2016 VAA Fall Conference

2016 Field Density Pilot Projects
VDOT perspective

October 4, 2016
Rob Crandol, P.E.
Assistant State Materials Engineer
Credit

Much of this content is credited to:

Bob Horan, PE & Greg Harder, PE

Asphalt Institute Regional Engineers
FHWA Density Demo – Virginia workshop July 13, 2016
• Interstate highways – 1956

• AASHO Road Test - 1958-62
  • still widely used for pavement design
  • legal truck load - 73,280 lbs.

• Legal load limit to 80,000 lbs. - 1982
  • 10% load increase
  • 40-50% greater stress to pavement

• Radial tires, higher contact pressure

• FAST Act raising load limit to 120,000 lbs. (in select locations)
Led to Rutting in 1980s

Courtesy of pavementinteractive.org
Which led to...Superpave

- Fixed the rutting problem
- Gyratory compaction lowered binder contents
- Add in higher and higher recycled materials
Improved Compaction = Improved Performance

A BAD mix with GOOD density out-performed a GOOD mix with POOR density for ride and rutting.

WesTrack Experiment
Durability Concerns

• SAPA’s, Asphalt Institute, NCAT, & NAPA all concerned with durability
  • Need for more binder in the mix

• Many DOT’s looking for ways to improve durability
  • Minimum binder contents
  • Optimize mix designs
  • Balance rutting with fatigue

• In the past, improved density was not typically being considered
Importance of Compaction

“Compaction is the single most important factor that affects pavement performance in terms of durability, fatigue life, resistance to deformation, strength and moisture damage.” – C. S. Hughes, NCHRP Synthesis 152, *Compaction of Asphalt Pavement*, (1989)

“The amount of air voids in an asphalt mixture is probably the single most important factor that affects performance throughout the life of an asphalt pavement. The voids are primarily controlled by asphalt content, compactive effort during construction, and additional compaction under traffic.” – E. R. Brown, NCAT Report No. 90-03, *Density of Asphalt Concrete—How Much is Needed?* (1990)
Effect of In-Place Voids on Life
Washington State DOT Study

Percent Service Life vs. In-situ Air Voids, %

- 7%: 93%
- 8%: 92%
- 9%: 91%
- 10%: 90%
- 11%: 89%

Graph shows a decrease in percent service life as in-situ air voids increase.
In-Place Voids vs Fatigue Life

**Effect of Percentage of Air Voids on Fatigue Life**

20°C, 500 microstrain

\[ N_f = -1361.88 \times AV^2 + 15723.35 \times AV + 88162 \]

\[ R^2 = 0.98 \]

**Fatigue Life, cycles** vs **Air Voids, %**

- **UK-AI Study**
  - 1.5% increase in density leads to 10% increase in fatigue life.
“A 1% decrease in air voids was estimated to improve the fatigue performance of asphalt pavements between 8.2 - 43.8%, to improve the rutting resistance by 7.3 - 66.3%, and to extend the service life by conservatively 10%.”
...and then there’s permeability

Permeability at the Longitudinal joint

Photo: Wes McNett
Permeability can be Catastrophic
Finer NMAS mixes generally less permeable at equivalent air void levels!

From NCAT Report 03-02
<table>
<thead>
<tr>
<th>Mix Size</th>
<th>Authors/Report</th>
<th>Year</th>
<th>Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm Mixes</td>
<td>E. Zube - California Dept. of Highways</td>
<td>1962</td>
<td>8.0</td>
</tr>
<tr>
<td>12.5 mm Mixes</td>
<td>B. Choubane, et al – Florida DOT</td>
<td>1998</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>J. Westerman – Arkansas HTD</td>
<td>1998</td>
<td>6</td>
</tr>
</tbody>
</table>

Critical Voids where permeable

9.5 mm Mixes

12.5 mm Mixes
“...to ensure that permeability is not a problem,

the in-place air voids should be between 6 and 7 percent or lower.

This appears to be true for a wide range of mixtures regardless of NMAS and grading.”
– NCHRP 531
2016 Pilot Specifications
Section 315 – Asphalt Placement

1. **Field compaction requirements:**
   - Slight increase in field density control strip requirements (all Superpave surfaces now 92.5%)
   - QC by contractor – still required roller pattern, control strips
   - QA / acceptance – done with plugs/cores (similar to SMA)

2. Incentive of up to 5% of unit bid price, per ton, for consistency. (*must be 100% pay, and have 80% of plugs from each sub-lot be 92.5 -96.5 % to receive bonus*)

   **Pilot projects only**
Paving and Asphalt Mix Quality

- 15 total Pilot Projects in 2016

Status as of early August:
- 2 projects eliminated: SMA (Staunton interstate)

- 13 remaining – only 8 underway as of early August*
  * all districts but NOVA & Staunton had at least one pilot job underway

- 8 underway – 5 projects in excess of 10,000 tons
## Pilot Projects
### (figures as of early August 2016)

<table>
<thead>
<tr>
<th>District</th>
<th># of Project</th>
<th>Project</th>
<th>Status</th>
<th>Tonnage as of 7/20</th>
<th>Total tons</th>
<th>% complete (pilot only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bristol</td>
<td>1</td>
<td>PM1F-961-F17</td>
<td>On-going</td>
<td>25,207</td>
<td>74,568</td>
<td>34 %</td>
</tr>
<tr>
<td>Salem</td>
<td>2</td>
<td>PM2H-033-F16, PM2L-009-F16</td>
<td>-</td>
<td>0, 5,583</td>
<td>18,743, 17,286</td>
<td>0 %, 32 %</td>
</tr>
<tr>
<td>Lynchburg</td>
<td>2</td>
<td>PM3E-041-F16, PM3F-071-F16</td>
<td>On-going, On-going</td>
<td>19,669, 2,198</td>
<td>35,928, 48,849</td>
<td>55 %, 4 %</td>
</tr>
<tr>
<td>Richmond</td>
<td>2</td>
<td>PM4A-042-F16, PM4E-042-F16</td>
<td>On-going, -</td>
<td>35,085, 0</td>
<td>36,604, 23,079</td>
<td>96 %, 0 %</td>
</tr>
<tr>
<td>Hampton Roads</td>
<td>3</td>
<td>PM5F-090-734, PM5H-114-F16, PM5P-091-F16</td>
<td>-</td>
<td>0, 4,099, 0</td>
<td>4,511, 15,452, 19,843</td>
<td>0 %, 27 %, 0 %</td>
</tr>
<tr>
<td>Fredericksburg</td>
<td>1</td>
<td>PM6B-966-F16</td>
<td>On-going</td>
<td>54,647</td>
<td>112,476</td>
<td>49 %</td>
</tr>
<tr>
<td>Culpeper</td>
<td>1</td>
<td>PM7E-967-F16</td>
<td>On-going</td>
<td>10,348</td>
<td>28,985</td>
<td>36 %</td>
</tr>
<tr>
<td>Staunton</td>
<td>2</td>
<td>PM8Q-085-F16, PM8T-968-F16</td>
<td>SMA + IM, SMA</td>
<td>6,715, 5,459</td>
<td>0</td>
<td>n/a</td>
</tr>
<tr>
<td>NOVA</td>
<td>1</td>
<td>PM9J-029-F16</td>
<td>-</td>
<td>0</td>
<td>32,673</td>
<td>0 %</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>156,836</td>
<td>468,997</td>
<td>33 %</td>
</tr>
</tbody>
</table>
Density Comparison: Regular vs Pilot

- Over 450 cores so far
- Limited data – only 27 cores so far

Reduction in low density readings in the field for pilot projects (the blue columns)!
• Positive density trend for pilot vs. regular jobs - Achieving higher average density (shifting the population higher), as well as minimizing population of lowest density ranges.

• Early feedback from the field is very positive - Achieving higher densities, while contractors realizing bonus incentive payments!
Full data analysis in late 2016

STAY TUNED!
And now........

A contractor’s experience with 2016 pilot density projects

Chris Blevins – W&L Construction