RECLAIMED ASPHALT SHINGLES

Current Status of Use in U.S.A.

Gerry Huber
Current Use

* 1,100,000 tons (2010)
* 1,200,000 tons (2011)

* Manufacture waste
* Post Consumer (tear off)
Asphalt Shingle Availability

* Supply
  * Manufacture Waste 1,000,000 tons
  * Post Consumer (tear off) 10,000,000 tons

* Use
  * 1,200,000 tons
RAS Use by Customers

2011

Tons (1,000’s)
- DOT: 454
- Other Agency: 372
- Commercial and Residential: 366
Geographic Distribution of RAS Use

Table:

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>Yes</td>
<td>22</td>
<td>32</td>
</tr>
<tr>
<td>N.R.</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Legend:
- Red: Not reported any year
- Light Red: Reported previous year but not 2011
- Green: 2011
Greenhouse Gas Emissions, U.S. EPA

Why Use Shingles?

- Shingles contain:
  - Asphalt binder
  - Tear-offs: 25 – 30% binder
  - Manufacture waste: 18 – 22% binder
  - Mineral matter
    - 40 to 60%
    - granules and fillers
  - Fibers
    - 8 to 12%

- Shingles Theoretical value
  - Asphalt binder
    - $125 / ton
  - Mineral aggregates
    - $15 / ton

- Cost
  - Sorting
  - Shredding
    - $25 / ton
Positive Economics

- Material Replacement
  - Liquid asphalt
  - Aggregates
  - Fibers

- Net materials savings
  - $3 to $6 per ton of mix
Use of Reclaimed Asphalt Shingle in HMA

- Standard definitions for RAS
- RAS to be processed
  - 100% passing 12.5-mm sieve
  - Allows blending of RAS with fine aggregate
    - Prevent agglomeration
- Addresses deleterious materials
* Design Considerations when Using Reclaimed Asphalt Shingles in New HMA

* Design considerations
  * RAS size can affect the fraction of RAS binder that contribute to the final blended binder
  * fibers in RAS may require additional virgin asphalt binder
Previous Grind Specification
Finer Grind
RAS Asphalt Binder Availability

- AASHTO PP 53, Section 6
- Volumetric design w/o shingles
  - Virgin asphalt content
- Add Shingles to design
  - Asphalt content increases

- 5.8%
  - 5.45% virgin
  - 1.55% RAS
- 6.9%
Calculate Availability (Initial)

\[ F_c = \frac{P_{bv} - P_{bvr}}{(P_{sr})(P_{br})} \]

- Virgin Asphalt no Shingles
- Virgin Asphalt with Shingles
- Initial Estimate Contribution
- Percent of Shingles
- Asphalt Content of Shingles
Calculate Availability (Initial)

\[ F_c = \frac{P_{bv} - P_{bvr}}{(P_{sr})(P_{br})} \]

- 5.45%
- 5.8%
- 28%
- 5.0%
- 30.6%
Final Estimate of Asphalt Binder Availability

* Section 6.2.6
  * True availability factor is always greater than the estimated value.
  * True value defined calculated in Equation 2

\[ F = 100 \left( \frac{1 + F_c}{2} \right) \]
Section 6.2.6

WHAT’S WRONG?

True value defined calculated by Equation 2:

\[ F = 100 \left( \frac{1 + F_c}{2} \right) \]
Experiment

* Design mixture with no shingles
* Add shingles (with full asphalt content)
  * Calculate VMA and air voids
* Add shingles (with half normal asphalt content)
  * Calculate VMA and air voids
* Add shingles (with no asphalt content)
  * Calculate VMA and air voids
## Properties of Shingles in Study

<table>
<thead>
<tr>
<th>Source</th>
<th>Maximum Specific Gravity, $G_{mm}$</th>
<th>Average Asphalt Content, %</th>
<th>Effective Specific Gravity of the Aggregate, $G_{se}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago MW</td>
<td>2.204</td>
<td>19.0</td>
<td>2.615</td>
</tr>
<tr>
<td>Indianapolis TOS</td>
<td>1.908</td>
<td>23.2</td>
<td>2.573</td>
</tr>
<tr>
<td>Stockton TOS</td>
<td>1.779</td>
<td>30.6</td>
<td>2.619</td>
</tr>
</tbody>
</table>
Design with Stockton Shingles

<table>
<thead>
<tr>
<th>Mix Design Material Blend</th>
<th>Virgin Blend</th>
<th>100% Extracted RAS</th>
<th>50% Extracted RAS</th>
<th>0% Extracted RAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>% AC Virgin</td>
<td>5.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% RAS AC</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% AC, Total</td>
<td>5.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMA, %</td>
<td>15.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Voids, %</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Add Asphalt for 4% Air Voids
Calculate Availability

\[ F_c = \frac{P_{bv} - P_{bvr}}{(P_{sr})(P_{br})} \]  *Initial*

\[ F = 100 \left( \frac{1 + F_c}{2} \right) \]  *Final*
Indianapolis Asphalt Binder Availability, %

- RAS Non Extracted
- RAS 50% Extracted
- RAS 100% Extracted
Chicago Asphalt Binder Availability, %

- 140.0%
- 120.0%
- 100.0%
- 80.0%
- 60.0%
- 40.0%
- 20.0%
- 0.0%

- RAS Non Extracted
- RAS 50% Extracted
- RAS 100% Extracted
Finding

* “Asphalt Binder Availability” not related to asphalt binder properties
  * Dependent on mineral matter in shingles
  * Dependent on %AC in the RAS
* Worst for manufacture waste
Next Steps

* Change PP53
  * Remove asphalt binder availability method
    * Replace with user defined value
  * Require finer grind

* Balloted December 2013
NCHRP 9-55 Study

* Recycled Asphalt Shingles in Asphalt Mixtures with Warm Mix Technologies
  * Started June 2013
  * To be completed September 2016
* Evaluate characteristics of RAS
* Minimize risk of poor durability
Determine effect of shingle asphalt binder on asphalt mix performance properties

- Fatigue
- Low Temperature Cracking
Outcome??

* Set design guidelines for performance
  * Grade of new asphalt binder?
    * Maximum asphalt binder ratio?
  * Finer grind size?
    * Homogeneity of the blend
Summary

* RAS Use is Increasing
* Positive Greenhouse Gas Benefits
* Driven by Economics
* Current AASHTO Specifications Updated
* NCHRP Study to Address Design Method
RAP and RAS
Green As The Wind

Thanks