Best Practices for RAP Management

60th Annual Asphalt Paving Conference
Asphalt Pavement Association of Michigan
March 29, 2016
Kalamazoo, MI
Outline

- Current RAP usage and practices
- Motivations for using RAP
- Benefits of milling
- RAP processing guidelines
- Sampling & testing
- Producing mixes with RAP
Estimates of RAP Usage

- NAPA surveys estimate that the national average RAP content slowly increased from 16.2% in 2009 to 20.4% in 2014.
  - RAP contents tend to be higher in commercial projects compared to government projects.
- RAP usage varies considerably from state to state.
Average RAP contents by state

2009

2010

2011

2012

2013

2014

Average RAP %

NCR  No Cos. Reporting  < 3 Cos. Reporting  0–9  10–14  15–19  20–29  ≥ 30

NAPA IS 138, 2015
Motivations for Higher RAP Contents

- Economic savings
- Environmental & Sustainability benefits
Recycling Economics Example

![Graph showing materials savings vs %RAP.

Materials Savings $/ton

%RAP

$0 $2.00 $4.00 $6.00 $8.00 $10.00 $12.00 $14.00 $16.00 $18.00 $20.00

$600 $500 $400

0% 10% 20% 30% 40% 50% 60%]
Conservation of Materials

At an average RAP content of 20%, we conserve over 66 million tons of aggregate and 9 million barrels of asphalt each year.
The average RAP content in Japan is 47%
Current RAP Practices

- In most (not all) places across the USA...
  - Project millings become property of contractor
  - Urban contractors have excess supplies of RAP
- RAP Management Best Practices
  - Inventory analysis
  - RAP processing options
  - Quality Control
  - Production concerns
Benefits of Milling

- Removes distressed pavement layers
- Helps improve pavement smoothness and cross-slopes
- Maintains curb heights, drainage inlets, and bridge clearances
- Creates a rough texture that bonds better with the overlay
Coring Projects as a Routine Part of the Rehabilitation Approach

- Use to determine which layers are damaged
- Set milling/rehabilitation depth
- Use cores to determine asphalt content of layers to be removed
Identifying Causes and Extent of Pavement Distress
Coring to evaluate damaged layers

- Stripping
- Reflection cracking
- Top-down cracking
- Poorly bonded layers
Scabbed Layer Left After Milling

Photo courtesy of Jim Scherocman
Milling for Success

- The primary reasons for milling is to remove distressed pavement layers and restore a good profile for the overlay.
- Examine cores to assess the competency of existing layers. Set the milling depth to remove damaged layers and to avoid leaving thin layers that are likely to scab.
Inventory Management

- RAP inventory, RAP usage, RAP supply
- Analysis of barriers to higher RAP contents
Inventory Management

Single source millings

Multiple source RAP stockpile

Separating stockpiles from single sources or combining all RAP into a multiple source stockpile for later processing
Avoid Contamination

It is vital to prevent dumping of any deleterious materials in the stockpiles from the beginning.

Clearly instruct all truck drivers hauling materials to the yard where to dump different types of materials.
It is considered a best practice *not* to further crush millings, but to use it “as is” in mix designs. It is still necessary to screen the millings to remove oversized particles.
Multi-Source RAP

- Multisource piles can be an agglomeration of materials from milled projects, pavement rubble, rejected mix, and plant waste.
- It should be obvious, but unprocessed multi-source RAP stockpiles are not suitable for use in new mixes.
Stockpiling and Processing RAP

Build in layers.

Don't push over edge of slope.

Excavate through layers to feed crusher.

Feed loader from side of stockpile, working up through layers.
Fractionating RAP
Should You Fractionate RAP?

If you answer “yes” to the following six questions, you should consider fractionating RAP.

1. Can your plant produce mixes containing ≥30% RAP without emissions problems or significant decline in production rate?
2. Does the market this plant supplies allow RAP contents above 30%?
3. Does your plant have an excess amount of RAP?
4. Do you have difficulty meeting mix design requirements such as minimum VMA, dust proportion or $P_{0.075}$ content?
5. Do you have trouble keeping RAP mixes within quality control and acceptance limits?
6. Does your plant site have enough additional stockpile area for a RAP fractionation plant?
Sampling RAP

- The goal of sampling RAP is to obtain representative samples for evaluating materials properties.
- Samples are needed from throughout the stockpile to assess variability. A minimum sampling frequency of 1 per 1000 tons with a minimum of 10 samples is strongly recommended.
Sampling RAP

Photos courtesy of Tim Murphy
Obtain samples from RAP stockpile

- 10 or more samples
  - Ignition method or Solvent extraction tests
    - gradations
    - asphalt contents
  - Combine samples for $G_{sb}$ and other aggregate tests
    - Determine averages and standard deviations of properties
    - Determine the appropriate RAP content based on the properties

- At least one sample
  - Extract and recover the RAP binder
    - Determine the true grade of RAP binder

Necessary for RAP contents above 25%
Summary & Analysis of RAP Data

Calculate average and standard deviation of asphalt contents, gradations, and estimated $G_{sb}$

<table>
<thead>
<tr>
<th>RAP property</th>
<th>Max. Standard Deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Content</td>
<td>0.5</td>
</tr>
<tr>
<td>% Passing Median Sieve</td>
<td>5.0</td>
</tr>
<tr>
<td>% Passing 75 micron Sieve</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Compare to these recommended tolerances
Producing Mixes with RAP

- Covered stockpile to control moisture
- RAP bin grate to remove chunks that can clog the feed
- RAP screen to remove oversized particles
- Steep-sided RAP bin for better flow onto feeder belt
Producing Mixes with RAP

Two RAP bins for fractionated RAP

In-line RAP crusher

In-line RAP crusher

Effects of Superheating
Effect of RAP Moisture on Superheating Temperature

Assumes 10°F loss from dryer to pugmill, 70°F outside air temp.

Astec T-127
Thank You!