a closer look at environmentally friendly pavement technologies
Recycled Materials

Why?

- Environmental Stewardship
  - Air Quality
  - Water Quality
  - Conserving Natural Resources

- Government Support
  - Local and State
  - TCEQ

- Economics – passing on the savings or passing on the cost
... creating momentum

Environmental Awareness  Agency Support  Economic Value
Recycled Materials

What?

• Recycled Asphalt Pavement (RAP)
• Fly Ash
• Crushed Concrete
• Tire Rubber (TR & AR)
• Compost
• Warm Mix Asphalt (WMA)
• Recycled Asphalt Shingles (RAS)
• Foundry Sand
Recycled Materials

must:

• Be safe
  – People
  – Environment

• Meet specifications

• Perform well

• Be readily available

• Be cost effective
Uses of RAP - 2006

- HMA: 13%
- Donated to Counties: 44%
- Backfill Pvmt Edges: 24%
- Rework Base: 6%
- Base Course: 4%
- Maintenance & Not Formally Accounted For: 9%

Total: 100%
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 mixtures in 2006.
Variability in RAP

Unacceptable levels of variability in many RAP stockpiles prevented us from using more RAP in HMA.
Fractionate the RAP Stockpiles
RAP PROCESSED BACK TO ORIGINAL INGREDIENTS
1980-1990’s HMA Facility with Single RAP Bin
Today’s HMA Facility with Multiple RAP Bins
Recycled Asphalt Pavement (RAP)

- Option to allow contractor to retain ownership
- Fractionated RAP
  - 20% in surface mixes
  - 30% in non-surface mixes placed < 8” from surface
  - 40% in non-surface mixes placed > 8” from surface
- Unfractionated RAP
  - 10% in surface mixes
  - 20% in non-surface mixes placed < 8” from surface
  - 30% in non-surface mixes placed > 8” from surface
RAP in Hot-Mix Asphalt

• Using RAP reduces construction costs, conserves resources, and reduces waste.
• Today’s value of RAP far exceeds values in the past.
• From August, 2007 to August, 2008 cost for asphalt binder increased an average of 94%.
  • PG 64 increased 103% from $334 to $678/ton.
  • PG 70 increased 91% from $414 to $790/ton.
  • PG 76 increased 89% from $442 to $837/ton.
Warm Mix Asphalt (WMA)

• An environmentally friendly technology enabling hot-mix asphalt to be produced, placed and compacted at lower mix temperatures
  – Up to 100°F lower than hot-mix asphalt
  – European technology
  – The Asphalt Paving Industry has been promoting the technology
Initial Thoughts

• Why Warm-Mix Asphalt?
  – Understanding the technology

• Where do we use it?

• What are the benefits?
  – Environmental
  – Economic

• What are the concerns?
  – Quality
  – Long Term Performance
VISCOSITY / TEMPERATURE

PG 64-22 (Approx.)
• Chemical binder additives:
  – Cecabase RT®
  – Evotherm™
  – Rediset™ WMX
  – REVIX™

• Chemical mixture additives:
  – Asphaltan®
  – Sasobit®

• Foaming admixtures:
  – Advera®
  – Aspha-Min®
  – Low Energy Asphalt

• Plant modification:
  – Double-Barrel® Green
  – Terex® WMA System
  – WAM-Foam
NORMAL COATING

20-25 μm

DB GREEN FOAM COATING

9 μm

COATING THICKNESS
FM 324 - Lufkin

HMA

WMA
Current Non-Attainment Areas
Loadout Temperatures

Control
Temp = 320°F

WMA
Temp = 270°F
Absorption in Roadway Cores

Warm Mix

Hot Mix
No Distress Evident after One Year
After Two Years of Service
Specification Development

• Allowed or Required?
  – Allowed at contractor’s option on all projects
    • Produce mixture between \(215^\circ F\) and \(350^\circ F\)
  – Required when shown on the plans
    • Produce mixture between \(215^\circ F\) and \(275^\circ F\)

• Approved List of Additives and Processes maintained by TxDOT

• Verify JMF 1 based on plant-produced mixture from the trial batch
Summary

- Approximately 400,000 tons have been placed in Texas to date
- Overall performance has been good
- Significant increase in resistance to cracking
- Less compactive effort required
- Longer compaction window to get densities
- Less asphalt absorption – more effective asphalt in the mix
Why Warm Mix?

- Reduced green-house gas emissions
- Reduced energy consumption
- Better performance of mixtures
- More effective compaction
- Safer working conditions
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-off): 11.5 million tons
• Less than 5% of shingle waste is recycled
Why Recycled Shingles?

- A good source for asphalt
- Reduce landfill consumption
- Conserve 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><strong>30-36%</strong></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>
Shingle Composition
Comparison with RAP

RAP

- Coarse Agg.: 60.0%
- Fine Agg.: 35.0%
- Asphalt: 5.0%

RAS

- Fine Agg.: 72.5%
- Asphalt: 24%
- Fibers: 2.5%
National Use

Allow shingles in mixes
Specs under development
Facilities in Texas

- Shingle Manufacturer
- Capability to process tear-offs
**TCEQ**

- **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%
  - Counter-flow drum (double barrel) – air quality issue
TxDOT

- Special Provision allows manufactured waste and residential “tear-offs”
  - up to 5%
  - deleterious limited to 1.5%
  - 100% passing 1/2“ sieve

- Can be combined with sand or RAP
Crossing the Economic Barrier

- Most unsuccessful attempts to recycle and incorporate shingles into mixes are due to improper sizing
- Best approach is to add the extra equipment necessary to process shingle down to sufficient size
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
Better

Faster

Cheaper

... creating value
Value ($/ton)

- RAP to Counties
- HMA-RAP
- HMA-RAS
- base RAP or RAS
- landfill costs for shingles
- backfill pvmt edges RAP or RAS

Values:
- 8
- 14
- 19
- 40
- 80
“We should treat our roads as assets, not commodities that can be used up, thrown away and replaced with new ones.”

- Don Brock, Astec Industries