# Balanced Mix Design (BMD)
# Task Force Update
# FHWA Expert Task Group on Asphalt Mixtures

DAVE NEWCOMB

# Our Leader

**Shane Buchanan, Oldcastle Materials Group**

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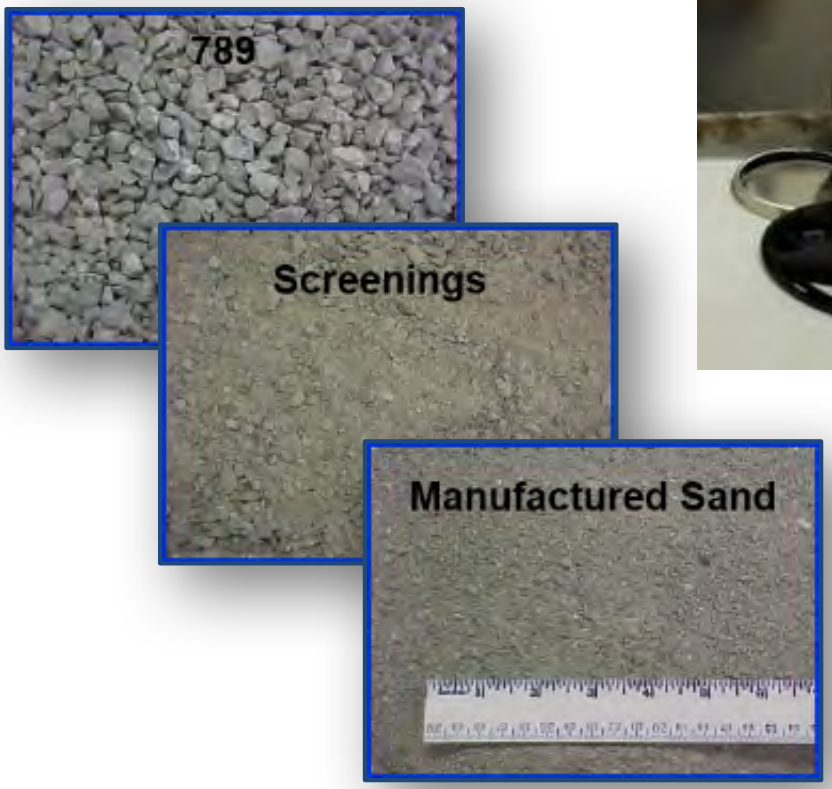
- Need for Balanced Mix Design
- Define Balanced Mix Design
- Review FHWA Balanced Mix Design Task Force Efforts
  - Current State Agency Practice
  - NCHRP Problem Statement Development
  - Technical Brief Development on Balanced Mix Design

# Need for Balanced Mix Design

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# History

**1890**
- **Barber Asphalt Paving Company**
- Asphalt cement 12 to 15% / Sand 70 to 83% / Pulverized carbonite of lime 5 to 15%

**1905**
- **Clifford Richardson, New York Testing Company**
- Surface sand mix: 100% passing No. 10, 15% passing No. 200, 9 to 14% asphalt
- Asphaltic concrete for lower layers, VMA terminology used, 2.2% more VMA than current day mixes or ~0.9% higher binder content

**1920s**
- **Hubbard Field Method** (Charles Hubbard and Frederick Field)
- Sand asphalt design
- 30 blow, 6" diameter **with compression test (performance)** asphaltic concrete design (Modified HF Method)

**Stability**

**1927**
- **Francis Hveem** (Caltrans)
- Surface area factors used to determine binder content; **Hveem stabilometer and cohesionmeter** used
- Air voids not used initially, mixes generally drier relative to others, fatigue cracking an issue

**Stability + Durability**

**1943**
- **Bruce Marshall**, Mississippi Highway Department
- Refined Hubbard Field method, standard compaction energy with drop hammer
- Initially, only used air voids and VFA, VMA added in 1962; **stability and flow utilized**

**Stability + Durability**

**1993**
- **Superpave**
- Level 1 (volumetric)
- Level 2 and 3 (performance based, but **never implemented**)

BINDER CONTENT LOWER

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http://asphaltmagazine.com/history-of-asphalt-mix-design-in-north-america-part-2/

# Design vs. Optimum

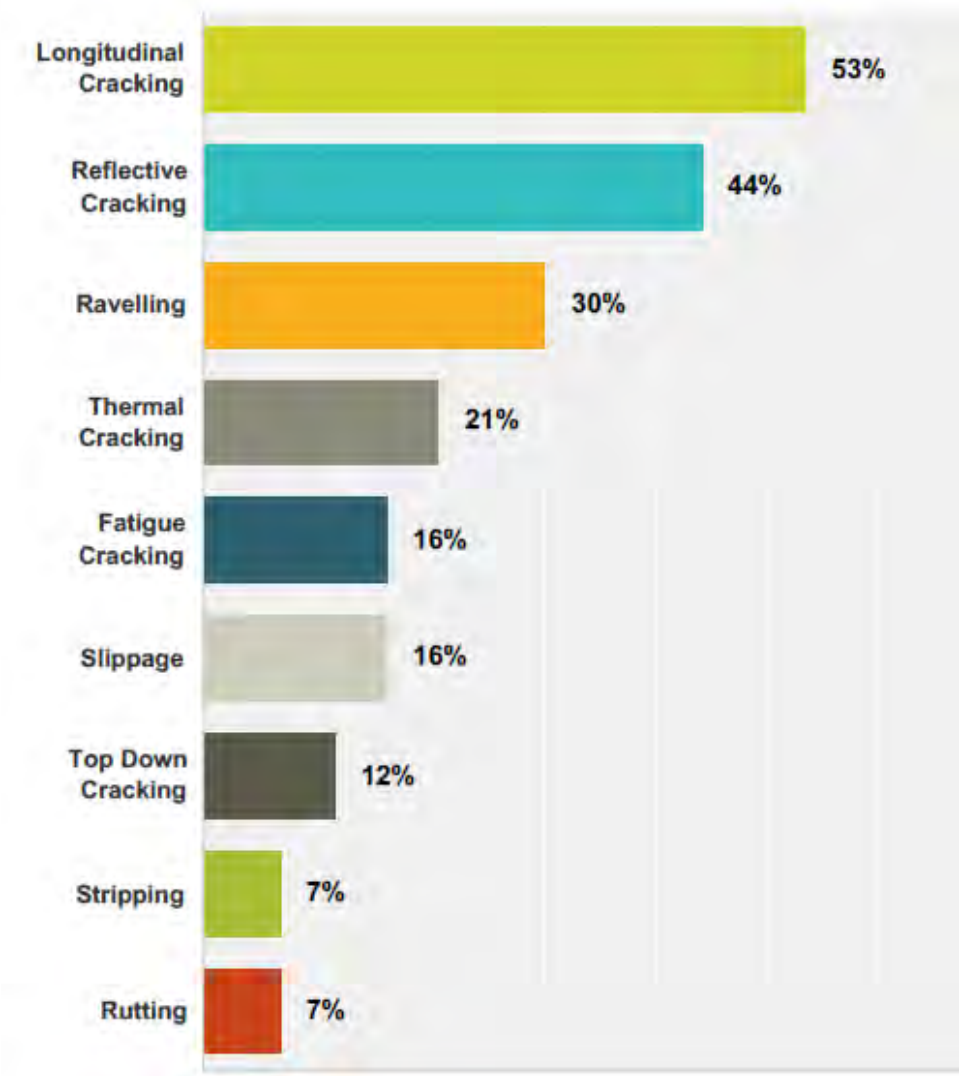
- Design and optimum interchangeable?
  - NOT the same
- Many design binder contents, but only one truly optimum
- Is 4% air voids the right target for every mix?
- Optimum: the best binder content for performance requirements/needs, and ultimately economics
- Goal: Close to optimum

# Oldcastle Survey

***Oldcastle Survey Question:***
***Within the past 5 years, what type of mix performance related distress has been most evident in your mixes?***

***~40 companies responding from ~30 states***

- Most reported distresses are related to mix durability.

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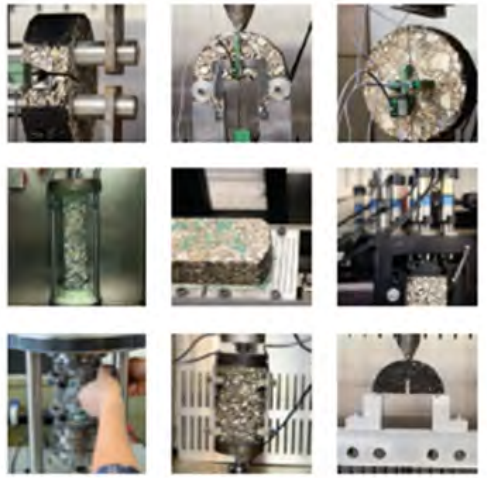
# Balanced Mix Design

- Durability related performance issues.
- New materials, new mixes
  - Polymers
  - More RAP/RAS
  - Asphalt additives
  - Etc.
- Some states doing “performance testing” during mix design and/or production to ensure performance.
  - This is balanced mix design.



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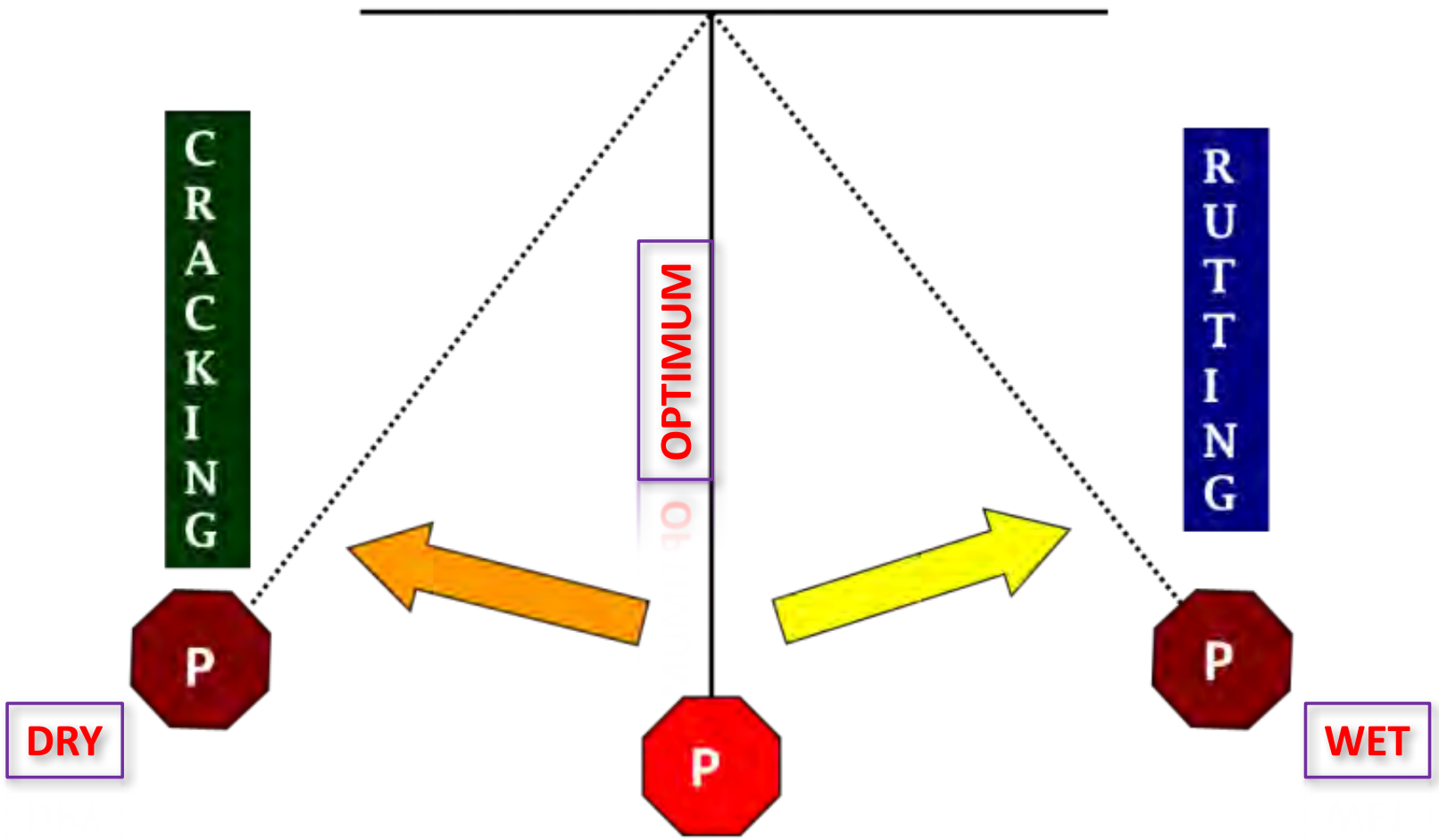
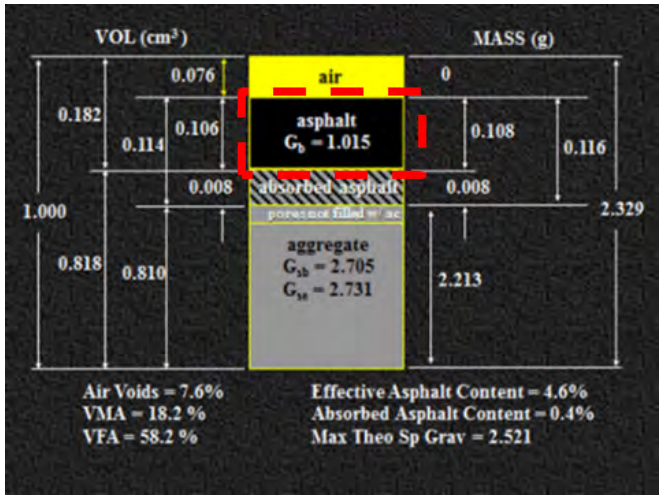
# Pendulum of Performance



# BMD Task Force Goals

- Define Balanced Mix Design
- Determine the current “state of practice” of BMD
- Present approaches/concepts for immediate use
- Recommend future needs (potential research) to advance BMD approaches
- Disseminate information

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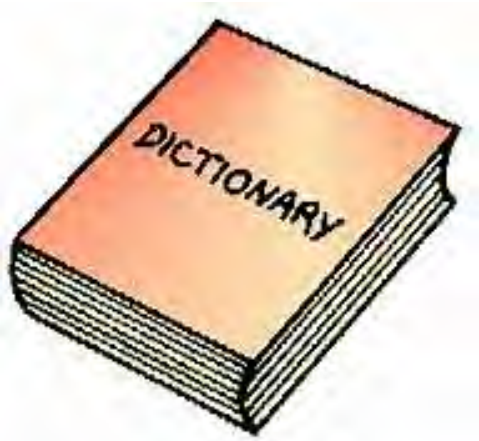
# BMD Task Force Work Items

- **Completed**
  - Definition of Balanced Mix Design
  - Survey of Agency Current Practice
    - Laboratory Balanced Mix Design Protocols
    - Field Acceptance Protocols
  - Research Problem Statement (RPS) Submitted to AASHTO)

- **Current**
  - FHWA Technical Brief on Balanced Mix Design
    - Draft prepared, reviewed and being revised

# Balanced Mix Design Definition



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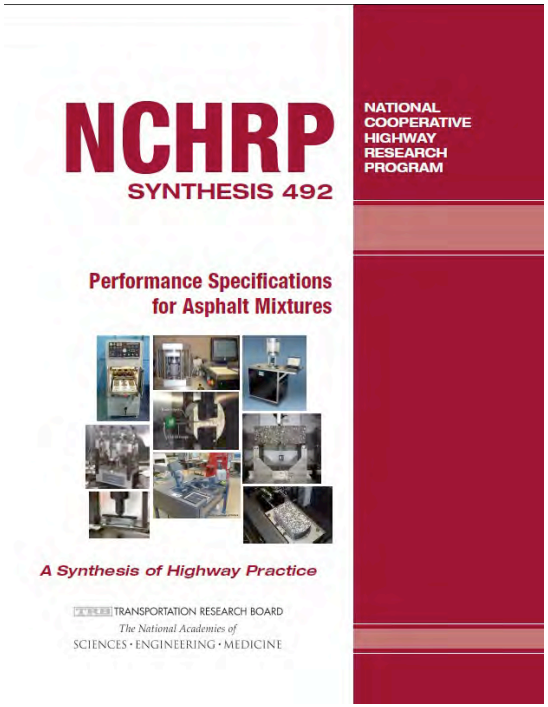
# Balanced Mix Design Definition

- *"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."*

- *Basically, it consists of **designing the mix for an intended application** and service requirement.*

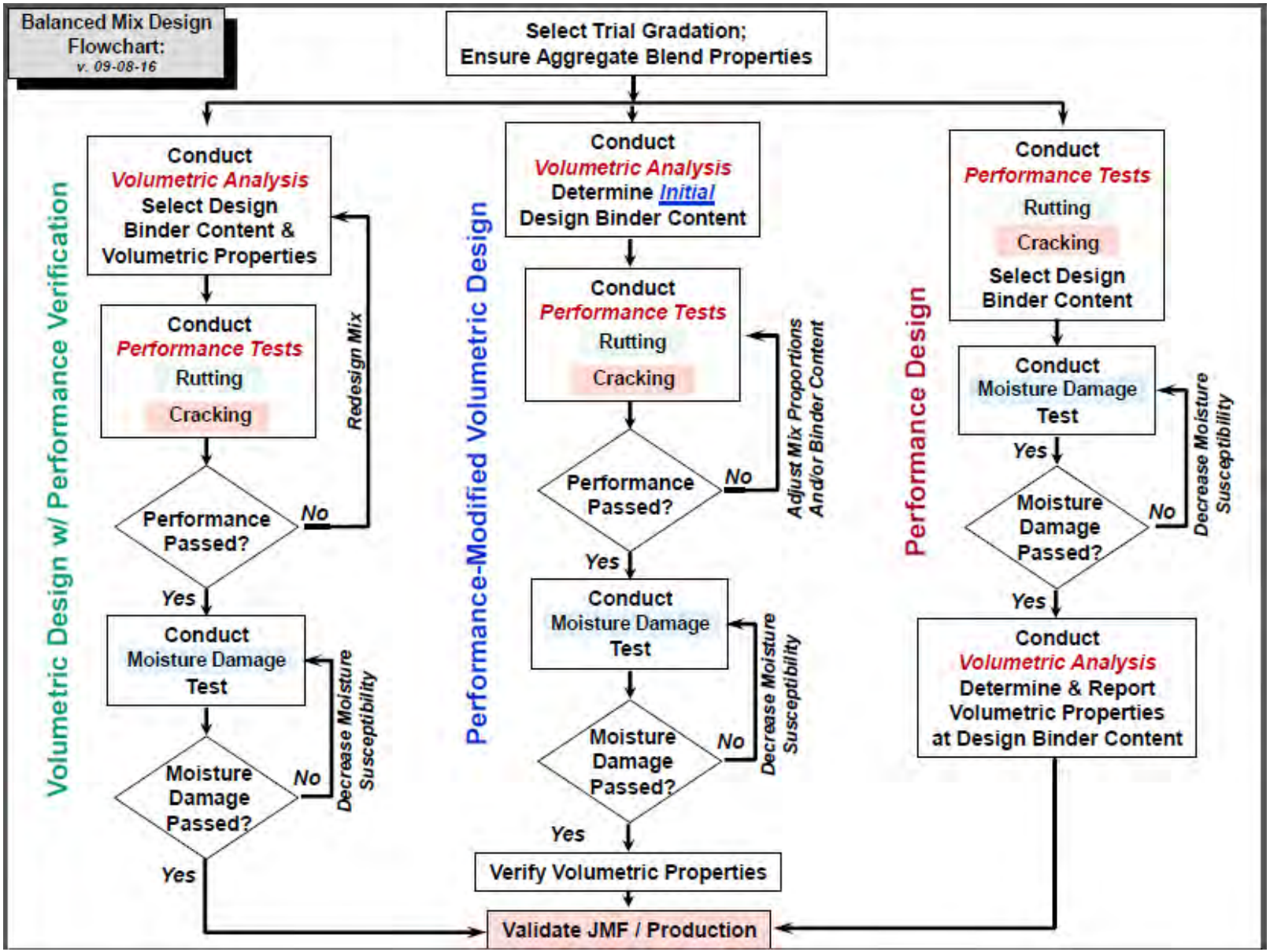
# Agency Practices Related to BMD



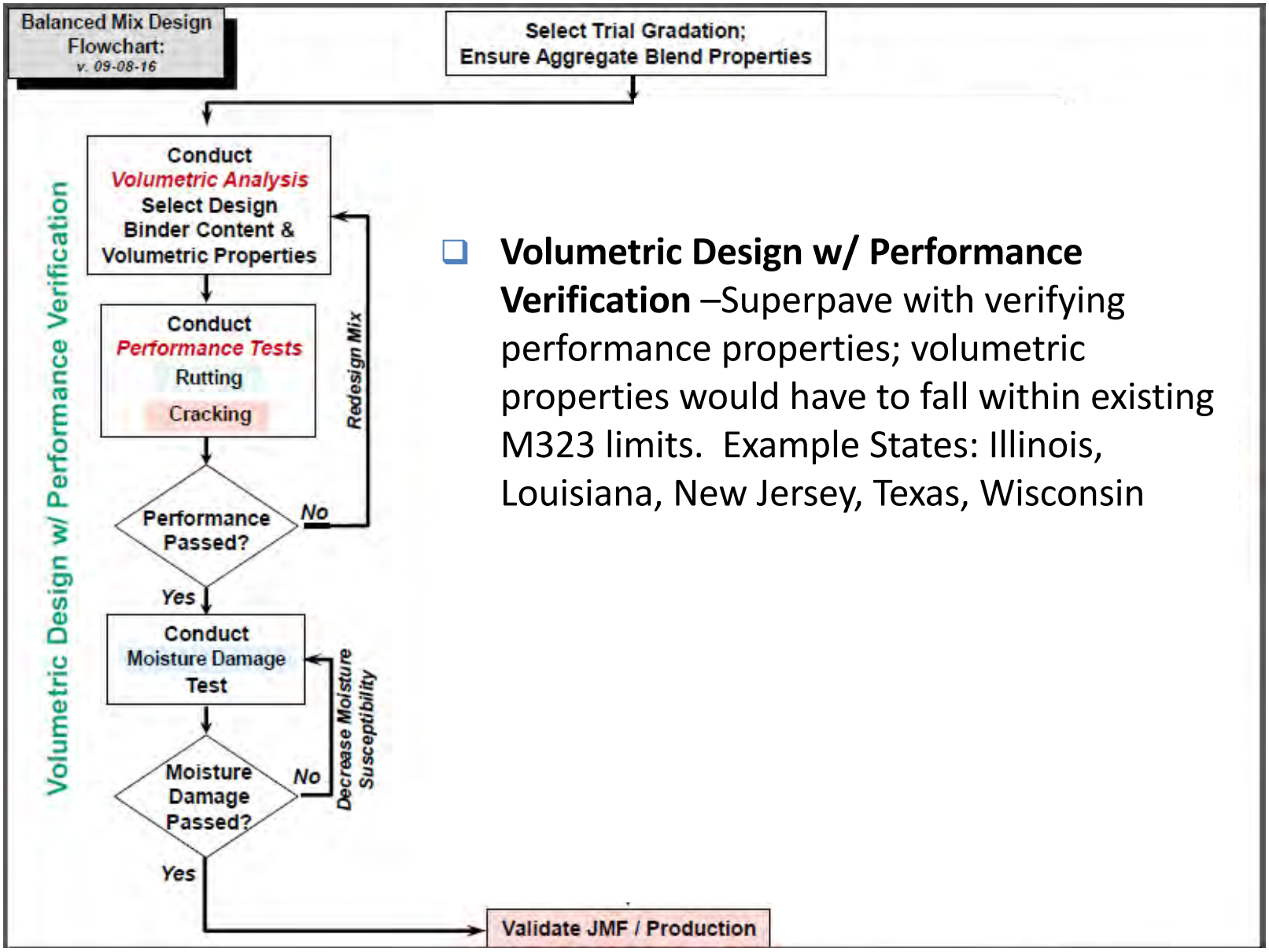

**McCarthy, Callans, Quigley, and Scott, III**
**NCHRP Synthesis No. 492**

# Agency Approaches

**Tim Aschenbrener and Kevin Hall**

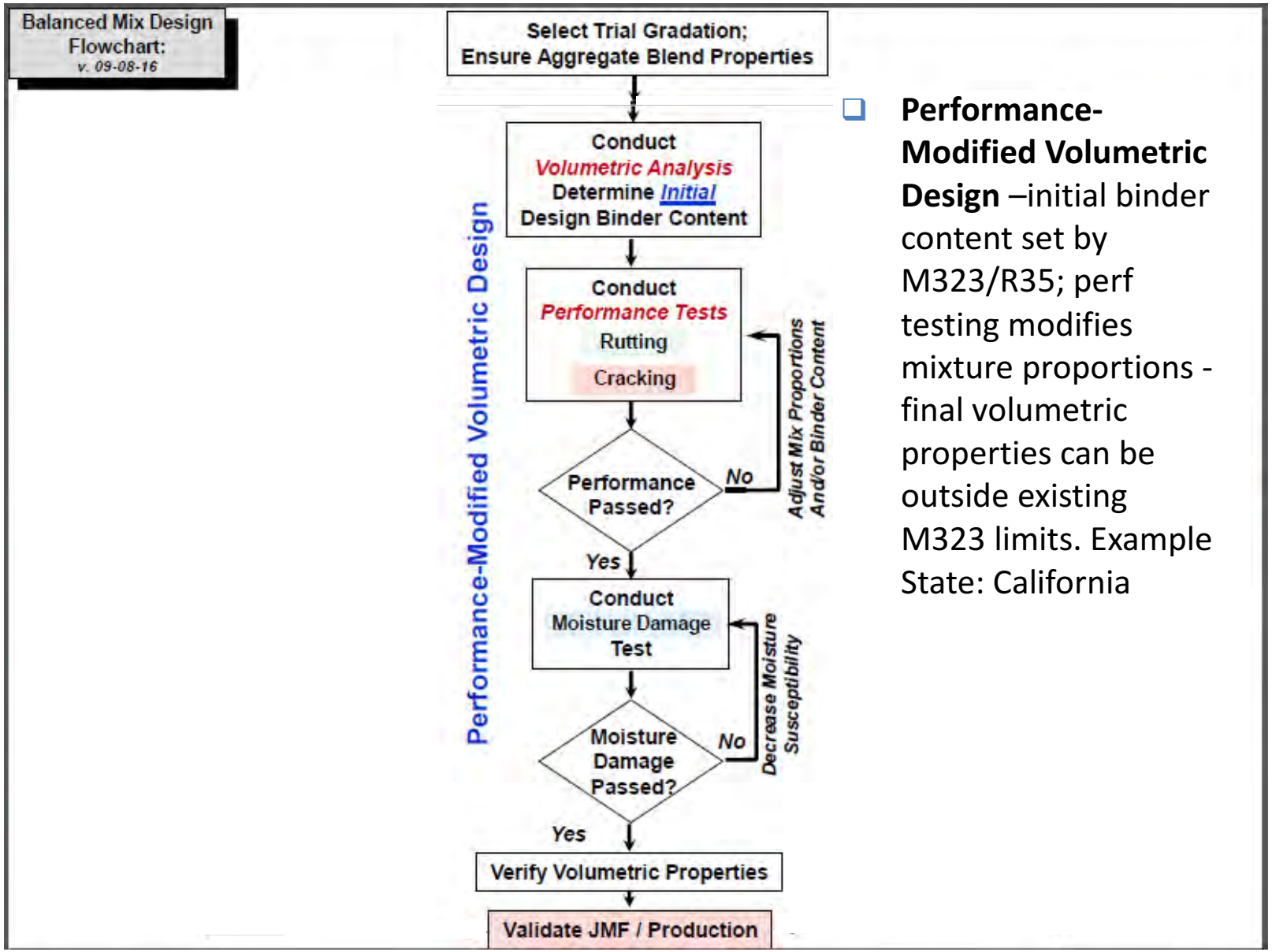


# Verified Vol Design



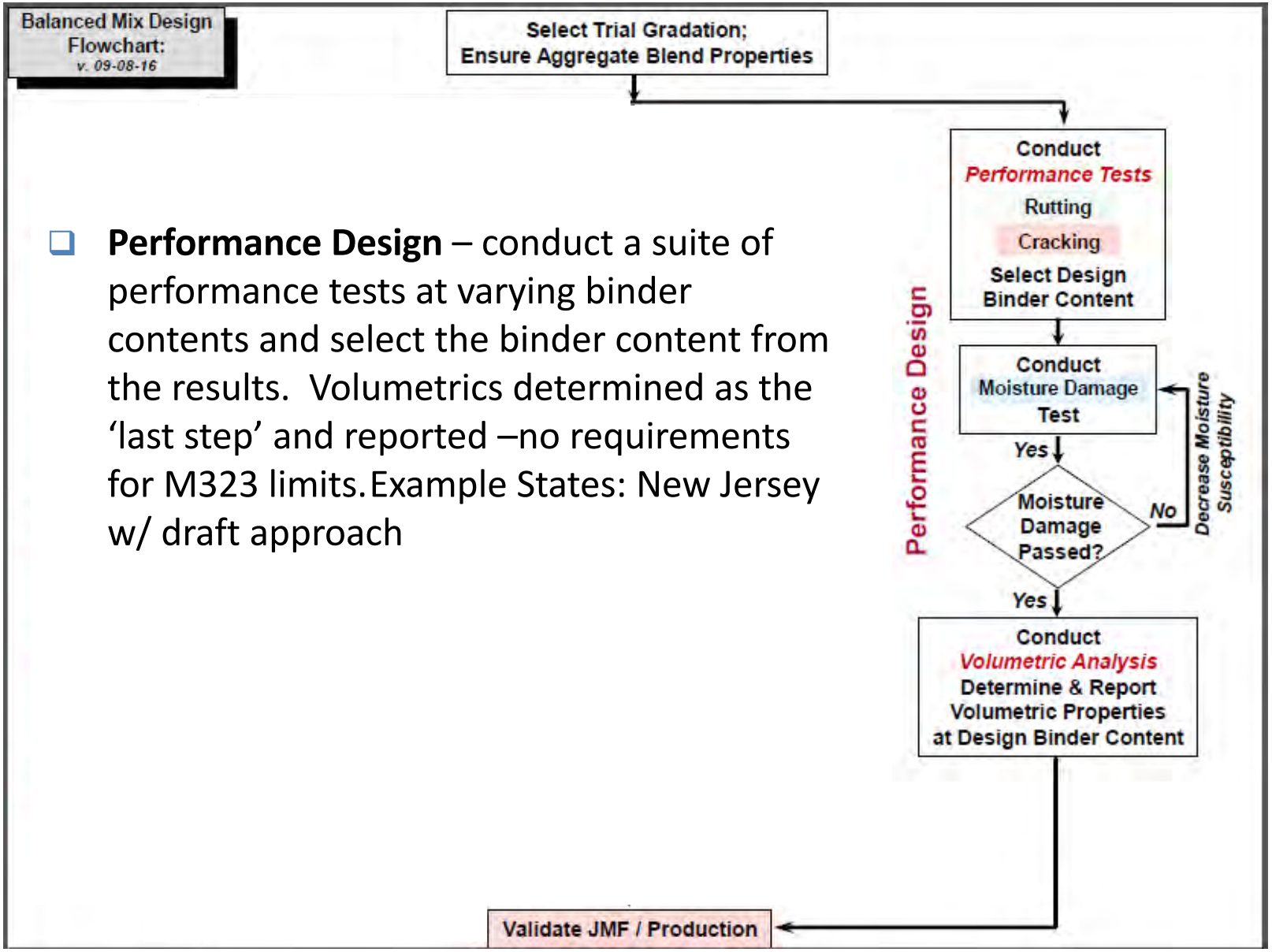

- **Volumetric Design w/ Performance Verification** –Superpave with verifying performance properties; volumetric properties would have to fall within existing M323 limits. Example States: Illinois, Louisiana, New Jersey, Texas, Wisconsin

# Performance Mod Vol Design



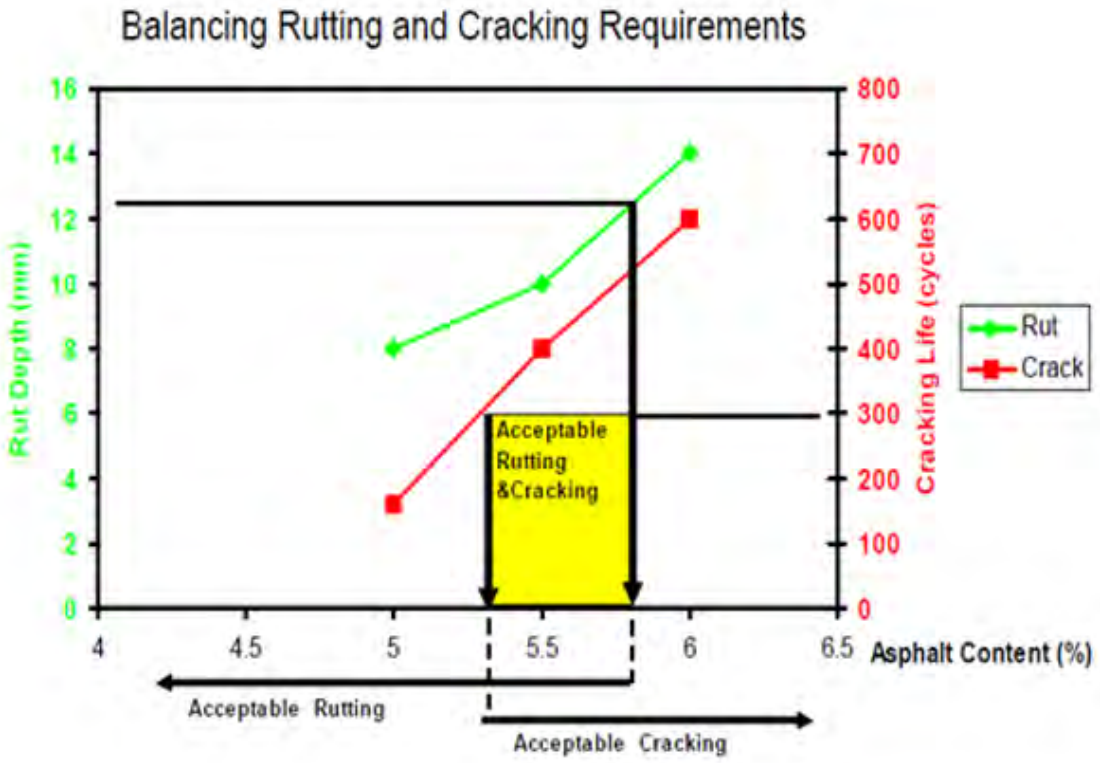

- **Performance-Modified Volumetric Design** –initial binder content set by M323/R35; perf testing modifies mixture proportions - final volumetric properties can be outside existing M323 limits. Example State: California

- **Performance Design** – conduct a suite of performance tests at varying binder contents and select the binder content from the results. Volumetrics determined as the 'last step' and reported –no requirements for M323 limits. Example States: New Jersey w/ draft approach



# BMD Basic Example

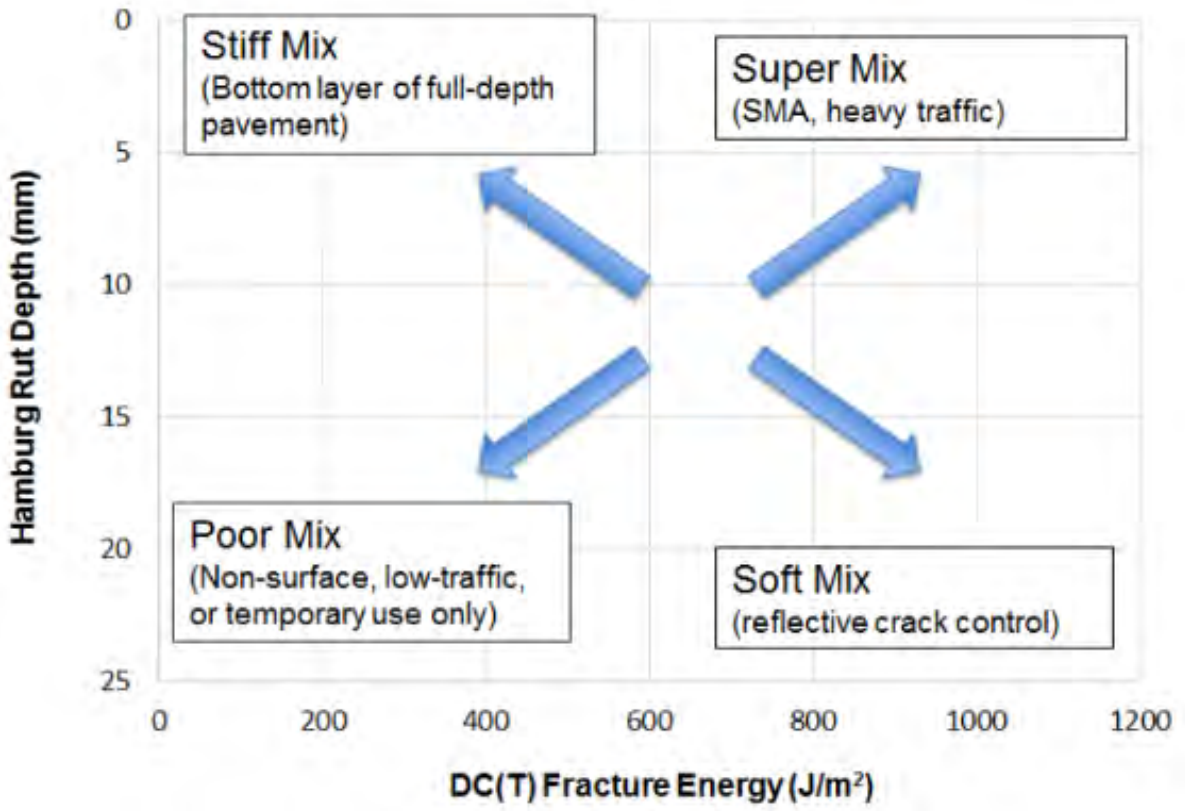
- **Texas DOT**
  - Volumetric design conducted
  - Hamburg Wheel Tracking Test (HWTT) AASHTO T 324
  - Overlay Tester (OT) Tex-248-F
  - Three asphalt binder contents are used: optimum, optimum +0.5%, and optimum -0.5%.
  - The HWTT specimens are short-term conditioned.
  - The OT specimens are long-term conditioned.




**Within this acceptable range (5.3 to 5.8 percent), the mixture at the selected asphalt content must meet the Superpave volumetric criteria.**

# Performance Testing to Understand Mixes

- Performance space diagrams show the performance of a mix related to multiple tests
- Allows the mix designer to visualize the mix performance and how to engineer the mix to provide the desired performance
- Illustrates the impact of varying mix factors on performance.




From: Performance-Space Diagram for the Evaluation of High and Low Temperature Asphalt Mixture Performance, Buttlar et al, AAPT 2016

# Need for Production Verification

## Design

### Optimize

- Local materials use, recycle, additives, cost, appropriate binder content
- Specific site/end use

### Establish

- Performance criteria
- Potential surrogate test correlation
- Volumetric property baseline

## Production

### Verify

- QC testing
- Volumetrics comparison to baseline
- Surrogate (“Quick”) tests
- Performance tests at “x” frequency

# BMD TF Work Products

## Research Problem Statement

## +

## FHWA Technical Brief

# Research Need Statement

- RPS prepared in June 2016
- Anticipated Results
  - 1) review of the state-of-the-practice of mix design
  - 2) review state-of-the-practice for performance testing,
  - 3) develop Recommended Practice for Balanced Mixture Design
  - 4) develop training and implementation plan and materials to move BMD ahead in State Highway Agencies (SHAs).

**NCHRP Problem Statement**

**I. PROBLEM NUMBER**

To be assigned by NCHRP staff.

**II. PROBLEM TITLE**

Development of a Recommended Practice for Balanced Asphalt Mixture Design

**III. RESEARCH PROBLEM STATEMENT**

**Background**

In September 2015, the FHWA Expert Task Group on Asphalt Mixture and Construction formed a Task Force on Balanced Mixture Design (BMD) to move forward changes in the way asphalt mixtures are formulated. The task group has defined BMD as ***"Asphalt mixture design using performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mixture aging, traffic, climate and location within the pavement structure."*** The objective of BMD is to design asphalt mixtures for performance using a rational approach instead of relying on strictly volumetric guidelines. The Task Force has identified three types of approaches used for a Balanced Mixture Design: A) Performance Testing, B) Superpave with Adjustments Based on Performance Testing and C) Superpave with Adjustments Based on Volumetrics and Performance Testing.

**~1 Million tons of HMA placed each day.**

- **Critical to address mix design in a more comprehensive manner**

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# Research Need Statement

- Favorable response during August SOM
- Status:
  - *Ranked high*
  - *Decision not to forward to RAC/SCOR*
  - *Pursuing NCHRP 20-07 Projects*
    - *More fully develop work items*
    - *Define state of practice*
  - *Probably next year before it is forwarded to RAC/SCOR*

# FHWA Tech Brief - Draft

- Tech Brief prepared and reviewed by full ETG.
- Submitted to FHWA for publication.


## Balanced Mixture Design Approaches for Asphalt Pavement Construction

DRAFT

This *Technical Brief* provides an overview of balanced mixture design (BMD) approaches used by states in asphalt pavement construction. These approaches are still under development and this document will attempt to show its current status and some of the issues that will need to be addressed in the future.

# What do We do with This?

Balanced Mix Design

Opt. AC

Set Volumetrics

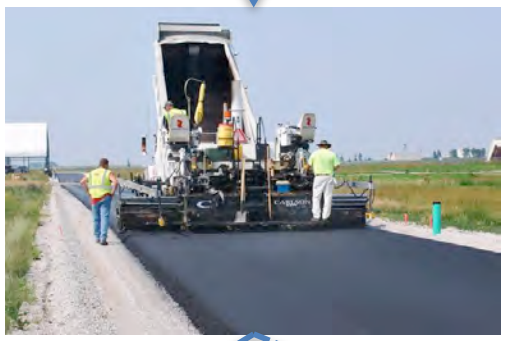
Set Tolerances

Table 11
Operational Tolerances

| Description | Test Method | Allowable Difference Between Trial Batch and JMF1 Target | Allowable Difference from Current JMF Target |
|---|---|---|---|
| Individual % retained for #8 sieve and larger | Tex-200-F or Tex-236-F | Must be within master grading limits in Table 8 | ±6.0[1] |
| Individual % retained for sieves smaller than #8 and larger than #200 | | | ±4.0[1] |
| % passing the #200 sieve | | | ±2.0[1] |
| Asphalt binder content, % | Tex-236-F | ±0.5 | ±0.5 |
| Laboratory-molded density, % | Tex-207-F | ±1.0 | ±1.5 |
| VMA, %, min | Tex-204-F | Note[2] | Note[2] |

1. When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 will be considered out of tolerance when outside the master grading limits.
2. Mixture is required to meet Table 8 requirements.

QC Volumetrics

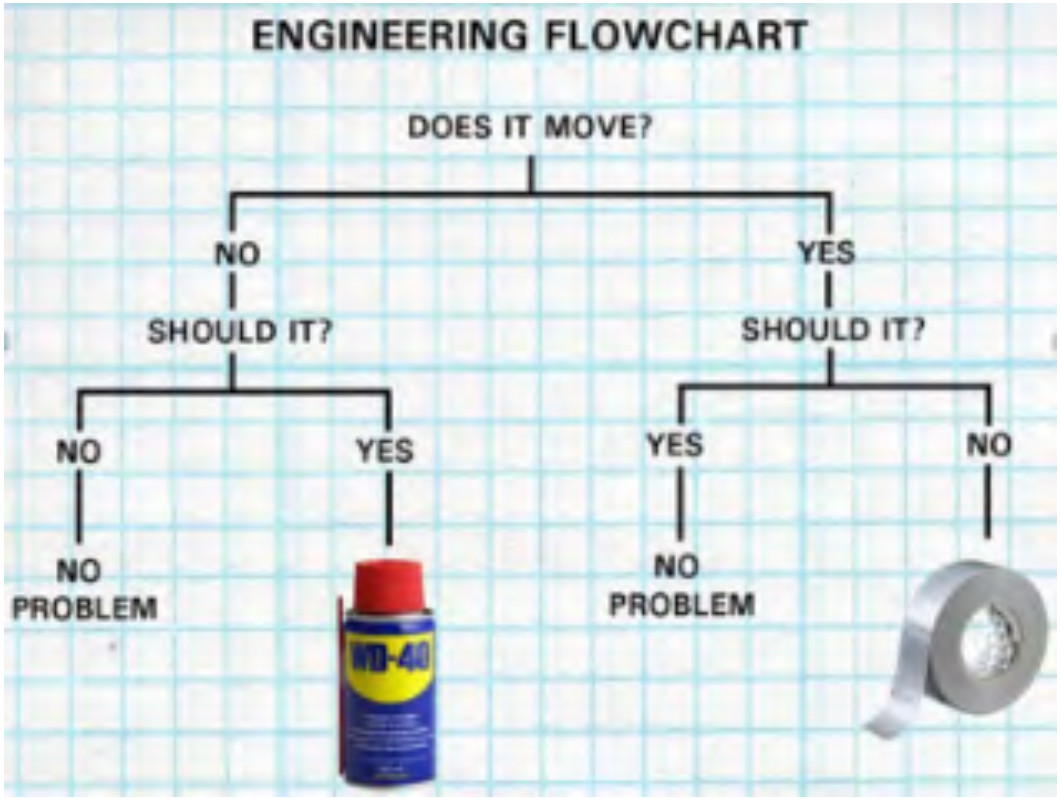


QA Volumetrics

Some Day

QA Performance Testing

- Key Foundational Points to Keep in Mind
  1. **"Use What Works"**
  2. **"Eliminate What Doesn't"**
  3. **"Be as Simple as Possible, Be Practical, and Be Correct"**



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# At the 2016 AAPT Meeting:

- Leading Edge Workshop: Cracking Tests
- 5 Presentations on Cracking Tests
- Symposium: Balanced Mix Design
- 5 Presentations on High RAP/RAS
- Implementation of Specifications
- Aging Behavior
- Forum Topic: World Asphalt Market

**2017 Meeting: Newport Beach, CA**
**March 19-27**

# AAPT/AI Webinar Series – Fatigue Cracking of Asphalt Pavements

Association of Asphalt Paving Technologists

**Duration:** 3 parts, each 1 Hour. 180 Minutes Total.

**Dates/Times:** Part I – Thursday, 20 October 2016, 12:00 – 1:00 PM EDT
Part II – Thursday, 27 October 2016, 12:00 – 1:00 PM EDT
Part III – Thursday, 3 November 2016, 12:00 – 1:00 PM EDT

**Cost:** Complimentary for AAPT and AI Member

**Complimentary for AAPT Members!**

**Instructors:** Andrew Braham, Ph.D., P.E., Associate Professor, University of Arkansas
Shane Underwood, Ph.D., Assistant Professor, Arizona State University

**Moderator:** R. Michael Anderson, P.E., Asphalt Institute Director of Research and Lab Services, Association of Asphalt Paving Technologists Executive Director

## Webinar Series Description

AAPT and the Asphalt Institute are hosting a three-part webinar series for understanding of fatigue cracking and a comprehensive review of the laboratory methods for fatigue cracking tests.


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