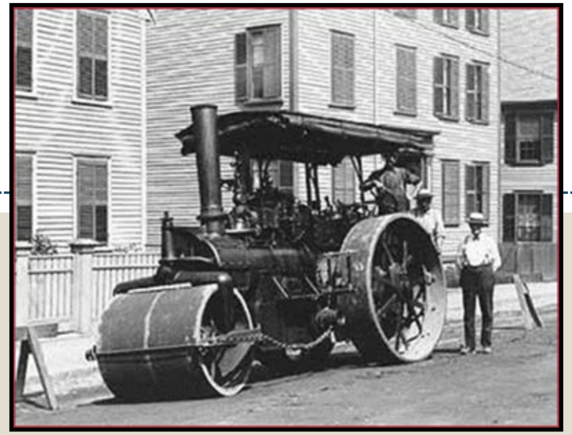
# Enhanced Durability Through Increased Density




**TIM ASCHENBRENER, P.E.**

MATERIALS AND QUALITY ASSURANCE TEAM

OFFICE OF ASSET MANAGEMENT,
PAVEMENTS AND CONSTRUCTION

FHWA


ASPHALT MIXTURE ETG
MAY 2, 2017

# Overall Objective

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

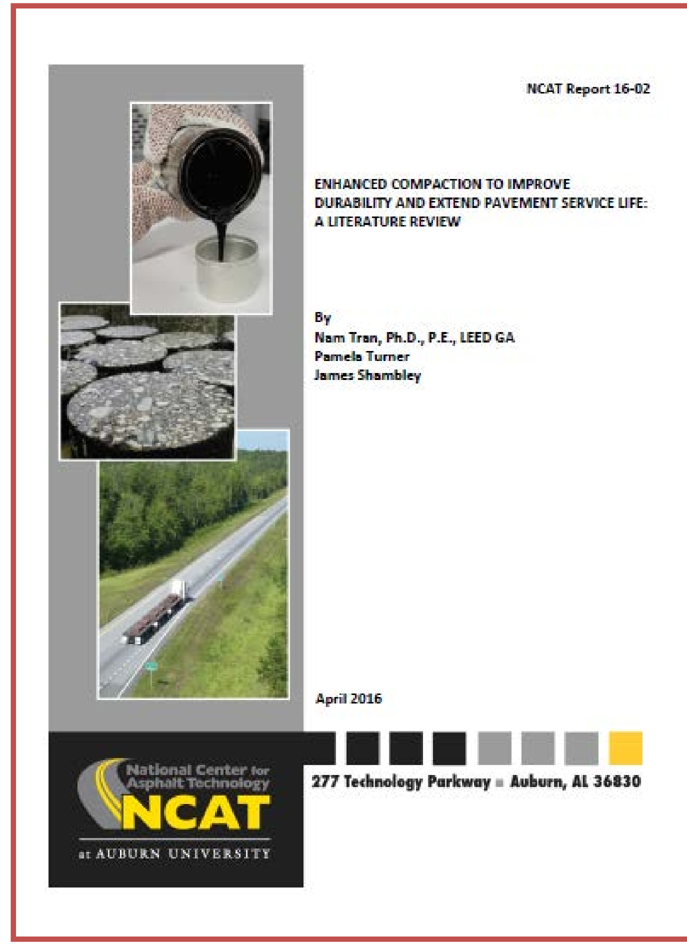
Ultimately,

achieving increased in-place asphalt pavement density that results in the highest asphalt pavement performance.

# NCAT Report 16-02 (2016)

"A **1% decrease in air voids** was estimated to:

- <u>improve fatigue</u> performance by 8.2 and 43.8%
- <u>improve the rutting</u> resistance by 7.3 to 66.3%
- **<u>extend the service life</u> by conservatively 10%**."

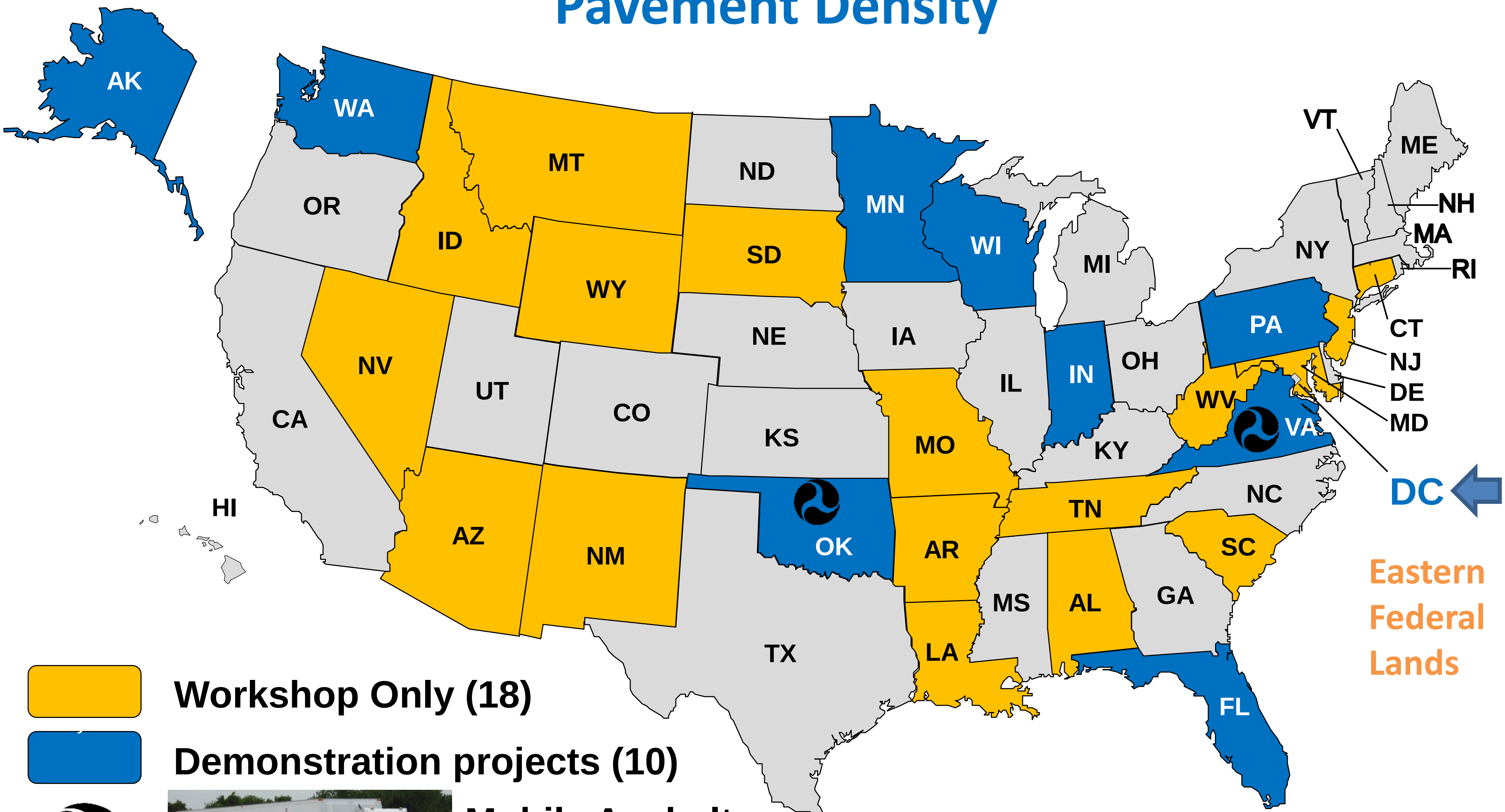



http://eng.auburn.edu/research/centers/ncat/files/technical-reports/rep16-02.pdf

# Project Support

- Compaction Workshop
  - Feedback Very Positive
  - Formal training
  - Comprehensive
- Field Projects
  - Pre-paving meeting attendance and advice
  - On-site technical advice

# Enhanced Durability of Asphalt Pavements through Increased In-Place Pavement Density




Workshop Only (18)

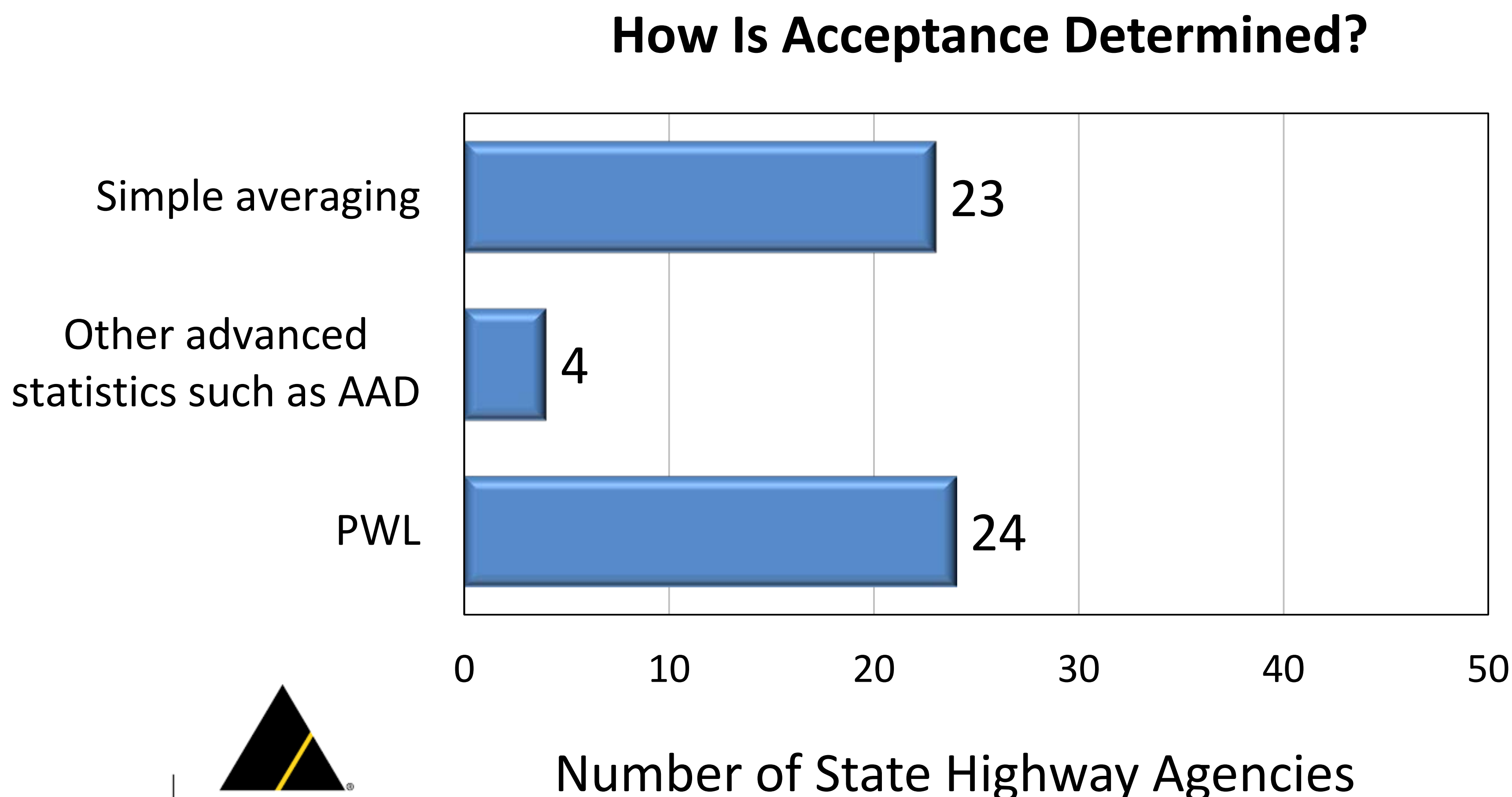
Demonstration projects (10)

Mobile Asphalt Testing Trailer (2)

# Achieving Increased In-place Density

1. % Density Requirement
2. Optimum Asphalt Content
3. Consistency
4. Best Practices
5. New Technology

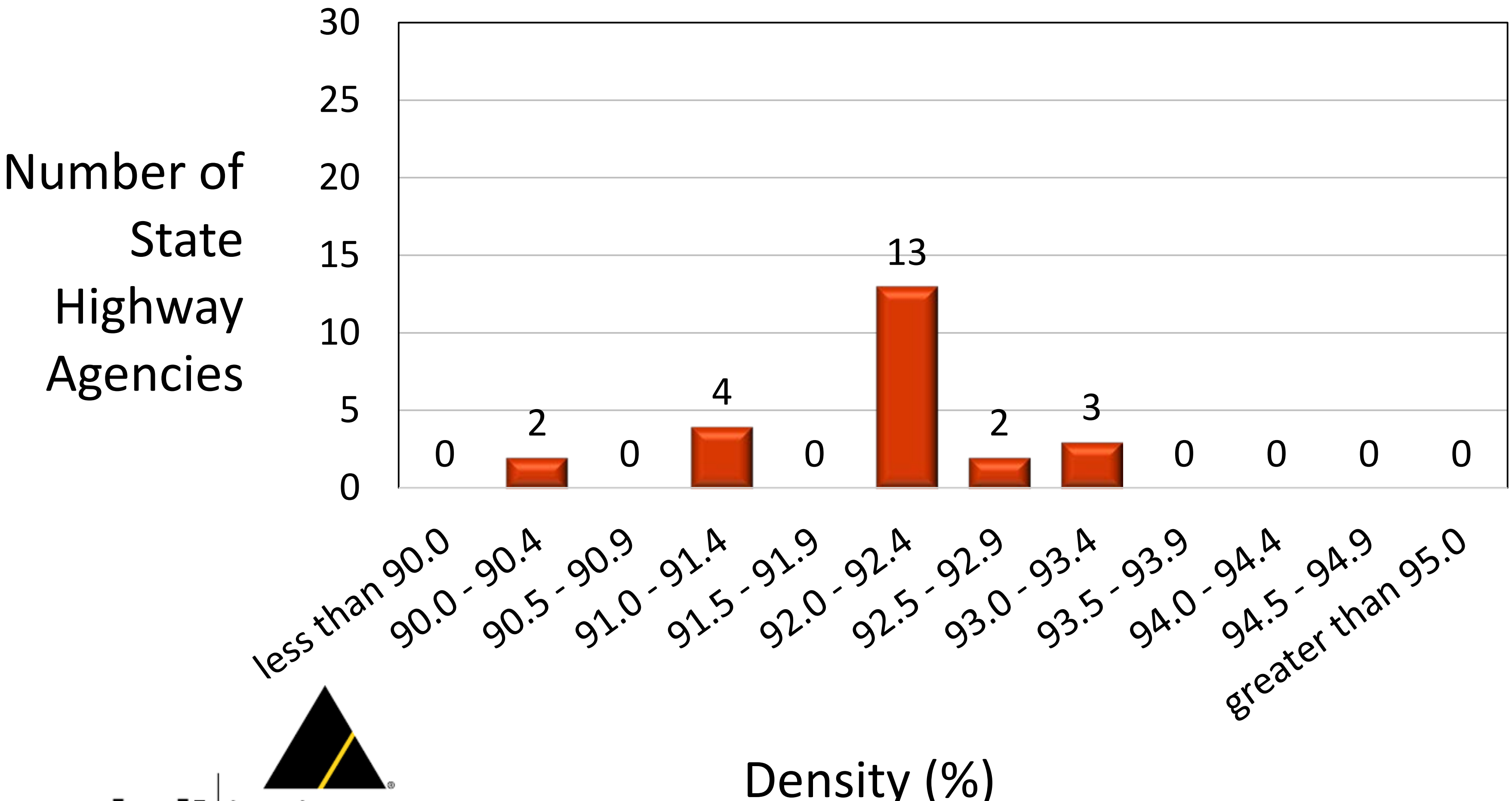
# How Is Acceptance Determined




asphalt institute

2016

# Minimum Lot Average

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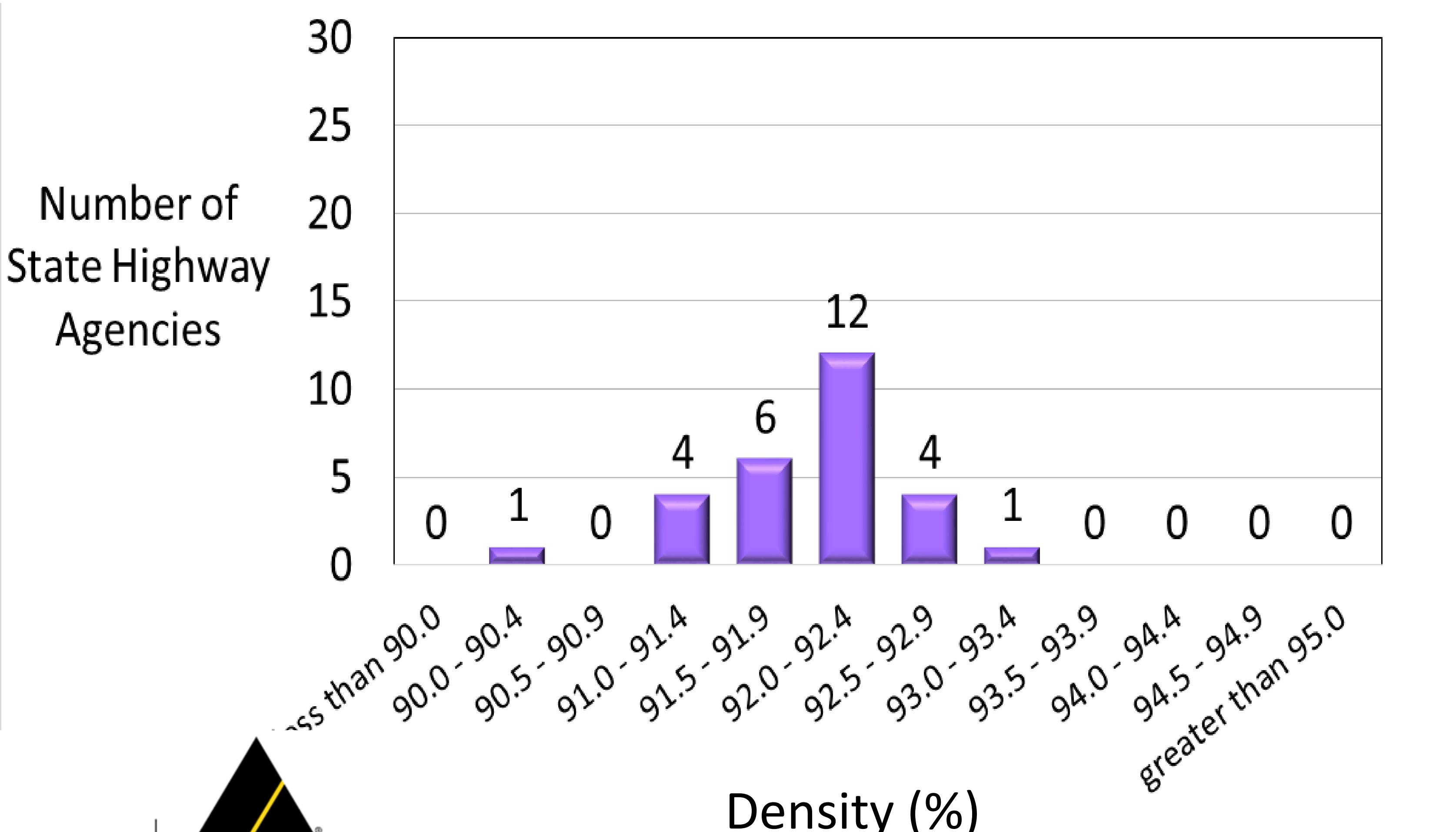
# PWL: Lower Specification Limit

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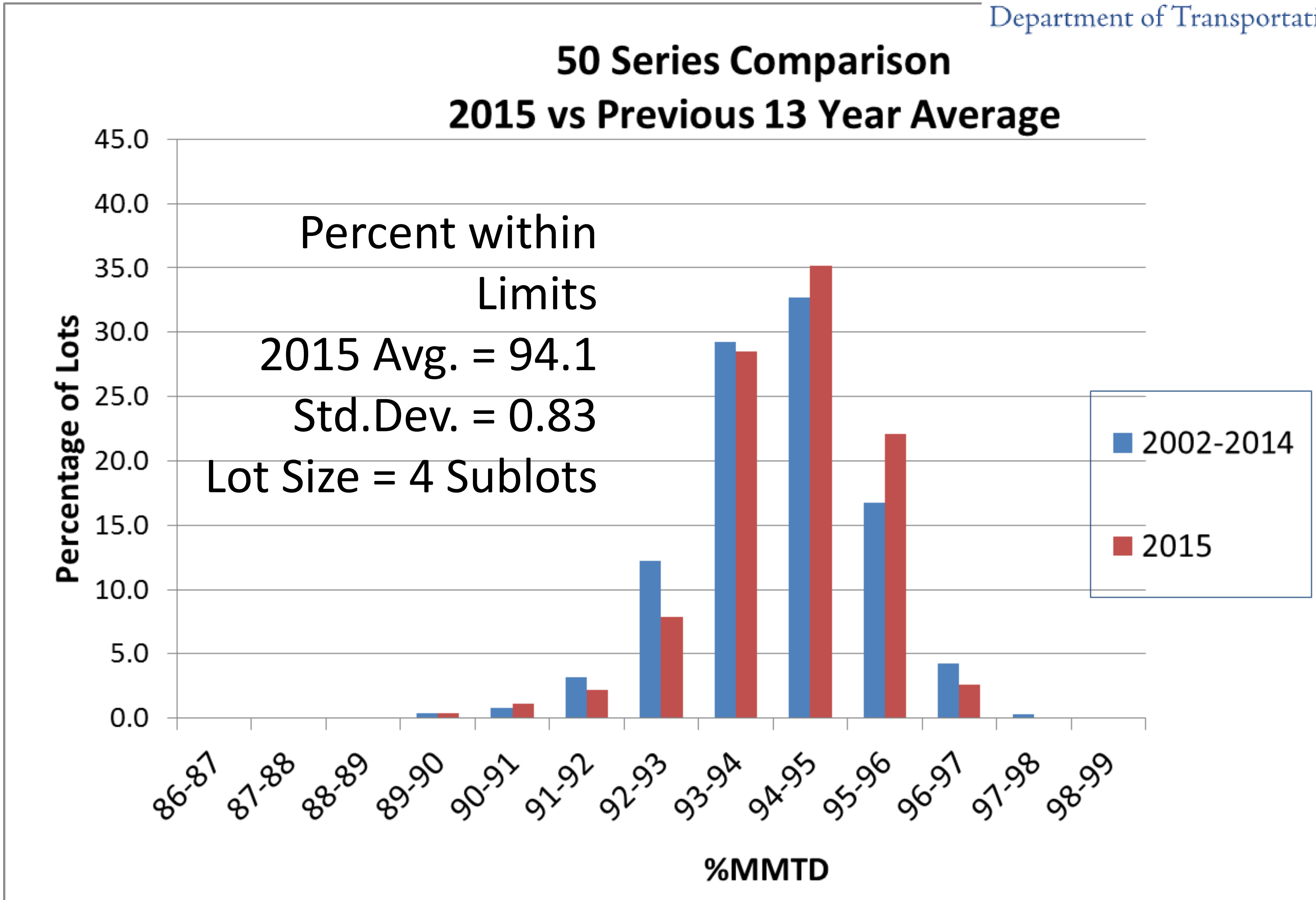
# NYSDOT Case Study

New York State Department of Transportation



# Achieving Increased In-place Density

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# Selecting Optimum with Superpave

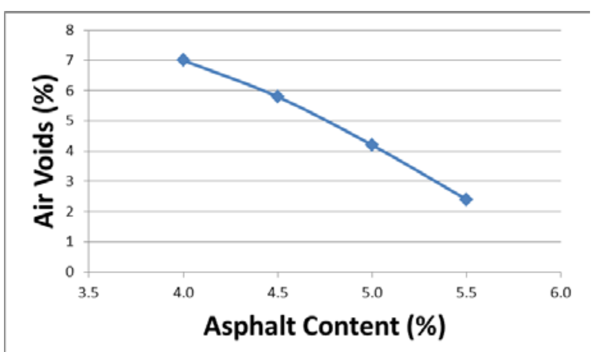
## What Changes Were Made to AASHTO Standards?

- Gyrations
- Air Voids
- Voids in the Mineral Aggregate (VMA)
- Is There Additional Criteria?

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO
THE VOICE OF TRANSPORTATION

# Asphalt Mixture Adjustments

| State | Adjustments | Additional Asphalt |
|---|---|---|
| 3 | ⇩ Gyrations (Regression) | 0.3% |
| 4 | ⇩ Air Voids (Regression) ⇧ VMA | 0.3% |
| 9 | ⇩ Gyrations ⇧ Air Voids ⇧ VMA | ≈ 0.3% |




**Important Note:**
Be sure to update minimum % density requirements

# FHWA Tech Brief

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 through partnerships 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, mixture design, testing, construction and quality control.

US Department of Transportation
Federal Highway Administration

Office of Pavement Technology

FHWA-HIF-11-031

December, 2010

SUPERPAVE MIX DESIGN AND GYRATORY COMPACTION LEVELS

*This Technical Brief provides an overview of the intent of the Superpave volumetric mix design and a suggested process to evaluate effects of changes to the gyration levels.*

### Issues with $N_{design}$

Superpave mix design was first introduced in 1993 with the completion of the Strategic Highway Research Program (SHRP). This new design system was not an evolution in mix design but a revolution. The Superpave (Superior Performing Asphalt Pavements) system introduced a new compactor, the Superpave Gyratory compactor (Figure 1) for densifying mixes in the lab. In addition the new design system introduced aggregate and binder requirements and mixture compactive effort tied to traffic.

Currently the Superpave mixture design system is the predominately used system in the US. Since its introduction many miles of roadway, using the Superpave system have been placed across the country. There has been some concern by various highway agencies that the Superpave mixture design system produces asphalt mixes that are too dry (too low asphalt binder content) and may have resulted in durability issues. A National Cooperative Highway Research Program (NCHRP) project 9-9(1), Report 573 "Verification of Gyration Levels in the $N_{design}$ Table," recommended a reduction in gyratory compaction levels based on studies of densification in the field. Though this study was quite extensive, the relationship in the study between gyratory compaction levels and densification in the field was not strong, as shown in Figure 2. Based on some general trends and statistical correlations the study produced a table that reduced the gyratory levels and recommended their use. The Federal Highway Administration's (FHWA) Asphalt Mixture & Construction Expert Task Group (Mix ETG) concluded after extensive evaluations that no general recommendation could be established for reductions of the gyratory levels. The ETG believed that the data has too wide a

**Title: Superpave Mix Design and Gyratory Compaction Levels**

**Purpose: Evaluate Effects of Changes to Gyratory Levels**

# Achieving Increased In-place Density

1. • % Density Requirement
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4. • Best Practices
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# Consistency is Important

## Standard Deviation

- State #5
  - Cores with lot size = 5 sublots
  - Old Spec: S.D. = 1.58
  - New Spec: S.D. = **0.98**
- State #6
  - Nuclear from individual tests
  - Control: S.D. = 1.58
  - Test Section: S.D. = **0.67**
- NYSDOT PWL Statewide
  - Cores with lot size = 4 sublots
  - 2007: S.D. = 0.92
  - 2015: S.D. = **0.83**

# Achieving Increased In-place Density

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# Equipment Manufacturer Feedback
# Other Best Practices

- Roller settings
- Vibration frequency vs. roller speed
- Amplitude
- Vibrating screed
- Mat temperature
- Paver speed

BOMAG FAYAT GROUP

CAT®

HAMM

SAKAI MASTERS OF COMPACTION

VOLVO

# % Density
# Test Sections


| State ID | Total | | Breakdown Roller | Field Density (% $G_{mm}$) | Δ from control | Specification | Require-ment | Incentive / Disincentive |
|---|---|---|---|---|---|---|---|---|
| | Rollers | Passes | | | | | | |
| 7 | 2 | 6 | No echelon | 92.1 | - 0.2 | % Control Strip | 98.0 | D |
| 2 | 1 | 9 | No echelon | 92.5 | + 0.7 | Min. Sublot | 92.0 | D |
| 9 | 2 | 14 | Echelon | 95.4 | + 2.1 | PWL | 91.0 | I / D |
| 10 | 3 | 15 | Echelon | 95.2 | + 2.7 | PWL | 92.0 | I / D |
| 5 | 3 | 15 | Echelon | 96.1 | + 1.7 | PWL | 92.0 | I / D |
| 8 | 2 | 18 | No echelon | 95.6 | + 0.2 | PWL | 92.0 | I / D |
| 6 | 2 | 24 | No echelon | 93.0 | + 1.0 | PWL | 91.0 | I / D |
| 4 | 4 | 26 | Echelon | 95.4 | + 1.9 | Min. Lot Avg. | 91.5 | D |
| 3 | 5 | 29 | Echelon | 94.1 | + 1.2 | Min. Lot Avg. | 92.0 | I / D |
| 1 | 3 | 30 | Echelon / No vibratory | 95.4 | + 1.9 | PWL | 91.8 | I / D |

PWL = Percent within Limits

# State 4: Cost / Benefit of Best Practices

- Benefit of 1 Percent Density Increase
  10 percent of $60 / ton mix = $$$$$$
- Cost of 1 Percent Density Increase
  Additional rollers ≤ $
  AVR to 3% W/binder ≤ $$
  WMA Additive ≤ $
  9.5mm vs. 12.5mm ≈ $$

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# QC Tools

## SHRP2 Products

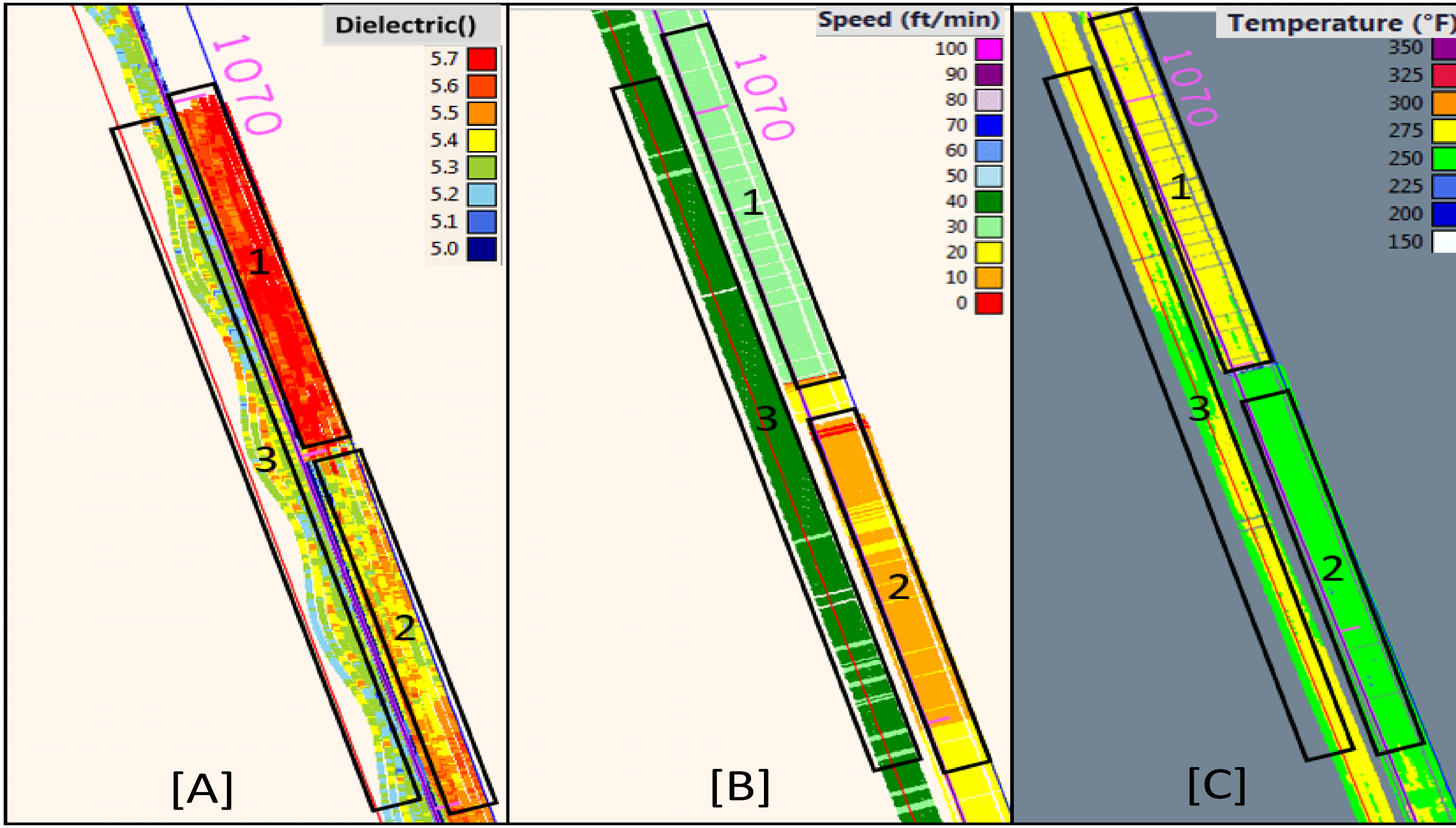
### Rolling Density Meter (RDM)

- Density from dielectric constant

### Thermal Temperature Scanner (IR Scan)

- Paver speed
- Temperature

# States #3 and #10




[A] Density RDM

[B] Paver Speed IR Scan

[C] Temp. IR Scan

# Can We Achieve Increased In-place Density?


Test Sections had Increased % TMD:

- From the control in 9 of 10 states
- More than 1% from control in 8 of 10 states
- To > 94% TMD in 7 of 10 states

Will there be changes?

- 7 of 10 states are changing specifications

# How Do We Achieve Increased In-place Density?

1. • % Density Requirement
2. • Optimum Asphalt Content
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# Next Steps

- SHAs' summary reports on 10 projects
  - Potential follow-up on field performance
- FHWA's best practices communication
  - Summary document
  - Tech Brief
  - Additional workshops (funding dependent)
- Extend field experiment
  - Soliciting until May 19, 2017

# Thank you

QUESTIONS / COMMENTS:

**TIM ASCHENBRENER, P.E.**
**FHWA**
SENIOR ASPHALT PAVEMENT ENGINEER
MATERIALS AND QUALITY ASSURANCE TEAM
OFFICE OF ASSET MANAGEMENT, PAVEMENTS AND CONSTRUCTION
LAKEWOOD, COLORADO

**(720) 963-3247**
**TIMOTHY.ASCHENBRENER@DOT.GOV**