Maximizing the Service Life of Dense Graded Asphalt Mixes

David Lee, P.E. - ARAC Chair
Salem District Materials
OUTLINE

Evolution/History

Perceived Underperformance of Superpave Mixes

Task Force Developed to Initiate Potential Research

ARAC Supports Phased Process

Results from Phase I

Modified Phase II

Phase III
• Over 30 years, VDOT evolved from Marshall to SUPERPAVE Design Procedures

• Progressed from the S-Series, to SM-2 Series to the present SM-9.5/12.5 mixes

• Moved from AC-10/20/30/40 to PG 64-22, 70-22 and 76-22 in 1996/1997

• Full implementation of SUPERPAVE in 2000
INITIAL CHANGES TO NATIONAL SUPERPAVE APPROACH

Removal of gradation restricted zone
Adoption of 1 gyration level
Elimination of BM-37.5
OTHER MODIFICATIONS SINCE 2000

Permeability requirement for surface mixes
Minimum AC content for BM-25.0A and D
Increase in RAP percentage without binder change
Addition of SM-9.0 and SM-4.75
PERCIEVED UNDERPERFORMANCE OF SUPERPAVE MIXES

• There is a clear perception by both VDOT and Industry leaders that our present Superpave mixes do not have enough liquid asphalt content and, as such, are not lasting as long as they could.

• This perception is supported by some recent data suggesting that our mixes are lasting 1-3 years less than previously determined. (McGhee/Clark)

• Majority of failures occurring due to age related cracking/fatigue.

• 2010 Research Report by G. W. Maupin “Investigation of Optimized Mixture Design for Superpave Surface Mixtures” recommended additional research on the subject.
TASK FORCE MEMBERS

Kevin McGhee - VCTIR
Todd Rorrer – VDOT
David Lee – VDOT
Rob Crandol - VDOT
Trenton Clark – VAA
Richard Schreck - VAA
Ken Arthur – Templeton Paving
Dickie Mattox – Superior Paving
Brent Moore – Branscome Paving
RESEARCH QUESTION

- Are dense graded mixes designed with SUPERPAVE system providing consistently longer service life compared to previous mixes?

- Criteria for Life
  - Durable or Fatigue resistant
  - Rutting resistant
  - No flushing
  - Skid resistant (surface mixes)

- Research Objective – Maximize the service life of dense graded asphalt mixes
PHASED PROCESS SUPPORTED BY ARAC

Phase I – Superpave Designed Mix Analysis

- **Comparisons**
  - Volumetrics for 50 and 65 Gyrations
  - Volumetric results for 50 and 75 blow Marshall
- **Mix gradations**
- **Bag samples for future phases**
Phase 1 – Sampled Mixes

SM – 9.5 Mixes:
- Branscome Deepwater
- Branscome Hampton
- Templeton Mt. Athos
- Superior Stevensburg

SM 12.5 Mixes:
- LeeHy New Kent
- Branscome Hampton
- Superior Stafford
VTM – SM 9.5 Mixes

Superpave

Marshall
### VMA – SM 9.5 Mixes

<table>
<thead>
<tr>
<th></th>
<th>50</th>
<th>65</th>
<th>LP</th>
<th>50</th>
<th>75</th>
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<tr>
<td>SGC</td>
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<tr>
<td>Marshall</td>
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Min. (Sup. & Marshall)
VMA – SM 12.5 Mixes

Min. (Sup. & Marshall)
RESULTS FROM PHASE I

• VTM – Superpave Gyratory (SGC) produces approximately 2% lower VTM than the Marshall hammer.

• VMA – SGC produces approximately 1-2% lower VMA than the Marshall hammer.

• Review of the data did not produce a definitive “simple solution” (i.e., just reduce the number of gyrations).

• Seeking Results of Marshall Gradation in SGC.
Phase II (Modified) – Marshall Designed Mix Analysis

- **Comparisons**
  - Volumetric results for 50 and 75 blow Marshall
  - Volumetrics for 50 and 65 Gyrations

- **Mix gradations**
- **Bag samples for future phases**
Phase III – Research Laboratory Testing
Phase III

Evaluate performance of dense graded mixes based on different mix designs (Produced mixes in the field and laboratory mixes):

- Current Superpave (VDOT 65 gyrations) vs Marshall (50 blows)
- Effect of mix gradation: coarse vs. fine

Performance Tests (Laboratory):

- Dynamic modulus (Stiffness indicator)
- Flow number (Rutting indicator)
- Indirect tension strength (Cracking indicator)
## MIXES BEING EVALUATED

<table>
<thead>
<tr>
<th>Mix Designation</th>
<th>S-5</th>
<th>SM-2</th>
<th>SM9.5</th>
<th>SM9.5</th>
<th>SM9.5</th>
<th>SM9.5</th>
<th>North Carolina</th>
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<tbody>
<tr>
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<td>Laboratory</td>
<td>Laboratory</td>
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<td>Laboratory</td>
<td>Plant</td>
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<tr>
<td>Design</td>
<td>Marshall 50 blows 4.5% VTM</td>
<td>Superpave 65 gyrations 4% VTM</td>
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<td>binder</td>
<td>PG 64-22</td>
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<td>Aggregate</td>
<td>Superior and Branscome (2 sources)</td>
<td>Branscome</td>
<td>Superior</td>
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<td>RAP (%)</td>
<td>30</td>
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<td>As produced</td>
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<tr>
<td>3/8 Sieve</td>
<td>96%</td>
<td>88-90%</td>
<td>According to VDOT specifications</td>
<td>As produced</td>
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<td>#4 Sieve</td>
<td>Will be determined</td>
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<td>#30 Sieve</td>
<td>23%</td>
<td>21%</td>
<td>22%</td>
<td>28%</td>
<td>21%</td>
<td>28%</td>
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<tr>
<td>#200</td>
<td>6%</td>
<td>6%</td>
<td>5.2%</td>
<td>5.2%</td>
<td>As produced</td>
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Phase III Project Status

Testing of field produced mixes will start in the second half of February

Characterization of raw materials and field mixes is under way:

- Gradation and asphalt content of field mixes
- Gradation and asphalt content of RAP
- Gradation of virgin aggregates

Final Report due late Summer
The Bottom Line

• We know we need mixes that have a longer fatigue life to prolong the development of cracking.

• We know we need to ensure that any added AC does not lead to rutting or bleeding.

• We believe the aggregate gradations need to be tighter on certain sieves as well as the addition of one or more control sieves (#30) to combat mix tenderness and rutting.

• We know higher RAP is not a bad thing, but the overall mix must be considered to get the right AC and gradations.
RESOURCES

- VAA Contractor members for Phase I & II
- VCTIR for Phase III
- VDOT/VCTIR/VAA for data analysis during each phase