2012 Western States Regional In-Place Recycling Conference

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Steven Escobar & Bob Staugaard
Asphalt Pavement & Recycling Technologies, Inc.
• In-Place Recycling – Key Aspects for Mix Designs:

1. Cold-In-Place Recycling
2. Hot-In-Place Recycling
3. Full-Depth-Recycling
1. Cores are sawed to proper depth of recycle.
2. Visual Inspection during sawing, crushing and sieving of cores can detect any potential problems in the mix.
<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Medium</th>
<th>Coarse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>3/4”</td>
<td>95 ± 2</td>
<td>85 ± 2</td>
</tr>
<tr>
<td># 4</td>
<td>50 ± 2</td>
<td>40 ± 2</td>
</tr>
<tr>
<td># 30</td>
<td>10 ± 2</td>
<td>5 ± 2</td>
</tr>
<tr>
<td>#200</td>
<td>0.8 ± 0.3</td>
<td>0.3 ± 0.3</td>
</tr>
</tbody>
</table>
Key Aspects:

1. Need representative samples of entire project.
2. Visual inspection of all cores for design.
   - Fabric
   - Asphalt Rubber/Polymer Modified
   - Road Mix (Liquid Asphalt Mixes)
3. Check base material for stability.
CIR Mix Design

- Mix Design Parameters:
  - Marshall Retained Stability – 70.0% minimum. (60% min. if Wet Stability > 1500 lbs.)
- Ratio of Emulsion Residue to Cement – 3.0 minimum.
- Raveling Test – 7.0% target value.
- Coating test for ERA - Good
CIR Mix Design

- Other Considerations:
  - Just in time training (JITT)
  - Emulsified Recycling Agent (ERA)
    Asphalt binder used to make ERA must meet bending beam requirements of AASHTO M320. Verifying low temperature requirements where the RAC is placed.
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• Hot-In-Place Recycling
1. Determine the AC content & recovered binder properties (PG, viscosity, or pen) from RAP.

2. Determine gradation on recovered aggregate.

3. Use blending chart & selected recycling agent (ASTM D4552/D4552M) to obtain appropriate consistency for the climatic conditions of job.
HIR Mix Designs - Key Aspects

4. Prepare blends with recovered binder & RA to target (blend chart) $\pm 25\%$ (RA). Determine consistency.

5. Prepare mixes with RAP & RA to above targets. If gradation needs adjustments or additional mix is required for thickness, incorporate all components. Use temperatures normally obtained in the field for mixing and compacting.

6. Determine stability and air voids.
Full-Depth-Reclamation
1. FDR-Asphalt Emulsion
2. FDR-Portland Cement
3. FDR-Lime Stabilization
4. FDR-Fly Ash
5. FDR-Cold Foam
FDR-Emulsion-Mix Design

• Similar to CIR but usually thicker depths:
• 3-15”.
• 3-4 components: RAP, Base/Sub base & blend of components.
FDR Emulsion-Mix Design

• Requirements separated by the fines content (p #200 sieve): < or ≥ 8%.
• Optimum Water Content key test: Amount of water to add depend on annual rainfall, < or > 20 inches & Sand Equivalent, > or < 30.
• Indirect Tensile Strength (ASTM D4867) - dry & conditioned.
FDR-Emulsion-Mix Design

• Resilient Modulus may be too sophisticated for this use. ASTM D4123 –Discontinued. Limited labs. to run ASTM D7369 which causes time delay in getting design done.

• Suggest using Marshall Stability for correlation with CIR values.

• Thermal Cracking (IDT)-AASHTO T322. Should be used in climatic zones < -20°C.
FDR-Emulsion-Mix Design

- Emulsion content range = 3.5-5.5w%.
- Major effort is getting uniformity of all components for mix design. Variation in sample location very common.
FDR-Cement Mix Design

• FDR-Cement:
• Compressive Strength-7 days @ 95% Humidity.
• Wet/Dry Strengths for durability.
• Wide variations among specifications on amount of cement, compressive strength targets.
FDR-Mix Designs

• No *uniformity* among FDR Mix Designs.
• Need to simplify testing procedures to have more practical approach.
• The strength of any FDR is mass or volume of layer being placed.
Thank you!

Questions?