Why More Recycling of Asphalt Pavements?

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International Sales Asia Oceania
Some Facts to Start:

- Asphalt is 95% Stone and 5% Asphalt
- 2.6M Miles of US Roads are 94% Surfaced with Asphalt
- 85% of Parking Lots & Airports are Surfaced with Asphalt
- There are 4,000 mixing plants in the USA
- In US, 500,000,000 tons of Asphalt are produced annually
- 60,000,000 tons is recycled into pavement annually
- 40,000,000 tons is recycled into other applications
- There are 300,000 employees in this industry
- NCAT Facility (40,000 sq. ft., 1.7 mile test track, $5M budget)
- Asphalt Plants have been de-listed by the EPA
Four Technologies that have the potential to transform the field of “Sustainable Pavements”:

- Warm Mix Asphalt (Typically 320°F now 280° to 212°)
- Doubling the use of Recycled Asphalt Pavements (RAP)
- Perpetual Pavements
- Porous Pavements and Open Graded Pavements
Doubling the use of Recycled Asphalt Pavements (RAP):

- Currently States Average Only 12% RAP
- Americas most Recycled Product (100M tons per year)
- Roofing Shingles are being introduced

- What if we increased RAP to 25% average per state?
  - 10% less greenhouse emissions
  - or over 2 million tons annually
Reclaimed Asphalt Pavement (RAP)

RAP Pile With 1/2” Minus to 3/4” Minus Aggregate
RAP is Worth the Virgin Material It Replaces
RAP

- Cold Planing generates “RAP” - Recyclable Asphalt Pavement
- All RAP is reusable as:
  - 1) New Hot Mixed Asphalt
  - 2) Cold Mixed Asphalt
  - 3) Stabilized Aggregate Base
  - 4) Aggregate Base
<table>
<thead>
<tr>
<th>Size</th>
<th>Operating Cost per Hour</th>
<th>Production Rate (sq yd/hr)</th>
<th>Production Rate (ton/hr)</th>
<th>Total Cost per Square Yard</th>
<th>Total Cost per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>$315.00</td>
<td>1250</td>
<td>70</td>
<td>$0.25</td>
<td>$4.56</td>
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<tr>
<td>2”</td>
<td>$320.00</td>
<td>870</td>
<td>90</td>
<td>$0.37</td>
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<td>3”</td>
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<td>700</td>
<td>110</td>
<td>$0.49</td>
<td>$3.14</td>
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<td>4”</td>
<td>$390.00</td>
<td>600</td>
<td>125</td>
<td>$0.65</td>
<td>$3.12</td>
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Based on using a BG RX-40 or CMI PR 450 (1970’s vintage) half-lane milling machine that operates 750 hr/yr. Costs not adjusted for inflation.

Half-Lane Milling Costs in the Early 1970’s
<table>
<thead>
<tr>
<th>Size (in)</th>
<th>Operating Cost per Hour</th>
<th>High</th>
<th>Low**</th>
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<tbody>
<tr>
<td>1</td>
<td>$385.00</td>
<td>$332.00</td>
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<tr>
<td></td>
<td>Production Rate (sq yd/hr)</td>
<td>3143</td>
<td>3600</td>
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<td></td>
<td>Production Rate (ton/hr)</td>
<td>170</td>
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<tr>
<td></td>
<td>Total Cost per Square Yard</td>
<td>$ 0.12</td>
<td>$ 0.09</td>
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<tr>
<td></td>
<td>Total Cost per Ton</td>
<td>$ 2.26</td>
<td>$ 1.66</td>
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<tr>
<td>2</td>
<td>$395.00</td>
<td>$340.00</td>
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<tr>
<td></td>
<td>Production Rate (sq yd/hr)</td>
<td>2461</td>
<td>3030</td>
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<tr>
<td></td>
<td>Production Rate (ton/hr)</td>
<td>272</td>
<td>334</td>
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<td></td>
<td>Total Cost per Square Yard</td>
<td>$ 0.16</td>
<td>$ 0.11</td>
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<td></td>
<td>Total Cost per Ton</td>
<td>$ 1.45</td>
<td>$ 1.02</td>
</tr>
<tr>
<td>3</td>
<td>$405.00</td>
<td>$349.00</td>
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<td></td>
<td>Production Rate (sq yd/hr)</td>
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<td>2651</td>
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<tr>
<td></td>
<td>Production Rate (ton/hr)</td>
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<td>Total Cost per Square Yard</td>
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<td>Total Cost per Ton</td>
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<td>$ 0.79</td>
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<td>4</td>
<td>$415.00</td>
<td>$357.00</td>
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<td></td>
<td>Production Rate (sq yd/hr)</td>
<td>1893</td>
<td>2272</td>
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<td></td>
<td>Production Rate (ton/hr)</td>
<td>410</td>
<td>502</td>
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<td></td>
<td>Total Cost per Square Yard</td>
<td>$ 0.22</td>
<td>$ 0.16</td>
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<tr>
<td></td>
<td>Total Cost per Ton</td>
<td>$ 1.01</td>
<td>$ 0.71</td>
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</table>

Based on using a Roadtec RX-700 half-lane milling machine with a 7’2” drum and housing that operates 750 hr/yr and uses fuel costing $3.00 per gallon.

*HIGH refers to high labor costs and abrasive aggregate (granite)

** LOW refers to low labor costs and soft aggregate (limestone)
Cold Recycling

Introduction to cold in-place recycling
Two major types of treatment

- **Partial Depth**
  - 0 to 150 mm (6”) normally
  - Uses Milling Machines

- **Full Depth**
  - Typically 100 mm to 400 mm (4” to 16”)
  - Uses Stabilizers
Single Machine Recycling
The Other Partial Depth Methods

Wirtgen adds a screed to their W-2100R to place the material.
The Train Machine Concept

Used when the Engineer’s design requires milled material needs to be screened, be of a uniform size and fully mixed in a pugmill.
RT-500 Roadtec CIR Trailer
The screen deck is fed by the milling machine if the material is too big, it goes to a crusher to reduce the size, an oversize conveyor loop back to the top of the screen. If the material passes the screen it goes to a belt and a belt scale to feed a double shaft pugmill.

As the belt scale sends the weight back to the computer, the pump sends the right amount of additives to the pugmill just as the material goes in. The now sized, additive added and mixed material is dropped onto the ground in a windrow ready to pave.

This machine can also be fed by a front end loader and can operate as a stand alone mixing unit without the milling machine for some static site projects.
An Astec Mobile 5 x 16 Screen deck with electric drives being fed by the rear loading RX-900-4 milling machine. A Telsmith 4248 Impactor crusher reduces the over size and re-circulates this to the screen deck. A 1.2 m wide conveyor with a weigh bridge weighs the material, sends a signal to the Bearcat computer that open and closes valves to add the liquid additives to the KPI pugmill. These can be emulsions, foamed asphalt and/or other liquids or solids. A portable generator set runs the entire CIR Trailer (RT-500).
RT-500 Working in Nevada
Full Depth Recycling

- Normally done with a Stabilizer
- Complete depth of materials are used
- Various materials are used as a stabilization medium –
  - Water
  - Cement, Lime or Fly ash
  - Emulsion (Water and Bitumen mixed)
  - Foamed Asphalt
  - Specialty oils and stabilization liquids
Full Depth means Stabilizers

• Originally designed to work in soils, the stabilizer has now become a Full Depth pavement recycling machine.

• The two shown here are adding fly ash into soil to create road (top) or parking lot base (bottom).
Stabilizers

• Stabilizers are used for pavement in-place recycling
• The Caterpillar Stabilizer shown here is working on a Michigan Interstate Highway
• This project used Bituminous Emulsion and was overlaid by two lifts of HMA, a binder layer and a wearing course.
Stabilizers use cement

• Dry Cement or fly ash can be placed on the ground and the stabilizer will mix this into the underlying materials.

• At the left, a wet slurry is sprayed onto the ground and the stabilizer is used to mix this into the roadway being stabilized.
Stabilizers come in Various sizes
Stabilizers reuse all materials

The use of a stabilizer can rehabilitate pavements that are almost beyond hope.

Additives have been developed that will rejuvenate the lowest residual penetration grades and mix these materials into the base to create a new base.

100% recycling is a major goal of the stabilization industry.
Screening and Processing RAP
Pavement Recycling

- Approximately 100,000,000 tons of asphalt pavement is reclaimed each year.
- That is 95% of what is produced using virgin materials.
- 75% is reused for new pavement.
- Another 20% is recycled for other highway uses (aggregate base, etc.)
RAP: Fractionating vs. Recycling

What Do We Mean?

Crushing And Screening

Breaking Apart the Bond (liberate)

Treating RAP Gradation Same As Virgin Mix
RAP: Recycling
Reclaimed Asphalt Pavement Bin (RAP)

Cold Feed Bins

1980-1990's HMA Facility with Single RAP Bin
RAP: How Fractionating adds

White Rock 3/8 - 4
White Rock 1/2 - 3/8
White Rock 4-0

C%
A%
AA%
B%
X%

SUPERPAVE MIX WITH 1/2 RAP
RAP: Recycling
RAP: Problems with Recycling

- Controlling gradation in mixes containing greater than 20% RAP
- Most rap around the country is either milled material or ½” minus crusher run
- Tough for lab to get uniform mix
RAP: Fractionating
RAP: High Frequency Screening

- Coarse material requires more amplitude and less frequency.
- Fine material requires less amplitude and more frequency.
- Utilizes aggressive screen vibration directly to screen media with almost no amplitude applied to side of box.
- High RPM allows material to stratify and separate at a much faster rate.
RAP: How Fractionating adds Value

Superpave Mix with Processed RAP - Choice #2
RAP: Handling
RAP: Fractionating
RAP: Fractionating
**RAP: Fractionating**

- Returns RAP to original size
- Fine RAP contains higher AC content
- 200’s in RAP help fill air voids
- More control over RAP gradation, therefore less variation in mixes
**RAP: Handling**

- Majority have no special RAP stockpiling
- About 1/3 of RAP stockpiles are placed on a sloped surface to aid in draining
- Very Few RAP stockpiles are placed on a paved surface to minimize contamination
- Only about 9% of RAP stockpiles are placed under cover to minimize moisture
**RAP: Maximize Value**

- Take care of your RAP
  - Keep it clean and uncontaminated

- Keep it dry:
  - Saves drying costs
  - Fractionates more readily
  - Can fractionate finer & faster

- Use RAP Fractions in most profitable ways
RAP: How Fractionating adds Value

- Takes Advantage Of Higher Asphalt Content In “Fine” RAP
- Provides Scarce/High Dollar Size Aggregate Material
- RAP is worth what it replaces
- Allows You To Adjust mix designs
RAP: How Fractionating adds Value

1/2 x 0
6% AC

1/2 x 4
4% AC

4 x 0
7% AC
RAP: Obstacles to Fractionating

- Reluctance to Make Changes
- Lack of Focus
- Lack of Research
- Lack of Trained Personnel
- Unsure of Return on Investment
- Putting out Fires
Most Difficult Part of Implementation is

GETTING STARTED
Ideal For Fractionating Millings

Self Contained

Easily Portable

Low Operating Cost

Low Entry Price For Fractionating
Level 3

- Will Handle Any Material Size
- Multiple Configurations
  - Fractionating
  - One-size Recycling
  - Closed Circuit
  - Open Circuit
- High Tonnages
- Site Mobile
- Has Uses In Other Materials
  - Concrete
  - Aggregate
Great for One-Site Operations

Customized to Fit Your Needs
- Self Contained or Line Power
- Various Tonnage and Feed Size Configurations

On-demand Sizing

Easy Access and Serviceability
Relocateable System
Relocateable System

- Ideal For Fractionating Millings
- One Or Two Site Processing
- Relocateable
- On-demand Fractionating
- Two Products
- Closed Circuit
Use the calculator below to determine exactly what being FRAP Ready could mean to your operation. Fill in the blank spaces with your operation's specific numbers. Calculations will be automatically updated as you enter information into one box and then advance to the next. Fill in all boxes to learn just how much you could save.

**Virgin Cost Calculators**

<table>
<thead>
<tr>
<th>Product</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Virgin Aggregate Cost (per ton):</td>
<td>15</td>
</tr>
<tr>
<td>Liquid Asphalt Cement Cost (per ton):</td>
<td>900</td>
</tr>
<tr>
<td>Percent Asphalt Cement in FRAP:</td>
<td>6</td>
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</tbody>
</table>

**Replacement Value**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virgin Aggregate:</td>
<td>16.92</td>
</tr>
<tr>
<td>Liquid Asphalt Cement:</td>
<td>24.00</td>
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<tr>
<td>Total Virgin Opportunity Cost Replacement (per ton):</td>
<td>49.92</td>
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**FRAP Costs**

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Acquiring RAP (per ton):</td>
<td>5</td>
</tr>
<tr>
<td>Cost of Fractionating RAP (per ton):</td>
<td>3</td>
</tr>
<tr>
<td>Total Cost of FRAP (per ton):</td>
<td>8.00</td>
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<tr>
<td>Realized Value of FRAP (per ton):</td>
<td>32.92</td>
</tr>
</tbody>
</table>

**Bottom Line Savings in HMA Design**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of FRAP used in mix:</td>
<td>30</td>
</tr>
<tr>
<td>Total Savings (per ton) in HMA Design:</td>
<td>3.08</td>
</tr>
<tr>
<td>Tons/hour:</td>
<td>200</td>
</tr>
<tr>
<td>Hours/day:</td>
<td>3</td>
</tr>
<tr>
<td>Days/week:</td>
<td>3</td>
</tr>
<tr>
<td>Weeks/year:</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total Savings (per Year):</strong></td>
<td>2.77 million</td>
</tr>
</tbody>
</table>

www.berapready.com
www.befrapready.com
Why More Recycling?
Because it is good for the environment and economically sustainable.

Vince Egan
Director
International Sales
Asia And Pacific Rim