Importance of Controlling Segregation in All Asphalt Layers

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Asphalt Mixture Segregation

- What is it?
- What does it look like?
- How is it quantified?
- How does it affect pavement performance?
Segregation Defined

- I cannot define it, but I know it when I see it!
Segregation Defined

- “Separation of the coarse aggregate particles in the mix from the rest of the mass.”
  —Jim Scherocman, Asphalt Magazine

- “When segregation is present in a mixture, there is a concentration of coarse materials in some areas of the paved mat, while other areas contain a concentration of finer materials.”
  —Segregation, Causes and Cures, AASHTO
Segregation Defined

“Segregation is a lack of homogeneity in the hot mix asphalt constituents of the in-place mat of such a magnitude that there is a reasonable expectation of accelerated pavement distress(es).”
—NCHRP Report 441: Segregation in Hot Mix Asphalt Pavements
Segregation
Segregation Quantified

- Good luck!
- Visual “measurement”
- Change in gradation and asphalt binder content
- Mechanical measurements
  - Segregation can affect pavement performance
Pavement Design Assumptions

- Homogeneous material properties
- Isotropic layers
- Materials characterized by modulus value
Fatigue Cracking

Asphalt Mixture

Base Course

Subgrade

Tension

Compression
Rutting

HMA

Base Course

Subgrade
Segregation and Performance
# Mixture Property Reduction

<table>
<thead>
<tr>
<th>Mixture Property</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permeability</td>
<td>Increases with level of coarse segregation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic modulus</td>
<td>10-20%</td>
<td>20-30%</td>
<td>30-50%</td>
</tr>
<tr>
<td>Loss of fatigue life</td>
<td>38%</td>
<td>80%</td>
<td>99%</td>
</tr>
<tr>
<td>Rutting</td>
<td>No strong influence</td>
<td>Mixed results</td>
<td></td>
</tr>
</tbody>
</table>

Source: NCHRP Report 441
Using decreased mixture properties, the Pavement ME Design program was used to predict distresses
- 20-year design life
- Just over 11 million heavy trucks
- Columbus, Ohio weather
- Three pavement layers, 1.5 inches surface mixture, 2.5 inches intermediate mixture, 3.0 inches base mixture, over 10 inches of prepared A-6 subgrade
Segregation and Performance

- Five different scenarios
  - No segregation in any layers
  - Only surface layer segregation
  - Only intermediate layer segregation
  - Only base layer segregation
  - All three asphalt layers segregated
- Segregation represented by 40% modulus reduction, reduction in binder content, and increase in air voids
Pavement ME Design

- Total rutting, inches
- Asphalt mixture rutting, inches
- Bottom-up fatigue cracking, % lane area
- Top-down fatigue cracking, feet/mile
- Asphalt thermal cracking, feet/mile
- Terminal IRI, inches/mile
Predicted Rutting

- None: 0.73 inches
- Surface: 0.75 inches
- Intermediate: 0.83 inches
- Base: 0.77 inches
- All Layers: 0.89 inches

Total Rutting, inches
Predicted Fatigue Cracking

<table>
<thead>
<tr>
<th>Fatigue Cracking, %</th>
<th>None</th>
<th>Surface</th>
<th>Intermediate</th>
<th>Base</th>
<th>All Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21.7</td>
<td>23.2</td>
<td>22.9</td>
<td>69.8</td>
<td>82.1</td>
</tr>
</tbody>
</table>
Predicted IRI

IRI, inches/mile

- None: 166
- Surface: 185
- Intermediate: 171
- Base: 193
- All Layers: 219
## Predicted Pavement Distress

<table>
<thead>
<tr>
<th>Segregation Case</th>
<th>Rutting Increase, %</th>
<th>Fatigue Cracking Increase, %</th>
<th>IRI Increase, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>2.7</td>
<td>6.9</td>
<td>11.5</td>
</tr>
<tr>
<td>Intermediate</td>
<td>13.7</td>
<td>5.3</td>
<td>3.1</td>
</tr>
<tr>
<td>Base</td>
<td>5.5</td>
<td>221.3</td>
<td>16.5</td>
</tr>
<tr>
<td>All layers</td>
<td>21.9</td>
<td>277.9</td>
<td>32.2</td>
</tr>
</tbody>
</table>
Predicted Pavement Life

- Rutting Life
- IRI Life
- Fatigue Cracking Life

Categories: None, Surface, Intermediate, Base, All Layers
Summary

- Uniformity in all layers is important
- Lack of density and permeability can greatly affect asphalt mixture performance
- Lack of uniformity in any layer can increase likelihood of distresses and decrease pavement life
Thank You!