Setting Asphalt Content
For Hot Mix Asphalt

How Much Is Enough?
How Much Is Too Little?

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Composite Material
Rut Resistance
Proportions of Material
Asphalt Content / Imposed Strain
Durability
Environmental Cracking
High Permeability
Leading Cause of Death??

- Rutting
  - ✗
- Cracking
  - ✔
Current Durability Concerns

- Mostly Cracking
  - Random and Block Cracking
  - Top Down Cracking
- Some raveling
- Some moisture damage
- Longitudinal Joints continue to be Concern
1960s Age of Cracking

* Strong Emphasis on Cracking

  * Related to Structural Design
    * AASHO Road Test

  * Development of Beam Fatigue Test
1980s Age of Rutting

* National Catastrophe

* Blamed on Asphalt Quality
  * “Taken all the goodies out of asphalt.”

* Led to Strategic Highway Research Program

Superpave
1990s – 2000s

* Implementation of Superpave

* Higher Stiffness Asphalt Binder
  * AC20 (PG64ish)
  * AC10 (PG58ish)
  * PG 70 and PG 76 become more common

* Improved Aggregate Requirements
1990s – 2000s cont’d

* Improved Density Specification
  * “End Result Specifications”
  * 10 to 12% voids moved to 7 to 9% voids

* Volumetric Acceptance
  * Instead of asphalt content and gradation
Rutting became Non-Issue (less of an issue)

Cracking has become the ISSUE
What’s Changed?
Changes since 1990s

- Shift from Agency to Industry
  - Design, Production and Control shifted to Industry
  - Contractor Mix Design
  - Plant Settings done by Contractor
Changes since 1990s cont’d

* Increased Use of RAP

* Introduction of Shingles
  * Very limited in 1990s
  * Today
    * Commonly used in many States
Asphalt Binder Additives

- Recycled Engine Oil Bottoms
  - Mostly used for Lower Temperature Grades
- Reported to cause cracking
  - Investigations continue
Changes since 1990s cont’d

* Asphalt Binder Additives
  * Polyphosphoric Acid
    * Common in early 2000s
  * Polymer Modified Become More Common
    * SBS was most common (only) polymer used
    * Modified Asphalt was relatively new
What Caused Cracking?

What are people saying?
“Causes of Cracking”

- Too much RAP
- Need to limit (ban) RAS
- REOB is cause
- Asphalt mixes are “Too Dry”
Reduce design gyrations

**Wrong**

- True only IF gradation is held constant AND gyrations are reduced
  - VMA will increase
  - 25 gyrations ≈ 1.0% VMA
- BUT gradation is not a design criteria
Common “Solutions” to Increase Asphalt Content

* Reduce design air voids
  * i.e. 3.0% air voids would increase asphalt content 0.4%

**Maybe**

* BUT
  * Make sure controls are in place to hold VMA at the previous design levels.
  * Otherwise change gradation and reduce air voids without increasing asphalt content.
Common “Solutions” to Increase Asphalt Content

* Increase design VMA criteria
  * 1.0% VMA ≈ 0.4% asphalt content

* The only real way to increase asphalt content.
* Increasing VMA will increase
  * Total asphalt content
  * Effective asphalt content
Common “Solutions” to Increase Asphalt Content

* Require use of fine-graded mixes
  * “Contractors are designing their mixes on coarse side to reduce the amount of asphalt they need.”

* Asphalt content is set on basis of VMA minus air voids plus absorbed asphalt.
Use deduct factor for RAP and RAS
  * i.e. for RAS set binder content at 70% of RAS binder
  * “Reduces the amount of RAS binder”

Wrong

* i.e. 12% asphalt binder replacement desired from RAS
* With 100% contribution
  * 3% RAS with 20% asphalt binder
    * RAS binder is 0.6%
    * Total Binder is 5.0%
With 70% contribution

- Percent RAS increased
  - 4.3% RAS added
  - $0.7 \times 0.86\%$ RAS binder $= 0.6\%$
  - Virgin binder 4.4%
  - “Total” binder $= 5.0\%$

- Perceived ABR $= 12\%$

- Actual ABR $= \frac{0.86}{5.26} = 16.3\%$
How Much Asphalt is Enough?

* Two Part Answer
  * Asphalt on Outside of Aggregate
  * Asphalt Absorbed into Aggregate
How Much Asphalt is Enough?

* Asphalt Outside of Rock
  * Based on Volume

<table>
<thead>
<tr>
<th></th>
<th>9.5-mm</th>
<th>12.5-mm</th>
<th>19.0-mm</th>
<th>25.0-mm</th>
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<tbody>
<tr>
<td>Percent by Volume</td>
<td>11.0%</td>
<td>10.0%</td>
<td>9.0%</td>
<td>8.0%</td>
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<tr>
<td>Percent by Weight</td>
<td>4.4%</td>
<td>4.0%</td>
<td>3.6%</td>
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How Much Asphalt is Enough?

Asphalt Inside of Rock
- Depends on Absorption

<table>
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<tr>
<th>Aggregate Water Absorption</th>
<th>1.0%</th>
<th>2.0%</th>
<th>3.0%</th>
<th>4.0%</th>
<th>5.0%</th>
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<tbody>
<tr>
<td>Asphalt Percent by Weight</td>
<td>0.5%</td>
<td>1.2%</td>
<td>1.9%</td>
<td>3.0%</td>
<td>4.0%</td>
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How Much Asphalt is Enough?

* Total Asphalt Content
  * Inside Rock
  * Outside Rock

These values are approximate and will vary depending upon specific gravity of aggregates and actual absorption

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<th>19.0-mm</th>
<th>25.0-mm</th>
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<tbody>
<tr>
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<td>4.9%</td>
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THANK YOU