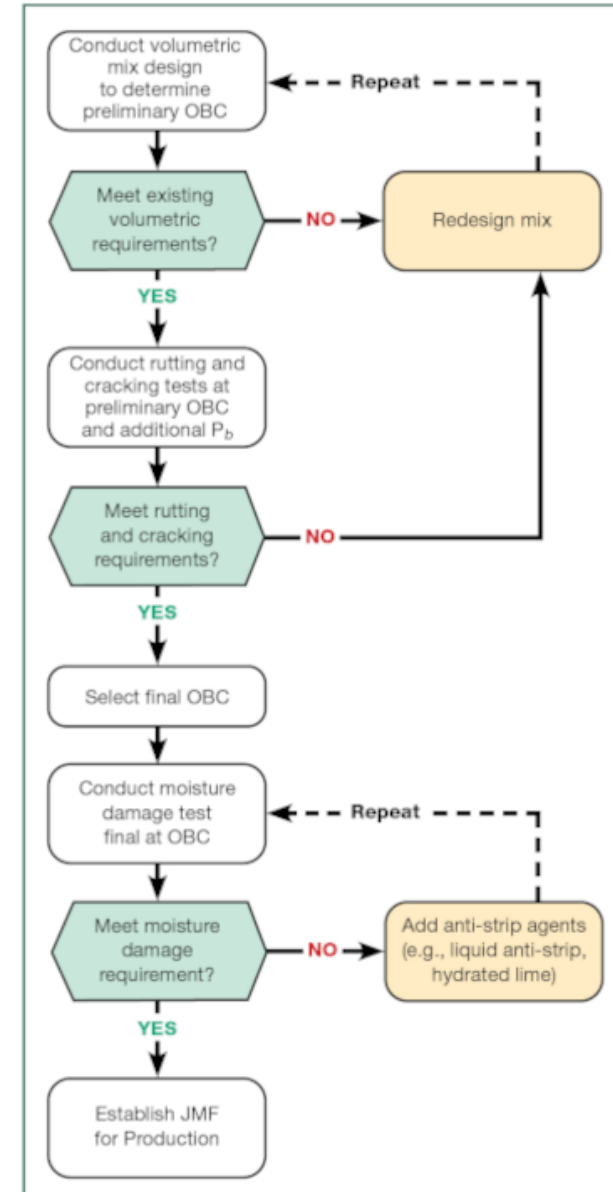


Figure 2. Graphical Illustration of the Volumetric Design with Performance Optimization Approach (Approach B)

## Approach C

- Allows some of the volumetric requirements to be relaxed or eliminated if the performance criteria are satisfied.
- The mix design modifications that can be used in performance optimization are not limited to changes in asphalt binder content.

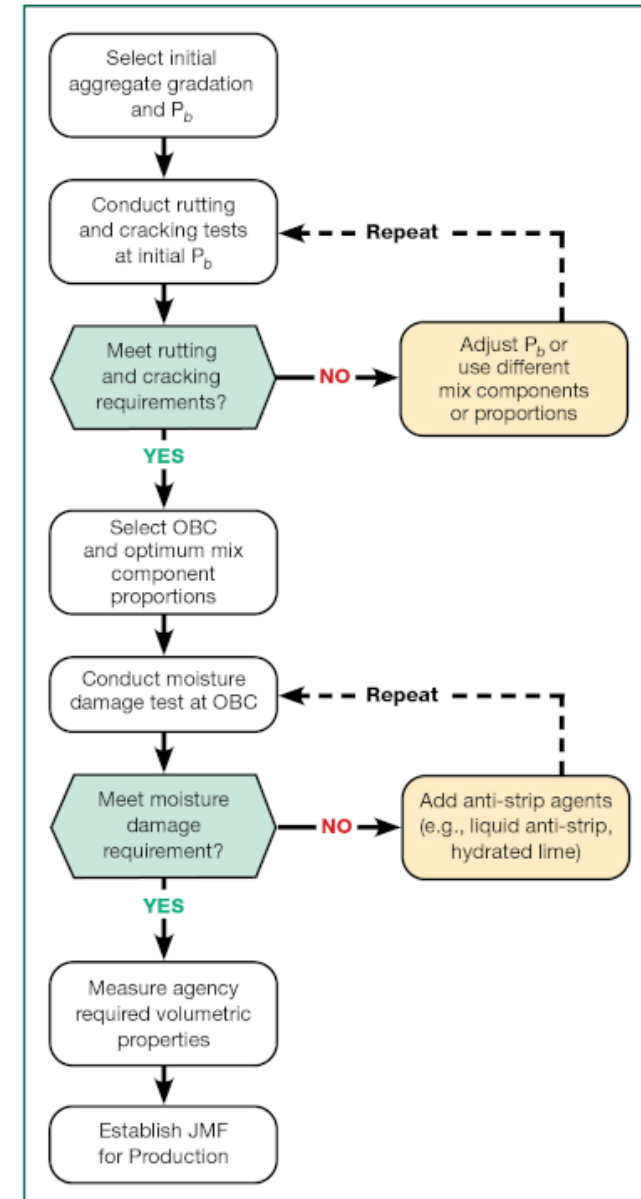


Figure 3. Graphical Illustration of the Performance-Modified Volumetric Design Approach (Approach C)

## Approach D

- Has no requirement on volumetric properties and relies solely on mixture performance test results for mix design optimization.
- Considered highest degree of innovation potential.

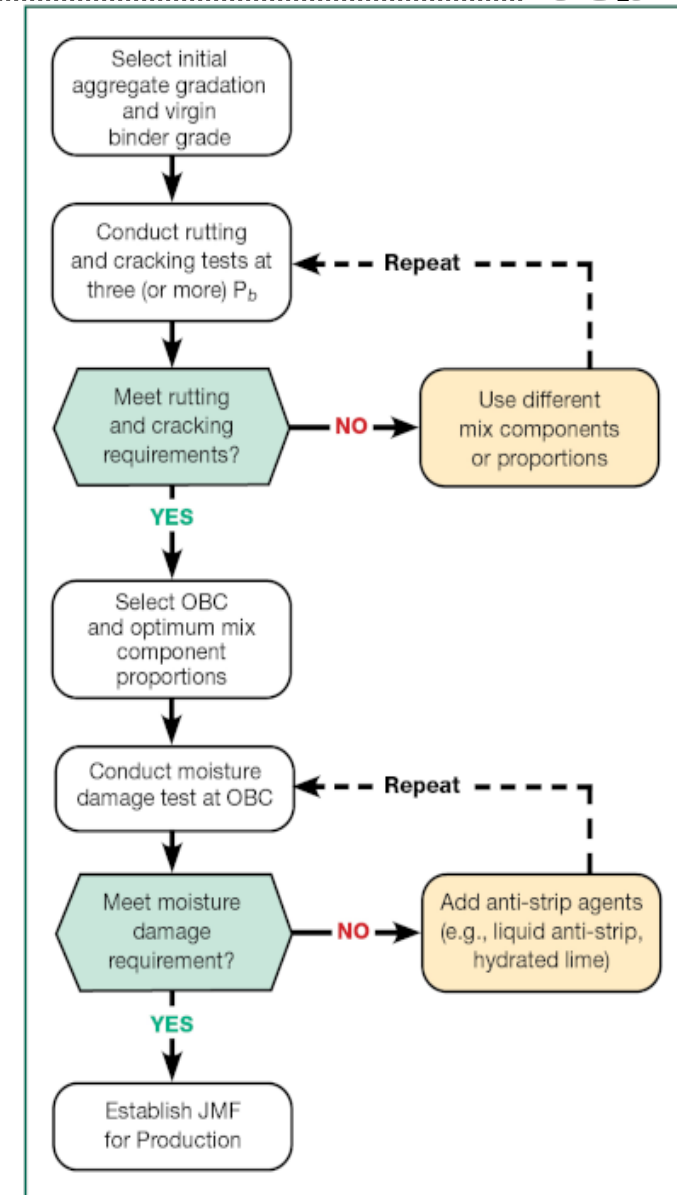
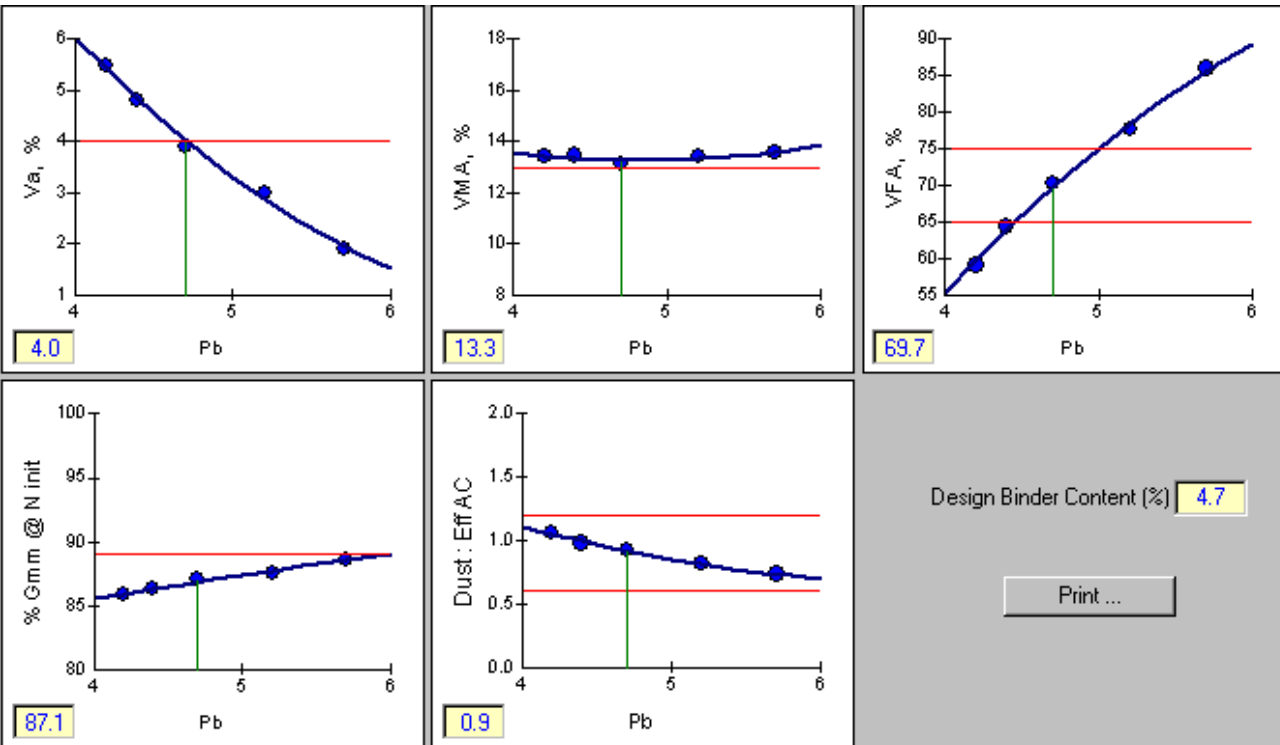


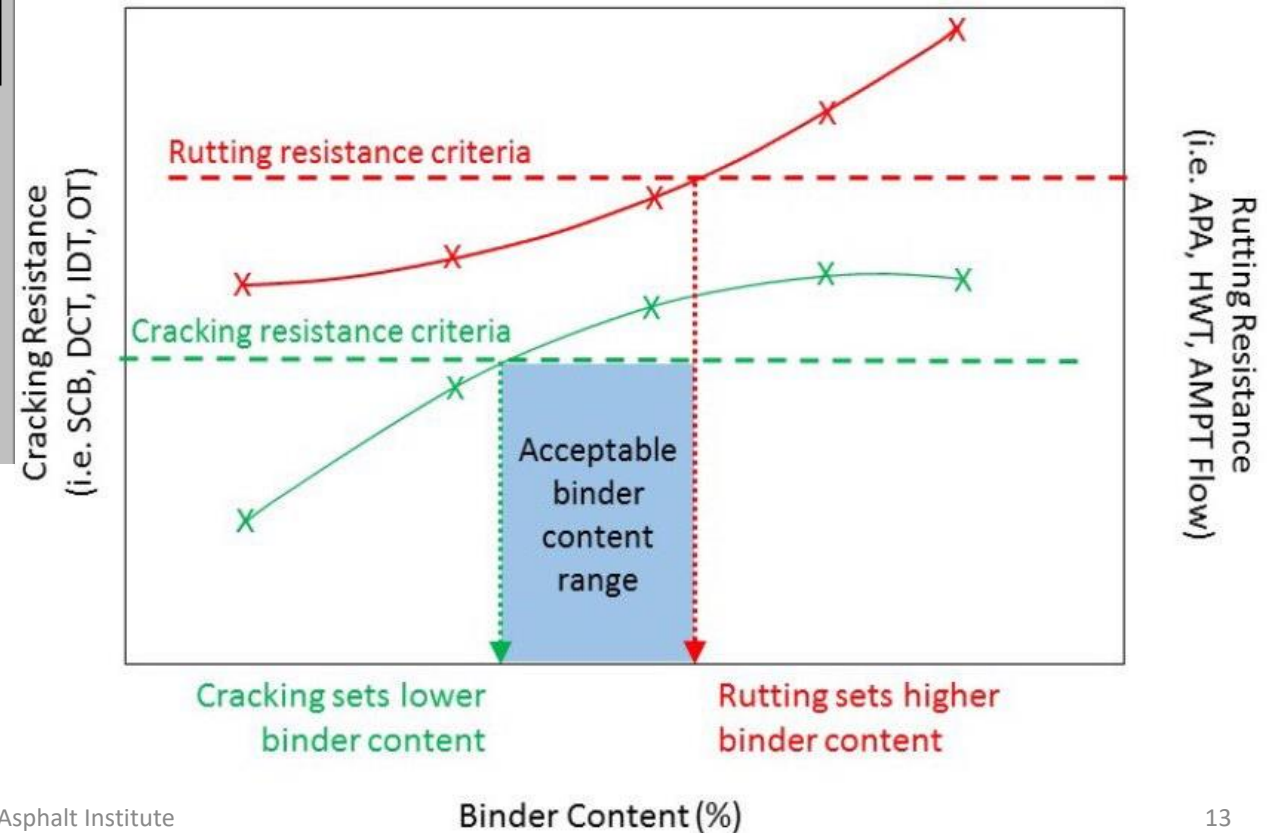
Figure 4. Graphical Illustration of the Performance Design Approach (Approach D)

# Optimum Binder Content Determination

## Volumetric mix design

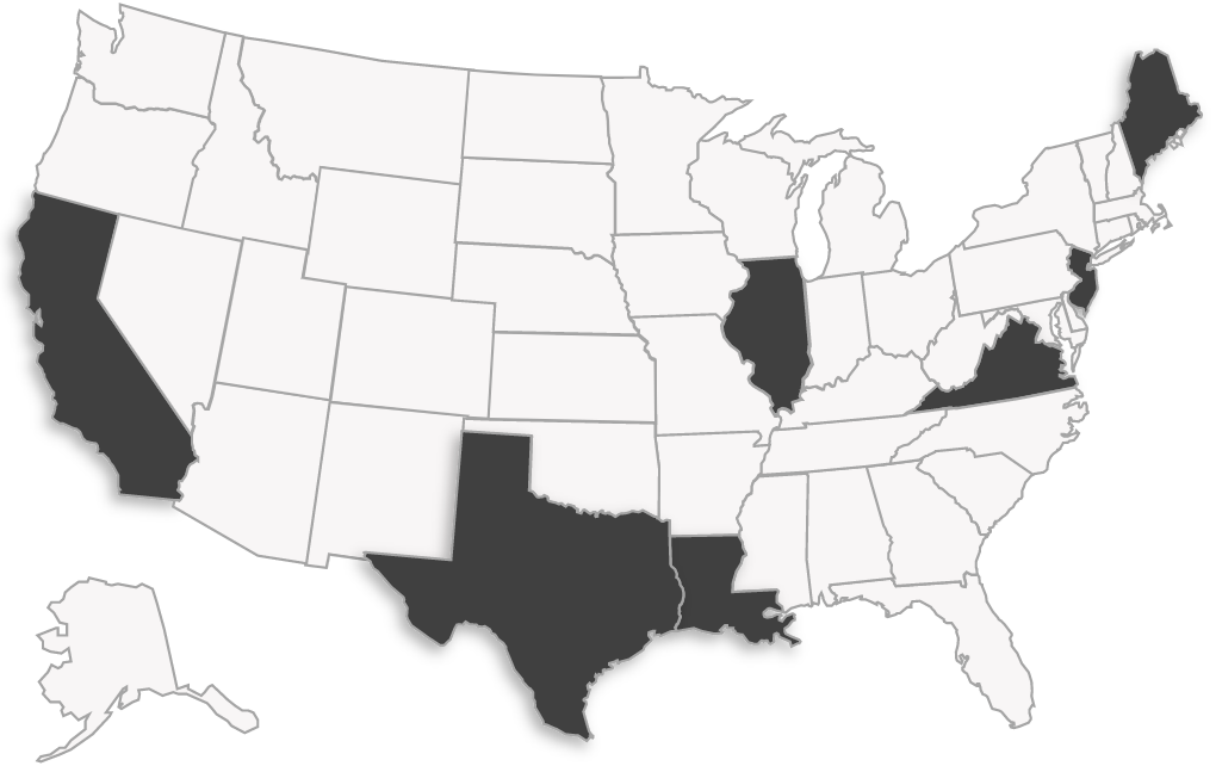


## Balanced mix design



# Lessons Learned: Tasks for BMD Implementation

- FHWA conducted interviews of seven early adopter State DOTs and those that serviced the agencies:
  - Material producers
  - Consultants
  - Paving Contractors
- Documented successful practices of overall process of implementing BMD as part of mix design and QA
  - Tech Brief: FHWA-HIF-22-048



## Early Adopter Agencies for BMD:

California, Illinois, Louisiana, Maine,  
New Jersey, Texas, Virginia

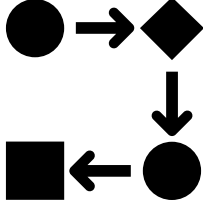
# Eight Tasks for BMD Implementation



Motivations and Benefits



Overall Planning



Selecting Performance Tests



Performance Testing Equipment



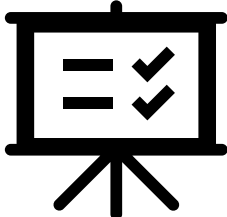
Initial Implementation



Training, Certifications & Accreditations



Specifications and Program Development

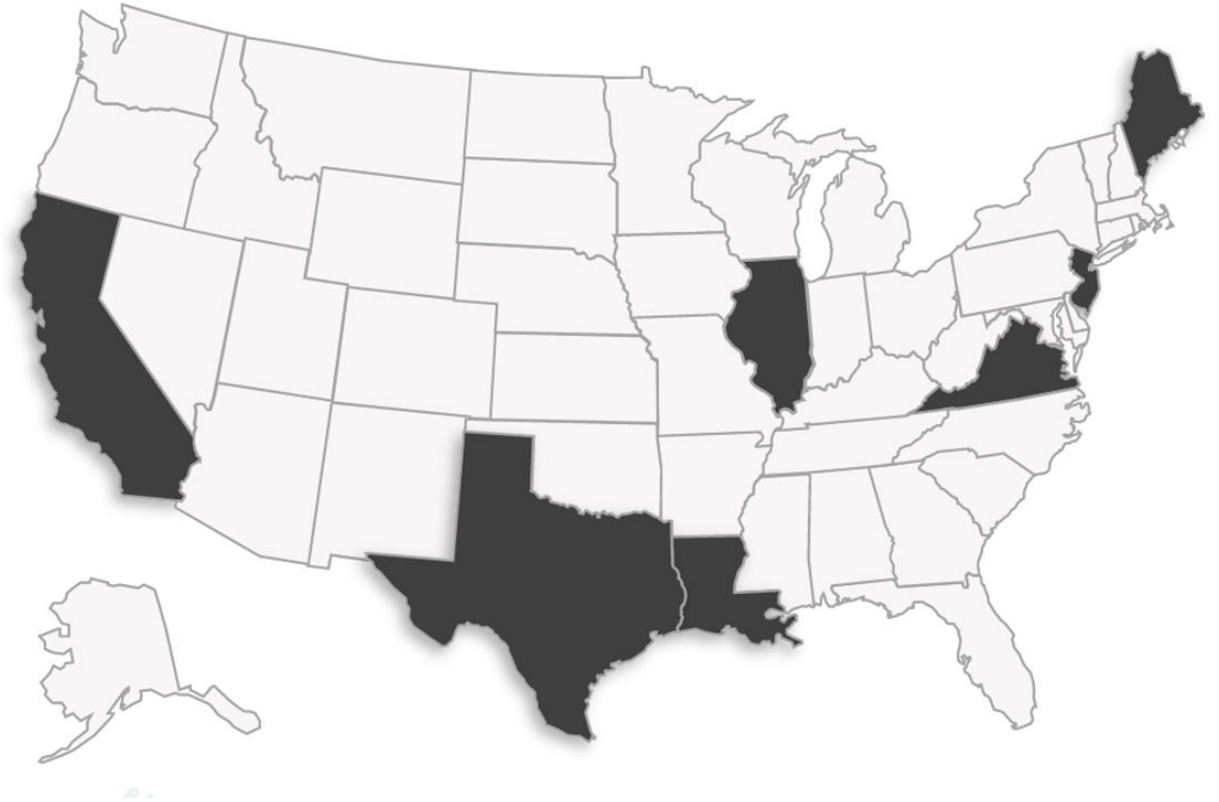


Establish Baseline Data



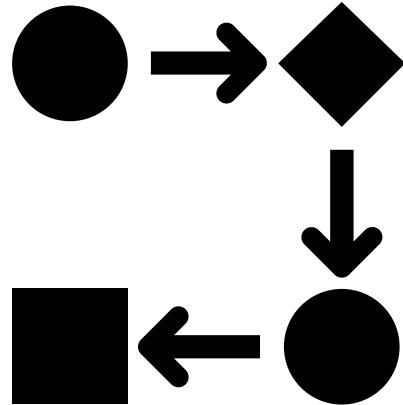
# Example of BMD Program Scopes

- California DOT
  - Performance of high-traffic asphalt mixes
- Illinois DOT, Louisiana DOT, and Virginia DOT
  - Performance of asphalt mixes containing high RAP
- Maine DOT
  - Premature failure of asphalt mixes
- New Jersey DOT, Texas DOT
  - High-performance and specialty mixes





For each type of asphalt *pavement distress*, there are several possible mixture performance tests.



Use *pavement management system data* in addition to field site visits to identify critical distresses and performance periods.

***Ensure test results have a strong relationship to field performance.*** Supporting the development of specification criteria.



## **Validation of Performance Testing**

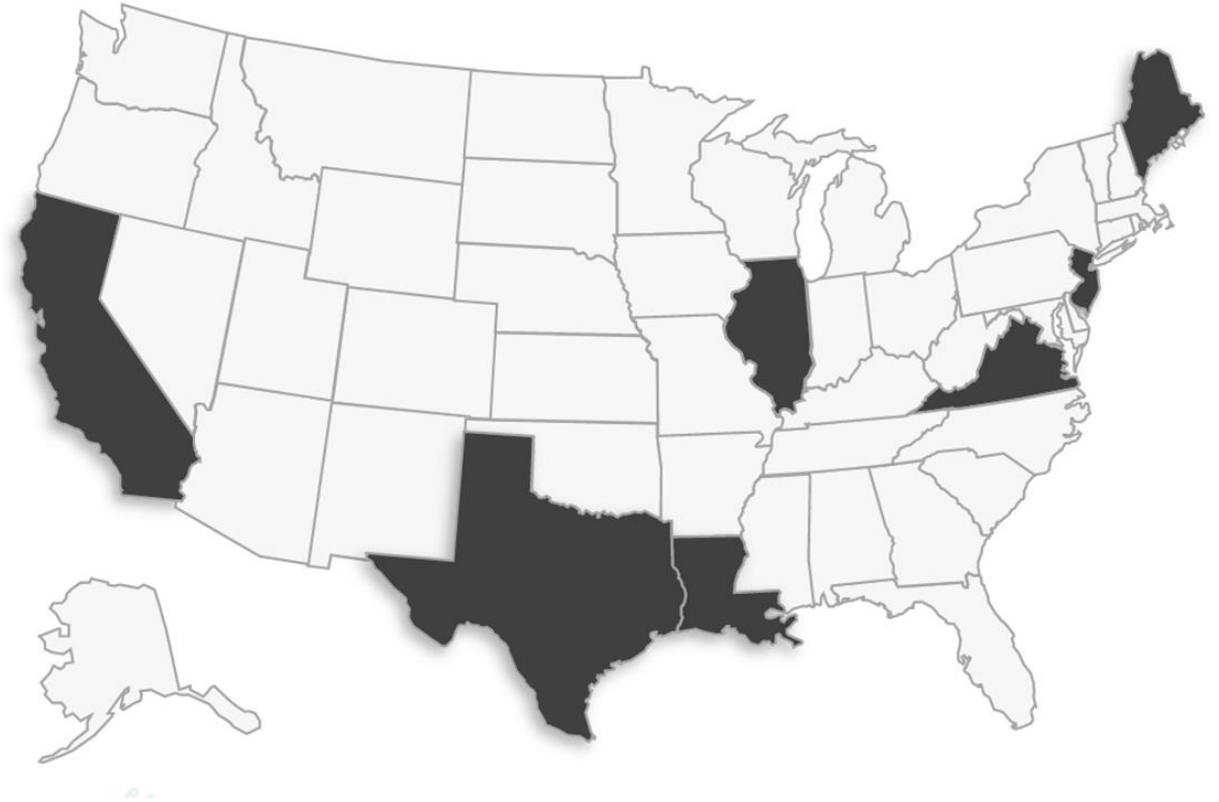
- Ensure that performance test results have a strong relationship to field performance.

## **Benchmarking of Asphalt Mixtures**

- Determine how existing asphalt mix designs perform using the selected performance tests.

# Example Asphalt Mixture Acceptance during Production

- California DOT, Louisiana DOT, Virginia DOT
  - Acceptance based on volumetric properties with performance tests for information.
- New Jersey DOT, Texas DOT
  - Surrogate performance tests correlated to mix design approval tests.
- Illinois DOT, New Jersey DOT, Maine DOT
  - Actual performance tests (same used during mix design)



- Equipment availability
- Additional staffing
- Full implementation will take years
- BMD performance tests may not fully replace current acceptance testing
- Mixture aging considerations
- Variability in BMD performance test results



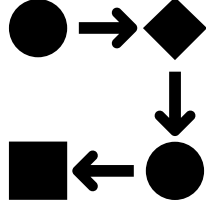
# Eight Tasks to BMD Implementation



Motivations and Benefits



Overall Planning



Selecting Performance Tests



Performance Testing Equipment



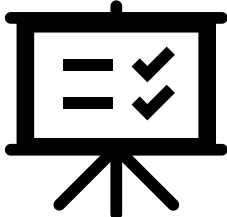
Initial Implementation



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Establish Baseline Data



**Thank you.**

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[aagbedor@asphaltinstitute.org](mailto:aagbedor@asphaltinstitute.org)

