Innovations in Recycled Asphalt Pavement (RAP)

“The Roads to the Future are Paved with Recycled Materials”

Rocky Mountain West Pavement Preservation Partnership

October 21st, 2015

James Emerson, APM
Pavement Recycling Systems, Inc.
What We Know

- Asphalt has always been Recyclable. #2 in world after Water
- Valuable material in Hot Mix Asphalt
- Used when and where feasible

How do we expand on the value?
Reclaimed Asphalt Pavement

The Need

- Some of the best aggregates are in our roads.
- Increasingly difficult to open new pits.
Expanding Recycled Asphalt

- **Cost Effect**
  - Shrinking budgets equal fewer asphalt overlay projects
  - Useable in asphalt paving projects “remove and replace”
  - Useable in Pavement Preservation
    - Central Plant Recycling
    - Slurry Seal
    - Chip Seals

- **High Quality/Perform Excellent**
  - Many cases out performs native aggregates
  - Neutral charge, works great with all emulsions/binders
  - Natural “black aggregate”
  - Quality “legacy” asphalt binders
RAP Management

- Products
  - Typical uses
  - Innovative uses
- Methods of Management
  - On Site Methods
  - Contract Methods
- Best Practices
Products

Typical Uses

- RAP Base
- Shoulder Backing
- Trucking yards
- Dust Control
- Crushed Miscellaneous Base

Is this the only use of such a valuable asset?
Valuable RAP Products

- RAP CCPR Asphalt Pavement
- RAP Terminal Blend Rubber Chip seals
- RAP chip, Scrub Seals
- RAP Slurry, RAP Micro Surfacing
- RAP Crack Fill Aggregates
- RAP Base
- RAP Shoulder Backing
- Crushed Miscellaneous Base
- RAP Haul Roads
- RAP Dust Control
Products
Cold Central Plant Recycling (CCPR)

Clean Rap = New Pavement:

- Stockpiled and kept clean
- Crushed RAP to specific gradation
- Mixed with engineered emulsion or foamed asphalt per mix design in a central plant close to project
- Transported to lay down area
- Paved as a recycled mix
- Compacted to specified density
- Readied for surface treatment
- Reduced carbon footprint
- Reduced truck traffic
- Reuse agency asphalt assets
Recycle Your Asphalt on Site!

Urban Quarry!

Value Engineered
City Of Menifee Newport Road
3” CCPR over 10” FDR Cement
Manheim Auto Auction 1-Million Square Feet 100% Recycled Asphalt
Modesto Shopping Mall 800,000 Square Feet 100% Recycled Asphalt

Value Engineered
RAP Products

Chip Seals
# RAP Chip Gradation

## TABLE 200-1.2.1 (A)

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing¹</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Medium 3/8”</td>
<td>Medium Fine 5/16”</td>
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<tr>
<td>1/2” (12.5 mm)</td>
<td>100</td>
<td></td>
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<tr>
<td>3/8” (9.5 mm)</td>
<td>85-100</td>
<td>100</td>
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<tr>
<td>No. 4 (4.75mm)</td>
<td>0-15</td>
<td>0-50</td>
<td></td>
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<tr>
<td>No. 8 (2.36 mm)</td>
<td>0-5</td>
<td>0-15</td>
<td></td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>-</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>No. 200 (75 um)</td>
<td>0-2</td>
<td>0-2</td>
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<tr>
<td>Residual Asphalt Content²</td>
<td>3.5% Min.</td>
<td>3.5% Min.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Based on dry weight of aggregate)</td>
<td>(Based on dry weight of aggregate)</td>
<td></td>
</tr>
</tbody>
</table>

¹ On unextracted RAP.  ² On extracted RAP. Determined by CT362, CT379 or CT382.
RAP Chip Material

Residual Asphalt

Chips
Single stones and conglomerations
Residual asphalt content will vary by sample
Laboratory Tests on Chip

- Los Angeles Abrasion (ASTM C 131)
  - 5% Loss - 100 Revolutions
  - 23% Loss - 500 Revolutions

- Cleanness Value: 58 (Cal 227)
  - Spec is 75 minimum
  - But not an issue

### Sieve Analysis:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Ave.</th>
<th>Extracted</th>
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<tbody>
<tr>
<td><strong>3/8”</strong></td>
<td>100</td>
<td>100</td>
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<td>100</td>
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<tr>
<td><strong>No. 4</strong></td>
<td>37</td>
<td>42</td>
<td>38</td>
<td>39</td>
<td>51</td>
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<tr>
<td><strong>No. 8</strong></td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>18</td>
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<td><strong>No. 16</strong></td>
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<td>4</td>
<td>4</td>
<td>14</td>
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<tr>
<td><strong>No. 30</strong></td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>12</td>
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<tr>
<td><strong>No. 200</strong></td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>6</td>
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<td><strong>Asphalt Cont.</strong></td>
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<td></td>
<td></td>
<td></td>
<td>3.9</td>
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</tbody>
</table>
RAP Chips 3/8”, 5/16”

Appearance is dirty but the dust is actually asphalt dust. Bonding capability is outstanding.
RAP Chip Seal San Bernardino County
El Rivino Road 2006 5/15” Chips

Before
After 8 years later
RAP Chip Scrub Seal Los Angeles County 2009 Avenue J

Scrub seal with polymer modified rejuvenating emulsion

Extensive block cracking and alligator cracking
RAP Chip Scrub Seal

Hand applied additional RAP chips to low areas

Rain fell that night
RAP Chip Seal 2014 After

Los Angeles County

Cracks Sealed 6 years later
RAP Products
Slurry Seal and Micro Surfacing
# RAP Slurry Gradation

## RAP Slurry Dust

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing UN-extracted</th>
<th>Percent Passing Extracted</th>
<th>ISSA Specification</th>
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</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<tr>
<td>No. 4</td>
<td>95-100</td>
<td>95-100</td>
<td>90-100</td>
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<td>No. 8</td>
<td>65-85</td>
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<td>65-90</td>
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<tr>
<td>No. 16</td>
<td>35-60</td>
<td>50-75</td>
<td>45-70</td>
</tr>
<tr>
<td>No. 30</td>
<td>18-38</td>
<td>35-55</td>
<td>30-50</td>
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<tr>
<td>No. 50</td>
<td>8-25</td>
<td>22-40</td>
<td>18-30</td>
</tr>
<tr>
<td>No. 100</td>
<td>5-20</td>
<td>13-38</td>
<td>10-21</td>
</tr>
<tr>
<td>No. 200</td>
<td>2-12</td>
<td>10-20</td>
<td>5-15</td>
</tr>
<tr>
<td>Residual AC</td>
<td></td>
<td></td>
<td>6.5% Min.</td>
</tr>
</tbody>
</table>

Residual AC 6.5% Min.
RAP Slurry Material

Consistent Residual Asphalt

Slurry Dust

Very few conglomerations

Residual asphalt remains very consistent
Type II RAP Slurry Aggregate
# RAP Slurry Seal

## RAP Slurry Seal vs. ISSA Type II

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
<th>ISSA Type II</th>
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</thead>
<tbody>
<tr>
<td>Emulsion</td>
<td>10% - 14%</td>
<td>*12% - 18%</td>
</tr>
<tr>
<td>Residual AC</td>
<td>12.5% Min.</td>
<td>7.5% - 13.5%</td>
</tr>
</tbody>
</table>
Conventional Equipment Super Results
RAP Slurry Black Aggregate
RAP Slurry compared to Conventional, City of La Mirada, California. Side by Side – One Year later, RAP is still black!
Methods of Management

- Use of RAP materials in conventional bids
  (SPECIFICATIONS AVAILABLE)
- Utilization of In House RAP
  - On Site Method

Existing RAP Stock Pile or New RAP Stock Pile Being Developed
Crush and Screen On-Site

The need can be for a specific product or products. A qualified operator can be contracted by time or quantity.

1. Contracted By Time
   1. Set Mobilization Cost
   2. Set Crushing Cost
   3. Set Screening Cost (Based on product, there may be more screening than crushing)

2. Contracted By Quantity
   1. Set quantity of product with unit price or lump sum contract.
      1. Small quantities can be expensive
      2. Understand that it is not unusual to have multiple products produced simultaneously.
Caltrans Maintenance

- In house crews
  - Chip Seal
  - Crack Seal
  - Shoulder Backing
- Contract Work
  - Slurry Seal
Caltrans Maintenance

- In house crews
  - Chip Seal
  - Crack Seal
  - Shoulder Backing
- Contract Work
  - Slurry Seal

Utilized four RAP piles separated by over 150 miles from each other.

This process allowed Caltrans to make multiple products from their own material.

The trucking cost can exceed $38 per ton to some locations.

Superior products used for two years with little to no additional cost.
Complete RAP Management

RAP Management Program allows the owner to contract:

- Import
- Stockpile Management
- Crushing, Screening and fractionation
- Export
Complete RAP Management

RAP Management Program allows the owner to contract:

- Import
- Stockpile Management
- Crushing and Screening
- Export
  - Trucking
  - Cost tracking
Best Practices

- Clean RAP for Slurry
  - Contaminated material should be segregated for use on other products
  - Sand Equivalent (SE)
- Utilization of multiple products at one time
  - Chips and slurry dust – Slurry and AC Base
- Minimum of two screenings for chips.
- Moisture content
  - Wet for chips on Emulsion Binders
  - Dry for chips on Hot Asphalt Binders
- Understand quantities to achieve best pricing
- RAP Slurry Seal can not sit more than two weeks to four week without being re-screened.
RAP Aggregate Products

Production

- Rap Chips (5/16” and 3/8”)
- Rap Type II Slurry Dust
- Crushed Miscellaneous Base
- AC Base
- RAP Base
- Mixing Aggregates for CCPR
5/16” Chips Made from RAP
Caltrans On-Site Management
RAP Chip and RAP Slurry (RAP Cape) Aggregates Produced Simultaneously
Finished Environmentally Friendly Product
Questions?

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