Estimating the Low Temperature PG-Grade of Binders in RAP without Extraction

Hussain U. Bahia, Tao Ma, Emil Bautista
University of Wisconsin

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Outline

• Relevance
• Testing Procedure
• Analysis Spreadsheet
• Next steps
Research Needs

- Modulus of RAP Mixes
- Fatigue Concerns
- Final Effective Binder Grade
- Performance of High RAP Mixes
- Need to Bump Binder Grade
- How to Better Control RAP - Fractionating
New Terminology

• **RAP**: Reclaimed asphalt pavement materials;
  - *Selective RAP (SRAP)*: sieved RAP material passing #8 sieve retained on single sieve or different sieves combined according to fixed gradation;
  - *PAV RAP (PRAP)*: consists of the aggregates extracted from SRAP mixed with PAV binder according to the same gradation and AC with SRAP;

• **Binders (B):**
  - *Fresh binder (FB)*: original asphalt binder not exposed to any aging process;
  - *SRAP binder (SB)*: aged binder in SRAP;
  - *PAV binder (PB)*: asphalt binder subjected to aged process of RTFO+PAV;
  - *Blended binder (BB)*: SRAP binder blended with fresh binder or PAV binder;

• **Mortar (M)**: RAP mixed with binder
  - *PAV mortar (PM)*: PAV RAP mixed with PAV binder by weight percentage;
  - *SRAP mortar (SM)*: SRAP mixed with PAV binder by weight percentage;
1. Evaluate the selected binder properties

2. Evaluate the compositions of selective RAP
   2.1 For each source, extract and determine the gradation the RAP aggregates from the selective RAP;
   2.2. Determine the selective RAP binder content for each RAP source material;

   • Evaluate mortar properties
   • Mix the SRAP and/ or extracted selective RAP aggregates with selected binder to get mortar with fixed gradation and binder content;
   • Evaluate the properties of the mortar in the BBR.
Mold Modification

1. Wider Sample
   12.5 x 10.0 mm
2. Teflon coated
3. Stronger end holders
First Approach: Test Mortars, Correlate to Binder

- From Fresh RAP: \( y = 0.796x + 1.8489 \)
  \[ R^2 = 1 \]
- From 2PAV RAP: \( y = 0.7204x + 1.8897 \)
  \[ R^2 = 0.9996 \]
First Approach: Use Blending Chart to Estimate RAP Binder Grade
Many Problems

- Correlations vary
- Highly temperature dependent
- RAP mortars very hard to control molding
- Blending charts do not work for all loading times
Example of the problem
New Approach

- Selective RAP to control molding
  - # 30, #50, #100
- Use PAV aged binder for blending
  - Can test at same temp as mortar
- Use more PAV binder to make molding better
- New analysis procedure avoiding blending charts and focus on S(60), m(60).
- It appears to be working based on verification
<table>
<thead>
<tr>
<th>Time (s)</th>
<th>2PAV</th>
<th>Fresh</th>
<th>Blended with 51.2% of fresh</th>
<th>Blended with 74.9% of fresh</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Calculated</td>
<td>Tested</td>
</tr>
<tr>
<td>8</td>
<td>55.6</td>
<td>10.9</td>
<td>24.2</td>
<td>23.6</td>
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<td>44.0</td>
<td>6.9</td>
<td>17.1</td>
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<td>13.6</td>
<td>0.8</td>
<td>3.1</td>
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</table>
The blending concept
New binder is a PG 70-16 (TG PG70-20)