Innovations in Recycled Asphalt Pavements

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What We Know

- Asphalt has always been recyclable. #2 in world after recycled water
- Valuable Material in Hot Mix Asphalt
  - Provided Feasible and Cost Effective
  - When Nearby to HMA Plant
  - More Going Out Then Into the Facility
    - No Inventory Build Up
Other Historical Low Value Reclaimed Asphalt Pavement (RAP) Uses

- Shoulder Backing
- Trucking & Equipment Yards
- Haul Roads
- Dust Control
- Crushed Miscellaneous Base

These Are Poor Uses for Such a Valuable Asset
No Need to Squander Virgin Aggregate

- RAP In Many Cases Out Performs Native Aggregates
- Neutral Charge, Works Well With Binders
- Cost Effective
- Environmentally Smart
Alternative Uses of RAP in Pavement Preservation

- Recycled In-Place
  - HIR - Hot In-place Recycling (Not Discussed)
  - Cold In-place Recycling (CIR)
- Cold Central Plant Recycling (CCPR)
- As Aggregate
  - RAP Chip Seals
  - RAP Slurry Seals/Micro Surfacing
  - RAP Cape Seals
Cold In-place Recycling (CIR)

**Distressed Pavement = New Pavement Using Train of Equipment that:**

- Mills deteriorated pavement - Reclaimed asphalt pavement (RAP)
- Crushes RAP to gradation
- Mixes with recycling agent
- Additive if needed
- Re-Paves recycled mix
- Compacts to specified density
- Readies for surface treatment
CIR Crushing and Sizing Train
(Some Variations But Same Concept)
Pavement Milled

- **Main Mill**
  - Self-propelled
  - Minimum 12.5 ft cutter
  - Automatic depth controls to maintain the depth
  - Control cross slope

- **Supplemental Mill**
  - Put millings in front of main mill to pickup and process
  - Shoulders and misc. areas
Cracking Pattern Disrupted

70% Rule for Mitigation of Reflective Cracking
May Add Additive (Dry Cement)

Spread Just in Front of Mill
Quick Lime Slurry

Applied to Cutting Teeth
Recycling Plant Meets All Calibration Requirements
Crushing and Sizing Equipment, 100% Closed Circuit System

Crushing and sizing equipment capable of reducing RAP to the 100% passing 1-inch to 1¼-inch sieve
Mixed in Pugmill

- Continuous pugmill equipped with paddles to provide sufficient mixing
- Belt scale and integrated microprocessor control
- Automatic controls to obtain the proper amount of binder
- Weighing and measuring devices calibrated

Emulsion or Foamed Asphalt Injection System

Mass Flow Meter
New Recycled Mix Windrowed
Pick Up and Installation

Caltrans State Route 33

Recycled Asphalt Surface
100% Recycled Asphalt
Cold Central Plant Recycling (CCPR)

Stockpiled Clean RAP

= New Pavement
1) Mill and Stockpile RAP

- **Onsite CCPR** - Cold Milled from Roadway and Recycled Back to Same Roadway
- **Imported CCPR** – RAP is Brought from One Project and Recycled to Another
- **Central Facility CCPR** – RAP Stockpiled from Various Projects for Future Use
Onsite CCPR

Same Road - RAP Milled from Roadway to be Reconstructed

Prior to Milling

Cold Milled

Stockpiled Nearby
Imported CCPR

RAP Imported from One Roadway and Processed and Returned to Different Application
Central Facility CCPR

RAP Imported from Various Projects and Stockpiled for Future Use
2) RAP is Sized (Typically 1” to 11/4” Max)

Using a Scalping Screen on the Feed Hopper of Processing Plant
100% RAP Crushed and Screened Closed Loop System

Screen
Crusher
Return
3) Can Supplement with New Aggregate

- 3/8” New Agg.
- 1” x No. 4 RAP
- No. 4 Minus RAP
- 3/8” New Agg.
4) Mix with Water and Recycling Agent
Adding Recycling Additives if Necessary

- Recycling Agents
  - Emulsified Asphalt
  - Engineered Emulsions
  - Polymer Modified Emulsions
  - Solvent Based Emulsions (CMS2s)
  - Expanded Asphalt (Foam)
- Recycling Additives (added in small quantities)
  - Cement Dry
  - Lime Slurry
Combination Processing Plant

- Crusher
- Screen Deck
- Mass Flow Meter
- Pug Mill
Asphalt for 3.3% Foamed Asphalt

After Sizing Standard Pugmill

1.0% Cement Added
5) Loaded into Trucks and Transported To Laydown Area

Swept and Tacked Prior to Paving
6) Pave Recycled Mix
7) CIR and CCPR - Compact to Specified Density

Pneumatic-tired roller at least 22 to 25 tons

Double drum vibratory steel-wheeled roller at least 10 tons
Cold Recycle Surface
Before Sealing
8) CIR and CCPR - Protect for Temporary Traffic

Apply fog-seal
Apply sand blotter
Release to traffic
9) CIR and CCPR - Cure and Reroll if Necessary

Typically 2 to 10 days

Reroll (supplemental compaction) if required (typically for emulsified asphalt)
10) CIR and CCPR - Final Surfacing

Because of Higher Void Ratio Must Be Sealed

HMA Overlay – Higher Volume Highways
High Shear Areas

Slurry or Micro Surfacing – Low Volume Shoulders and Lots

Chip Seal – Low Volume Highways
City Of Menifee Newport Road
3” CCPR over 10” FDR Cement
Auto Auction 1-Million Square Feet 100% CCPR Recycled
CIR Rural Areas – Caltrans State Route 36
Eucalyptus Avenue  Moreno Valley, July 2009
Project Profile; Moreno Valley, July 2009
“Energy and Cost Savings”

- 8,744 tons of asphalt removed and repaved.
- 840 fewer trucks used utilizing CIR, compared to a mill and fill operation.
- 1,649 fewer barrels of oil used.
- 79.6% fewer carbon emissions utilizing CIR compared to mill and fill operation.
- Cost savings to the City $262,320.00.
- Cut 30% off the project schedule.
RAP Aggregates

Single stones and conglomerations
Residual asphalt content will vary by sample
# RAP Chip Gradations

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing¹</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; (12.5 mm)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>3/8&quot; (9.5 mm)</td>
<td>85-100</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>0-15</td>
<td>0-50</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>0-5</td>
<td>0-15</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>-</td>
<td>0-5</td>
</tr>
<tr>
<td>No. 200 (75 um)</td>
<td>0-2</td>
<td>0-2</td>
</tr>
</tbody>
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Residual Asphalt Content²

- 3.5% Min. (Based on dry weight of aggregate)
- 3.5% Min. (Based on dry weight of aggregate)

1. On unextracted RAP  2. On extracted RAP
RAP Chips

Appearance may be dusty but the dust is actually asphalt

No need to wash. Wet with an emulsion and keep dry for asphalt rubber

Bonding is excellent
RAP 3/8” Terminal Blend Asphalt Rubber Chip Seal
RAP 5/16” PME Chip Seal
RAP Chip Seal San Bernardino County
El Rivino Road 2006 5/16” Chips

Before
RAP Chip Seal

10 years later
RAP Chip Scrub Seal Los Angeles County 2009 Avenue J

Scrub Seal with Polymer Modified Rejuvenating Emulsion Broomed into Cracks
RAP Chip Seal 2015 After

Los Angeles County

Cracks Sealed 6 years later
RAP Aggregates - Type II Slurry and Micro Surfacing
RAP Slurry and Micro Surfacing Aggregates

Very Few Conglomerations
Residual Asphalt Remains Consistent
Type II RAP Slurry Aggregate
RAP vs Conv. Agg. Differences

- RAP Slurry Light on Fines for Type II
  - Coating of Asphalt Limits Crushed Fines
- Need to Prevent Clumping
  - Limit Amount of Material Stockpiled
  - Rescreen if Necessary
- Needs to Be Rubber Tire Rolled
- 3% Latex Modified Minimum
  - Adds Early Retention Until Asphalts Meld
# RAP Slurry Seal

<table>
<thead>
<tr>
<th>Component</th>
<th>RAP Amount</th>
<th>ISSA Type II Amount</th>
</tr>
</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 Can Be Used
RAP Slurry compared to Conventional, City of La Mirada, California. Side by Side – One Year later, RAP is Blacker
Methods of RAP Management

- Require RAP Materials in Conventional Bids
- Utilization of In-house RAP
  - On Site Method

Existing RAP Stockpile or New RAP Stockpile Developed
RAP Aggregate Central Production Facility
5/16” Chips Made from RAP
RAP Chip and RAP Slurry (RAP Cape) Aggregates Produced Simultaneously
Some of the Best Aggregates Are in Our Roads
Increasingly Difficult to Open New Pits

Solution
Use Your RAP!
Questions?

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