Recycling in Asphalt Paving Operations

Robert E. Lee, P.E.
“We should treat our roads as assets, not consumables that can be used up, thrown away and replaced with new ones.”

- Don Brock, Astec Industries
Mission & Vision

Provide a transportation system that is:

- Safe
- Efficient
- Environmental Sensitive
- and Cost Effective
Why Recycled Materials

• Environmental Stewardship
  – Conserve Natural Resources
  – Air Quality
  – Water Quality

• Government Support
  – Local and State
  – TCEQ

• Economics – passing on the savings or passing on the cost
Environmental Stewardship

• Conserve Materials
• Reduce Waste
• Reduce Energy Consumption
• Improve Air and Water Quality
  – CO\textsubscript{2eq} emissions
• Paving Technologies that provide these Environmental Attributes
  – Warm Mix Asphalt (WMA)
  – Reclaimed Asphalt Pavement (RAP)
  – Recycled Asphalt Shingles (RAS)
Recycled Materials

must:
- Be safe
  - People
  - Environment
- Meet specifications
- Perform well
- Be readily available
- Be cost effective
What does TxDOT recycle?

• Reclaimed Asphalt Pavement (RAP)
• Fly Ash
• Crushed Concrete
• Tire Rubber (TR & AR)
• Compost
• Recycled Asphalt Shingles (RAS)
• Foundry Sand
Today reclaimed asphalt pavement is the most recycled material in the world.

Using RAP:
- Reduces construction costs
- Conserves resources
- Reduces waste
Recycled Asphalt Pavement
Using RAP in Texas

• TxDOT uses a significant amount of RAP each year.

• But we only used an average of about 3% RAP in our HMA in 2006.
Unacceptable levels of variability in many RAP stockpiles prevented us from using more RAP in HMA.
Fractionate the RAP Stockpiles
1980-1990’s HMA Facility with Single RAP Bin
Today's HMA Facility with Multiple RAP Bins
How did we increase our use of RAP?

- Allow the contractor the option to retain ownership
- Encourage the use of fractionated RAP
- Discourage the use of un-fractionated RAP
- Determine the greatest value for the material
Recycled Asphalt Shingles (RAS)

• Approximately 13 million tons of asphalt shingle waste is generated per year
  – Post manufacture (scrap): 1.5 million tons
  – Post consumer (tear-offs): 11.5 million tons

• Less than 5% of shingle waste is recycled
Why Recycled Shingles?

- A good source for asphalt
- Reduces landfill consumption
- Conserves natural resources
Typical Shingle Composition

- Granular/aggregate
- Waterproofing asphalt
- Base (fiberglass or organic felt)
- Waterproofing asphalt
- Back surfacing

<table>
<thead>
<tr>
<th>Component</th>
<th>Organic Felt</th>
<th>Fiberglass Mat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt cement</td>
<td>30-36%</td>
<td>19-22%</td>
</tr>
<tr>
<td>Felt (Fiber)</td>
<td>2-15%</td>
<td>2-15%</td>
</tr>
<tr>
<td>Mineral aggregate (#30)</td>
<td>20-38%</td>
<td>20-38%</td>
</tr>
<tr>
<td>Mineral filler/stabilizer</td>
<td>8-40%</td>
<td>8-40%</td>
</tr>
</tbody>
</table>
SH 31, Navarro County

- May, 1997
- Type C with AC-20
  - Section 1 – 5% man. waste
  - Section 2 – 5% tear-offs
  - Section 3 - Control
- Initial construction issues with tear-offs section
- Overall performance good - comparable to control
- Part of first research project in Texas
Louisiana Asphalt Index

$ per ton

PG 64-22  PG 70-22  PG 76-22
• Allow Manufactured Waste
  – Memo - March, 2006
  – Treated the same as RAP – counter flow drum
  – Up to 15%

• Added residential tear-off shingles
  – Memo – Feb., 2009
  – Asbestos certification and testing
  – Deleterious material < 1.5%
  – No direct flame for shingle material
Rule of Thumb

An addition of 5% RAS or 20% RAP in the mix gives roughly one grade bump in the binder as shown by the DSR.

<table>
<thead>
<tr>
<th>High Temp Grade</th>
<th>Type D PG 64-22</th>
<th>20% RAP</th>
<th>5% Shingles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>67</td>
<td>71</td>
<td>74</td>
</tr>
</tbody>
</table>

That same addition of 5% RAS or 20% RAP in the mix shows the stiffness doubling as shown by the Hamburg.
• Special Provision to Item 341-024
• Allows manufactured waste and residential “tear-offs”
  – up to 5%
  – deleterious limited to 1.5%
  – 100% passing 1/2” sieve, 95% passing 3/8” sieve
• RAS can be combined with
  – RAP
  – WMA
  – Substitute Binders (lower binder grade)
# New Specification

## Table 1A
Maximum Allowable Amounts of Recycled Binder, RAP & RAS

<table>
<thead>
<tr>
<th>Mixture Description &amp; Location</th>
<th>Maximum Ratio of Recycled Binder(^1) to Total Binder (%)</th>
<th>Maximum Allowable % (Percentage by Weight of Total Mixture)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unfractionated RAP(^2)</td>
</tr>
<tr>
<td><strong>Surface Mixes(^5)</strong></td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td><strong>Non-Surface Mixes(^6) &lt; 8 in. From Final Riding Surface</strong></td>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td><strong>Non-Surface Mixes(^6) &gt; 8 in. From Final Riding Surface</strong></td>
<td>45</td>
<td>20</td>
</tr>
</tbody>
</table>
Approved List

- Have met regulatory and specification requirements
- Have a quality control plan for asbestos testing plan in place
- Keep records of materials processed for chain of custody purposes
Plants & Processors

△ Shingle Manufacturer
• Capability to process asphalt shingles
National Use

Manufactured Waste Only

Man. Waste & “Tear-Offs”
Asphalt Roofing Shingles

Asphalt Roofing Shingles

"Recycling of asphalt shingles comes in as not only an economically viable addition to our hot-mix toolbox, but an environmentally conscientious change that can benefit everyone."
(From Roofs to Roads, Texas Asphalt Magazine, April 2009)

Specifications, Authorizations

TxDOT special provisions allow contractors to add up to 5% RAS to asphalt pavement

- Special Provision 341-024 Dense-Graded Hot-Mix Asphalt (QC/QA)
- Special Provision 340-003 Dense-Graded Hot-Mix Asphalt (Method)

A Texas Commission on Environmental Quality (TCEQ) Authorization Memo allows hot mix plants to include either post-industrial or tear-off recycled asphalt shingles (RAS) under the TCEQ Air Quality Standard Permit for Permanent Hot Mix Asphalt Plants.

Overview

Each year, U.S. shingle manufacturers and roofers generate more than 11 million tons of asphalt shingle scrap, primarily removed from roof tops.
# Recycled Materials Blending Program

## Mixture Information

<table>
<thead>
<tr>
<th>% Asphalt from JMF</th>
<th>Layer</th>
<th>Binder Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>Surface</td>
<td>PG 76</td>
</tr>
</tbody>
</table>

## Virgin Material Costs

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>PG 76</th>
<th>PG 70</th>
<th>PG 64</th>
</tr>
</thead>
<tbody>
<tr>
<td>$/T on</td>
<td>22.00</td>
<td>538.00</td>
<td>480.00</td>
</tr>
<tr>
<td>Price / Ton of Mix</td>
<td>$ 47.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Recycled Material Costs

<table>
<thead>
<tr>
<th>Blend</th>
<th>$/T on</th>
<th>% Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>RAP</td>
<td>15.0</td>
</tr>
<tr>
<td>2)</td>
<td>RAS</td>
<td>20.0</td>
</tr>
<tr>
<td>3)</td>
<td></td>
<td>20.0</td>
</tr>
</tbody>
</table>

## Blends

<table>
<thead>
<tr>
<th>Binder Grade</th>
<th>Virgin</th>
<th>Blend 1</th>
<th>Blend 2</th>
<th>Blend 3</th>
<th>Blend 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 76</td>
<td>0.0</td>
<td>15.0</td>
<td>5.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>PG 70</td>
<td>0.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>PG 64</td>
<td>0.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

% Recycled Material Limit: **20**

% Recycled Binder: **35**

## Economics (Mix Savings)

<table>
<thead>
<tr>
<th>Blend</th>
<th>Virgin</th>
<th>Blend 1</th>
<th>Blend 2</th>
<th>Blend 3</th>
<th>Blend 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycle Material Savings</td>
<td>$ -</td>
<td>$10.18</td>
<td>$5.26</td>
<td>$10.18</td>
<td>$10.18</td>
</tr>
<tr>
<td>Binder Substitution Savings</td>
<td>$ -</td>
<td>$1.89</td>
<td>$ -</td>
<td>$1.89</td>
<td>$5.23</td>
</tr>
<tr>
<td>Total Savings</td>
<td>$ -</td>
<td>$12.07</td>
<td>$5.26</td>
<td>$12.07</td>
<td>$15.41</td>
</tr>
<tr>
<td>Adjusted Price/Ton</td>
<td>$ 47.80</td>
<td>$35.74</td>
<td>$42.54</td>
<td>$35.74</td>
<td>$32.39</td>
</tr>
</tbody>
</table>

## Economics (Value of Recycled Material)

<table>
<thead>
<tr>
<th>Blend</th>
<th>RAP</th>
<th>RAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>$32.80</td>
<td>$105.20</td>
</tr>
</tbody>
</table>

### Recycled Materials

- RAP
- RAS

### Mix Savings

- Binder Substitution
- Materials

Graph showing the savings for each blend.
## Cost Savings

<table>
<thead>
<tr>
<th></th>
<th>Price ($/Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type D PG 64-22</td>
<td>$39.75</td>
</tr>
<tr>
<td>with 20% RAP</td>
<td>$34.80</td>
</tr>
<tr>
<td>with 5% Shingles</td>
<td>$36.10</td>
</tr>
<tr>
<td>with 15% RAP &amp; 5% Shingles</td>
<td>$32.39</td>
</tr>
</tbody>
</table>
Bottom Line

• An available 13 million tons of shingle waste, containing 25% liquid AC
• 3.25 million tons of reclaimable liquid AC
• At $475.00 per ton that’s $1.5 billion worth of liquid asphalt every year
RAP is Worth the Virgin Material it Replaces

10,000 Tons of RAP = 20 – 6000 Gallon Transport Trailers of Asphalt and 9500 Tons of Aggregate

Using 20% RAP in HMA reduces carbon emissions by about 8.5%
Recycled Asphalt Shingles

10,000 tons of ground shingles replaces:

- 468,000 gallons of asphalt
- 8,000 tons of aggregate
- Using 5% RAS in HMA reduces carbon emissions by approx. 7.0%
Combined Technologies

• WMA with 15% RAP and 5% RAS
  – 83 lbs. of carbon emissions per ton of mix as compared to 109 lbs. with HMA and no recycled materials

That’s over a 23% reduction in emissions
## Technology Use - FY 2010

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAP</td>
<td>630,000</td>
</tr>
<tr>
<td>RAS</td>
<td>27,000</td>
</tr>
<tr>
<td>Total Mix</td>
<td>9,000,000</td>
</tr>
</tbody>
</table>
Value ($/ton)

- RAP to Counties
- HMA-RAP
- HMA-RAS

- Landfill costs for shingles
- Backfill pvmt edges RAP or RAS

Base RAP or RAS
Questions?