Demonstration Projects, Related Specifications and Techniques for Improving Density

Image: Adam Hand

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Four Technical Briefs:

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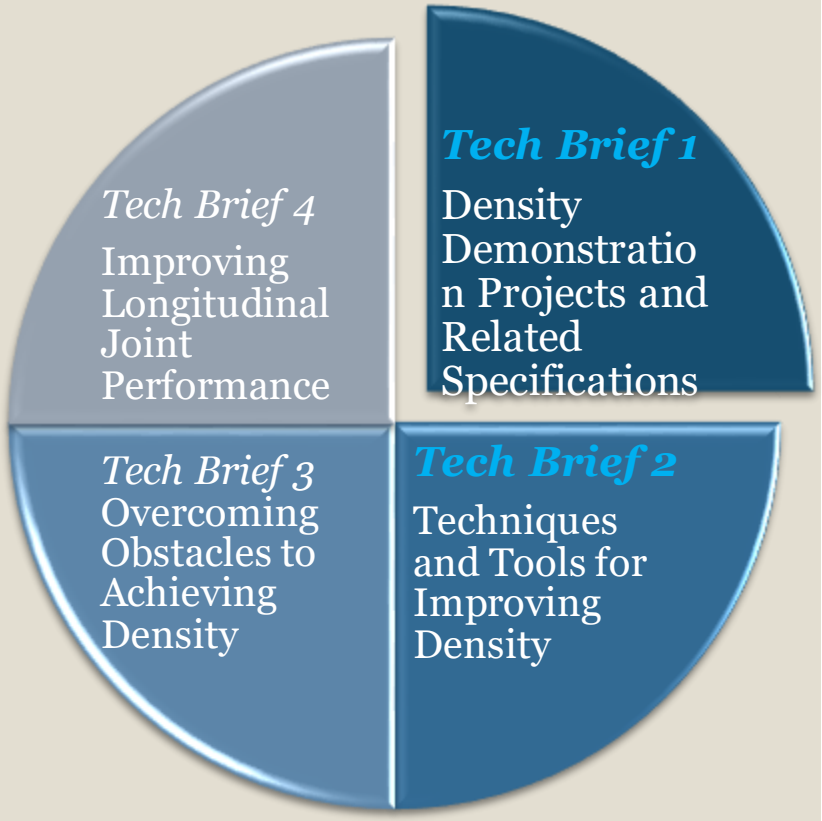

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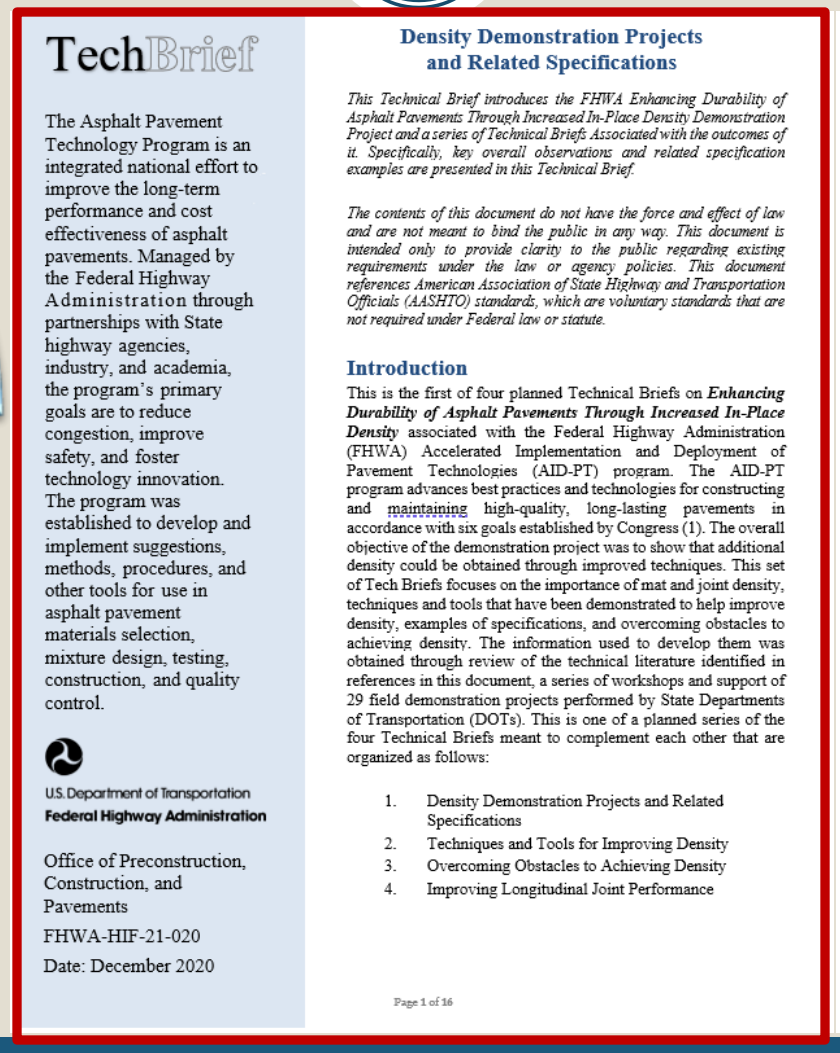

TechBrief

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 suggestions, methods, procedures, and other tools for use in asphalt pavement materials selection, mixture design, testing, construction, and quality control.

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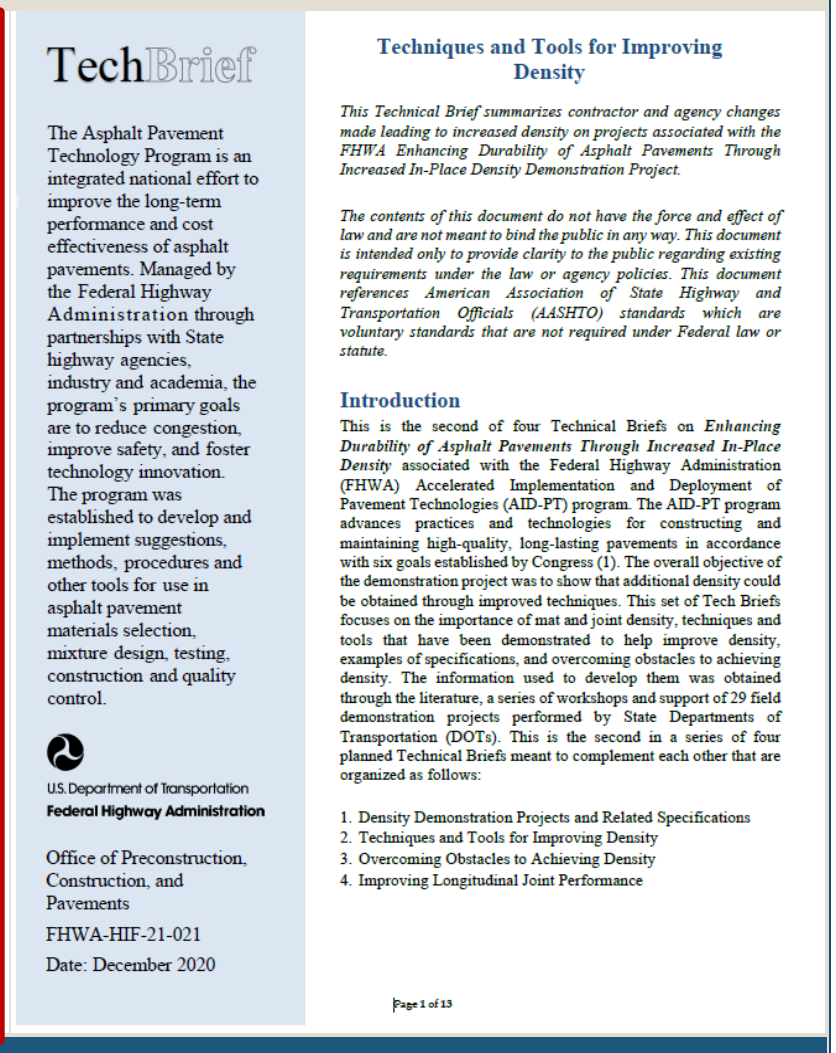

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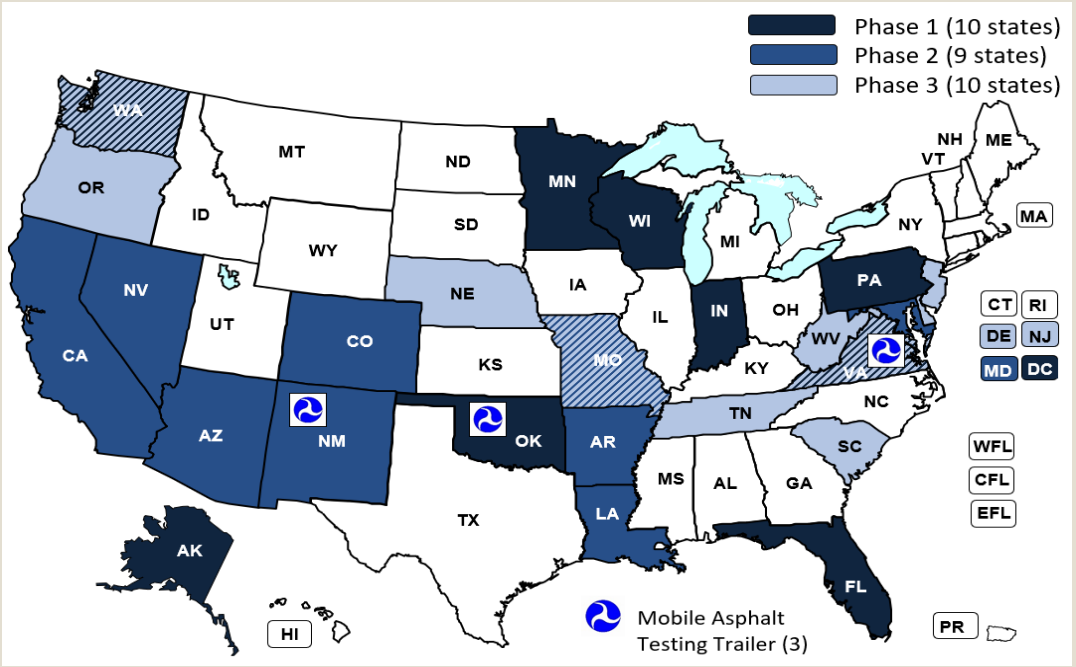
Objective of Technical Briefs

Demonstrate the ability to increase density through improved techniques

- Construction Practices
- Mixture Design Practices
- Specification Requirements



Why it is Important

- 1.0% Increase in Density ≈ 10% Increase in Service Life
- Service Life
  - 8 – 44% increase in Fatigue Performance
  - 7 – 66% increase in Rutting Performance
- Life Cycle Cost Savings
  - By increasing density 1%, save $88,000 Net Present Value for every $1 million in paving cost

Extend Service Life

Increase Cost Savings

FHWA Density Demonstration Project

- Contractors encouraged to use techniques that did not require additional rollers or a higher asphalt content, which would result in significantly increased cost
  - Increased rolling was supposed to be the only additional compactive effort (not additional rollers)
- DOTs conducted normal testing and frequency to measure density
  - Suggested that the in-place densities be based on cores or be referenced to cores for the control and test section
  - Suggested that the frequency be sufficient to calculate the standard deviation of the relative densities for each section

Demonstration Projects Metrics

Description	Demonstration Projects
Increased Density ≥ 1.0% from the Control Section	17 of 29
Test Section Achieved ≥ 94% Average Density	23 of 29
Increased Density ≥ 1% from the Control Section OR Test Section Achieved ≥ 94.0% Average Density	24 of 29

Literature Review: Key Findings

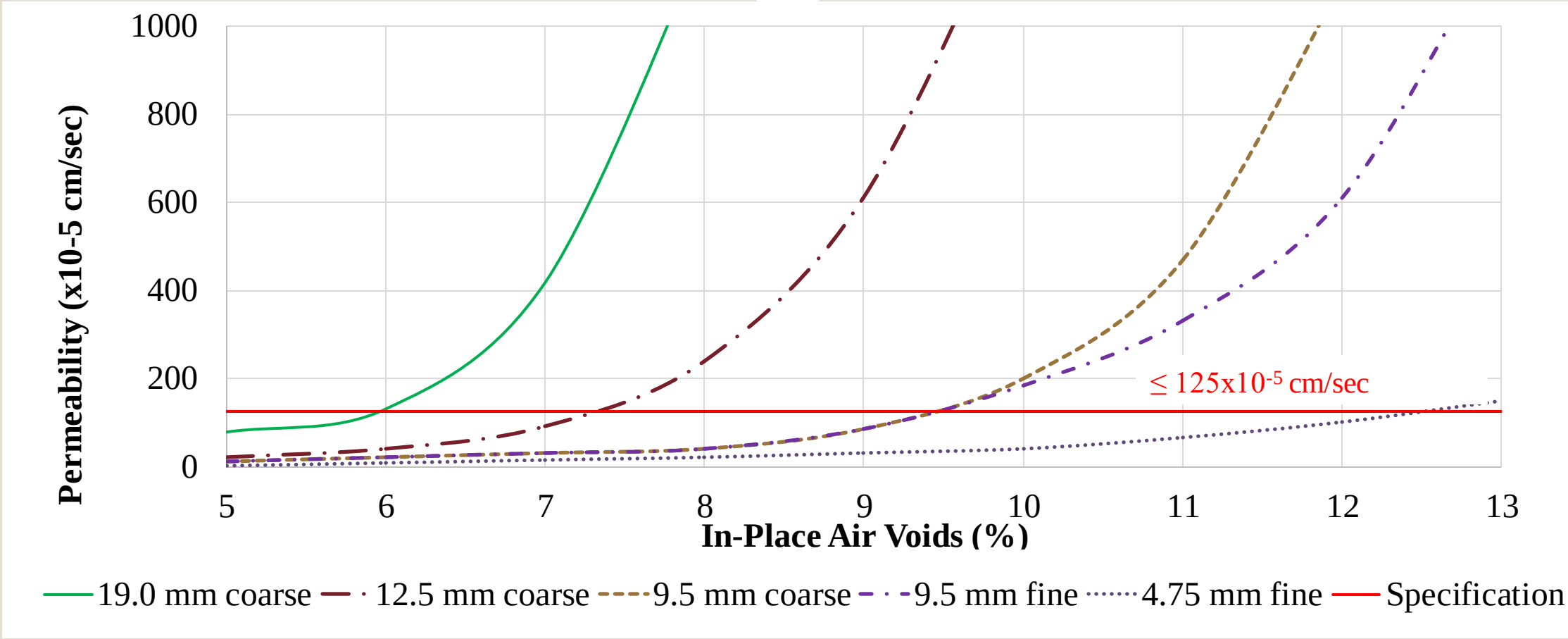
Pavement service life is significantly reduced when in-place density is below 93.0 percent

Water can enter pavements that are permeable and cause issues, reducing the service life. Permeability is also a function of NMAS

A target density less than 92.0 percent was considered inadequate

Image: Adam Hand

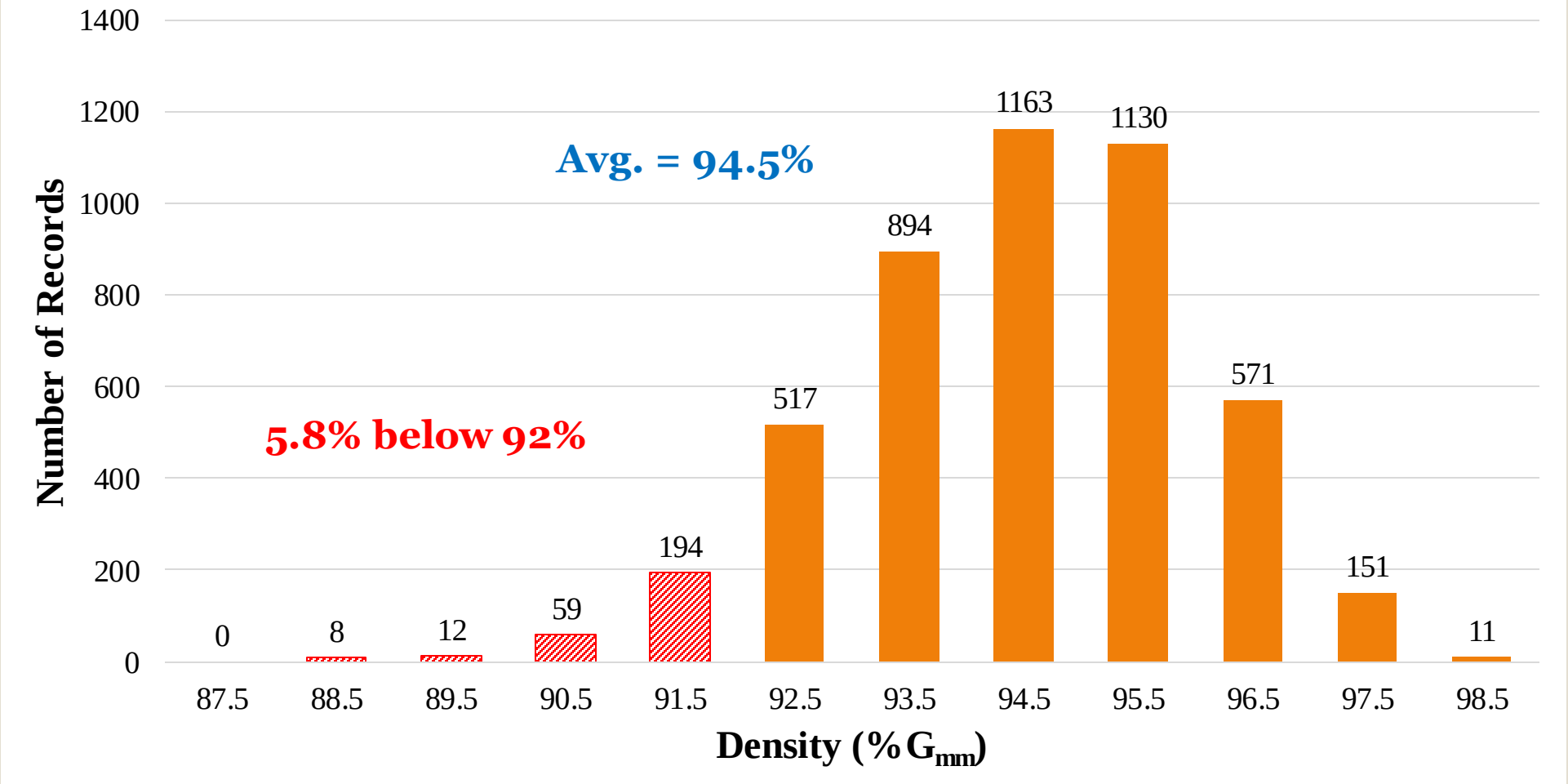
In-place Air Voids Versus Permeability for Different NMAS



Brown, E.R., M. Hainin, A. Cooley, and G. Hurley. *Relationship of Air Voids, Lift Thickness, and Permeability in Hot-Mix Asphalt Pavements*, NCHRP Report 531, Transportation Research Board of the National Academies, Washington, DC, 2004

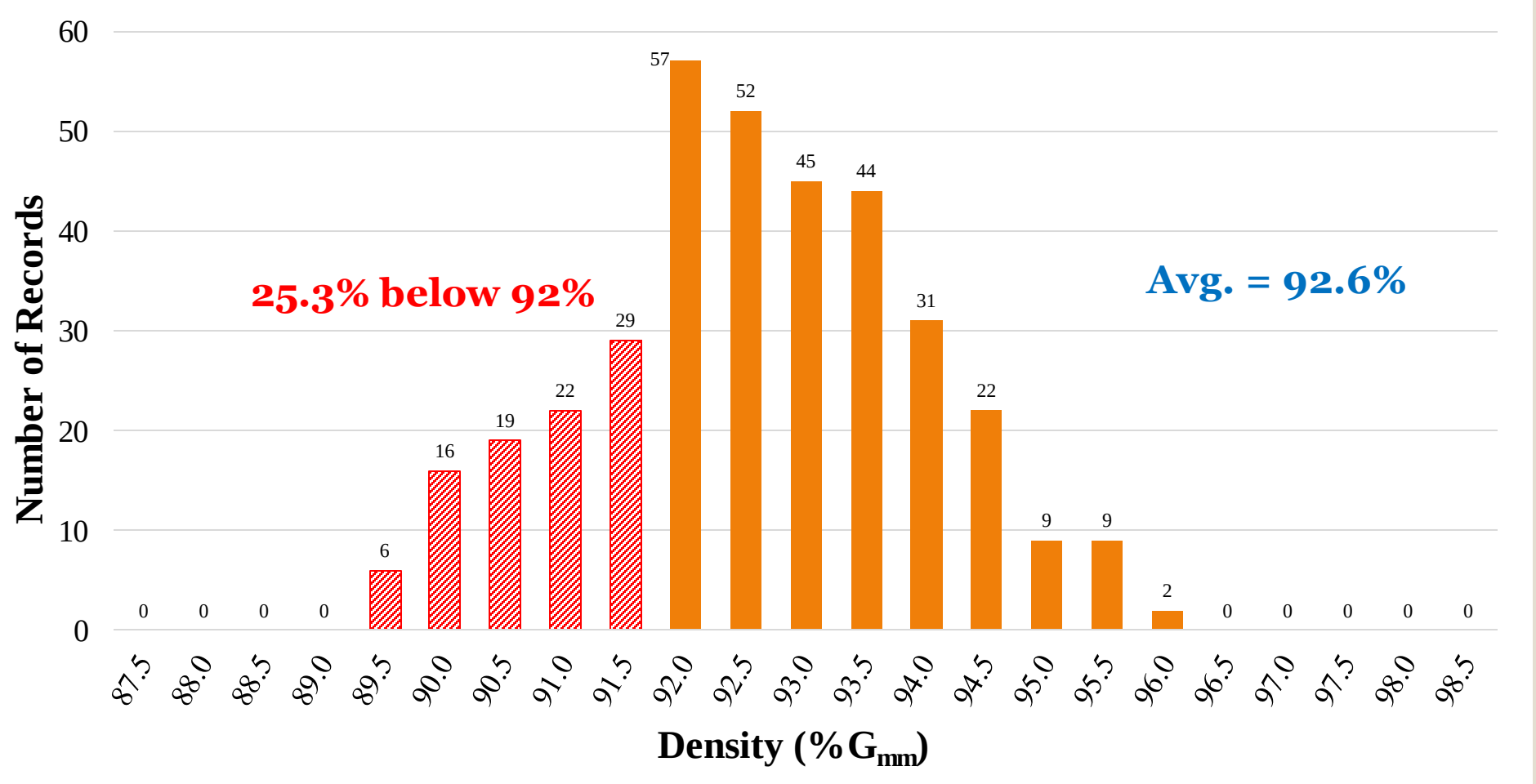
Maine DOT Percent Density Histogram

- Variation in percent density 2013 to 2017



“Example State” Percent Density Histogram

- > 25% of density test results below 92% G_{mm}



Lot Average Density Needed for PWL = 90%

- Most DOTs use PWL & with PWL of 90% = pay factor of 1.0 or 100%

- PWL Influenced By:
  - Average Lot Density
  - Density std. deviation
  - Specification Limits(s)

Lower Specification Limit (%G_{mm})	Target PWL (%)	Standard Deviation (σ)	Average Density Needed (%G_{mm})
92.0	90	0.75	*93.0*
		1.00	*93.2*
		1.25	*93.6*
92.5	90	0.75	*93.5*
		1.00	*93.8*
		1.25	*94.1*
93.0	90	0.75	*94.0*
		1.00	*94.3*
		1.25	*94.6*

TB1- Considerations for Improving Specifications

- Encourage minimum of five sublots per lot to balance buyer and seller risk
- Improve overall performance of asphalt pavements by minimizing in-place density test results less than 92.0 percent threshold
- Specification requirements for in-place density in twelve States play an important role in illustrating achieving minimal test results below the 92.0 percent threshold
- Understanding how lot average density and variability (σ) impact PWL is important for achieving desired PWL and Pay Factor

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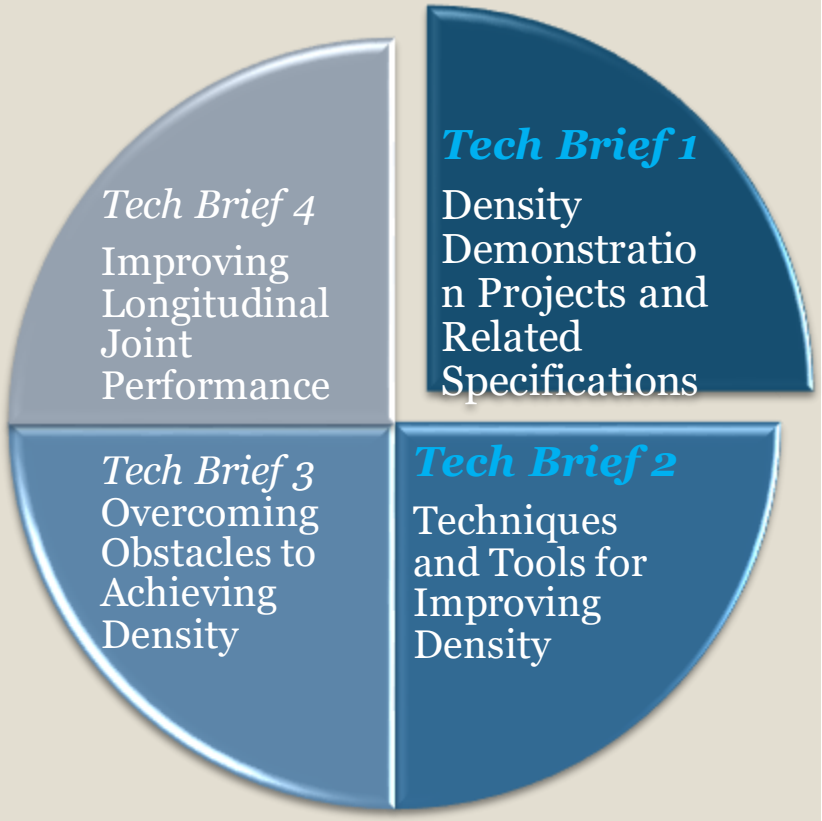

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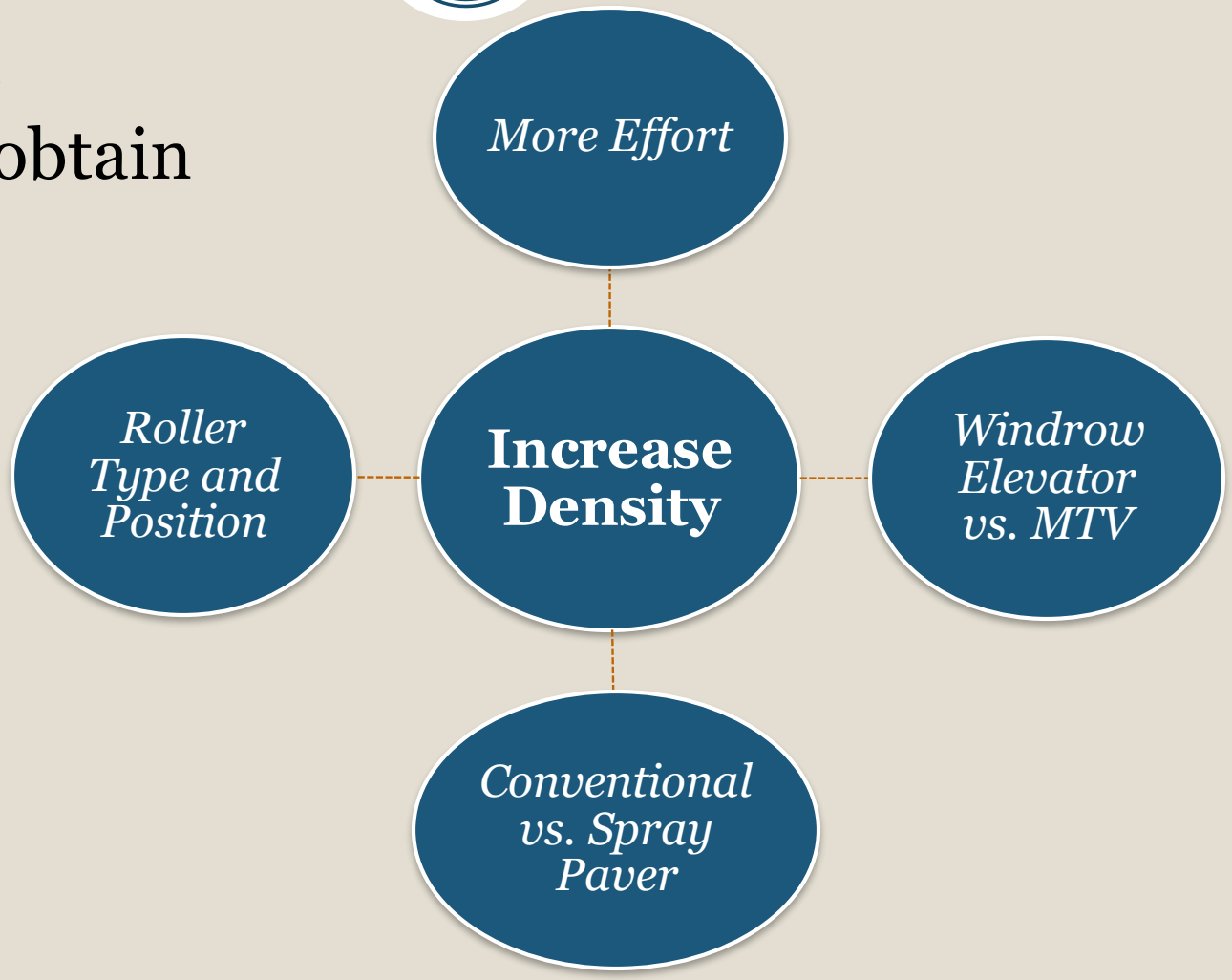
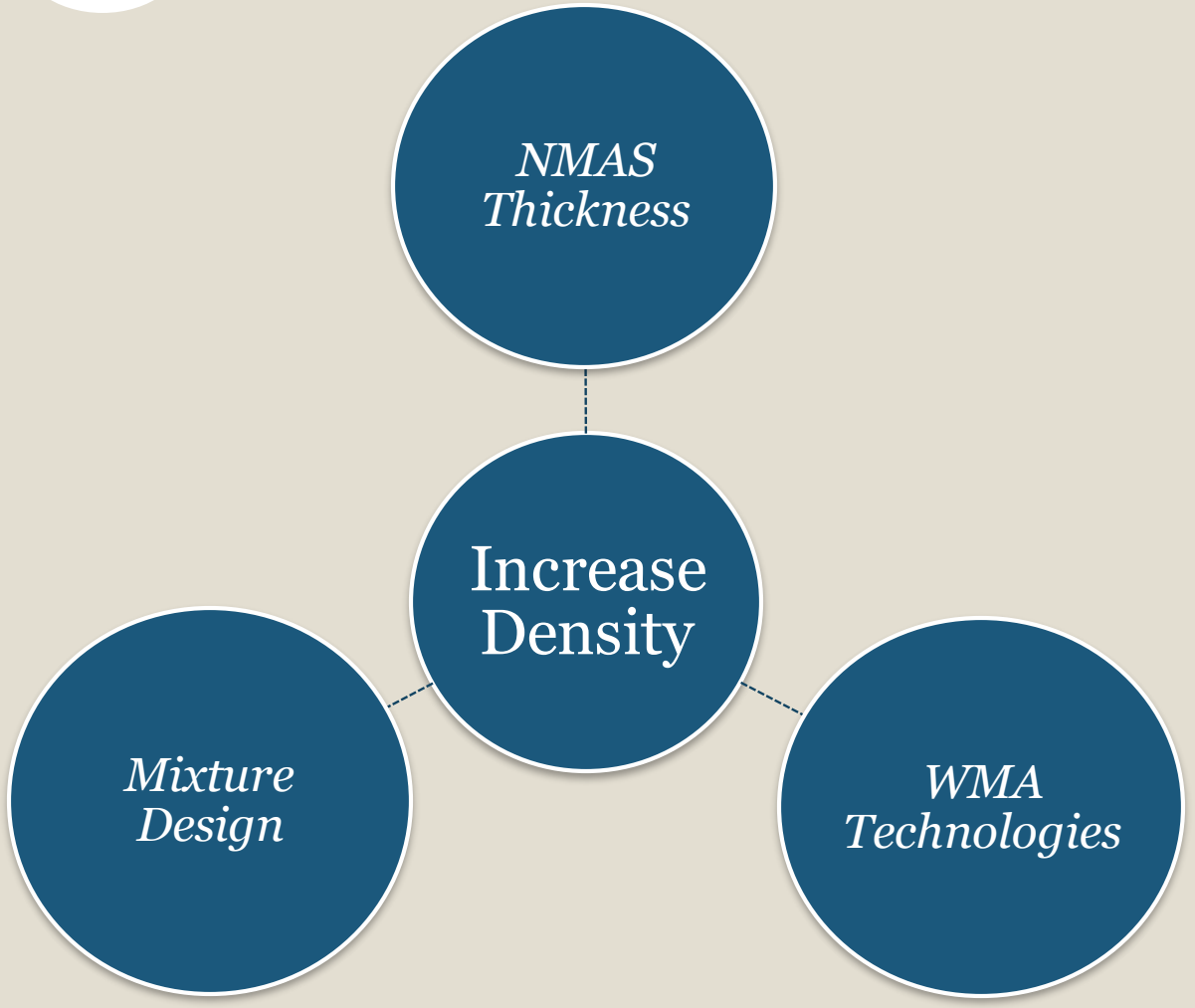
Changes Contractors Made in Demonstration Projects

Operational Changes
contractors made to obtain higher density:



Changes Agencies Made in Demonstration Projects

- Materials/Design changes made to obtain higher density:
  - Thickness to Nominal Maximum Aggregate Size (t/NMAS).
  - Increased Asphalt Content.
  - Warm-mix Asphalt (WMA) Technologies.



TB2 - Summary

- Several observations were made during the course of the demonstration projects related to the ability to achieve higher density
- With a sound asphalt mixture design that had appropriate asphalt content, achieving higher density was possible without extraordinary effort
- Using echelon breakdown and intermediate pneumatic rollers was effective
- In general, though not always, density increased with compactive effort.
- There was a trend for States to use smaller NMAS aggregates as there were few 19.0-mm NMAS mixtures and many more 12.5-mm. Many States were using or experimenting with 9.5-mm
- Many States made or planned density specification changes

Resources on Improving In-Place Density

- https://www.fhwa.dot.gov/pavement/asphalt/density/index.cfm

Thank You

Q & A

TECH BRIEF ID'S
FHWA-HIF-21-021 & FHWA-HIF-21-022
HTTPS://WWW.FHWA.DOT.GOV/PAVEMENT/ASPHALT/

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