TOWARDS GREEN RECYCLED ASPHALT SHINGLES AND FUTURE RECYCLED APPLICATIONS

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RECYCLING ROOFS INTO ROADS
Asphalt paving mixtures consist of:
- asphalt (or bituminous) cement
- coarse aggregates
- fine aggregates
- mineral fillers
ASPHALT PAVEMENT DETAILS

- Finished grade (top of surface course)
- Surface (or Wearing) Course (1” - 1 1/2”)
- Base (or Binder) Course (2 1/2” – 4”)
- Base (4” – 8”)
- Sub-base (8 – 12”)
- Undisturbed or Compacted Subgrade

Undisturbed subgrade is top of Excavation. Compacted subgrade should be compacted to 95% of dry bulk density at optimum moisture content.

Edge should be constrained or extend base to prevent cracking.
75% RECLAIMED or REUSED

• The Federal Highway Administration estimates that 100 million tons of asphalt pavement are scraped or “milled” off roads during resurfacing and widening projects each year.

• Of that, 75 million tons are reclaimed and reused as part of the nation’s roads.
• More asphalt pavement is recycled than any other product.

• Hot Mix Asphalt can be engineered to accept recycled products from other industries, helping to reduce our reliance on landfills.
FACTS ABOUT ASPHALT

• Asphalt is like an expensive carpet. It may be produced with a great deal of care and attention, but if it isn’t installed properly, it isn’t worth a cent.

• About 94 percent of the nation's roads and highways are surfaced with asphalt.

• Terminology: Asphalt

• Asphalt partially crystalline mixture
  – Bitumen (polymer-modified)
  – Aggregate (rock)
  – Sand

• “Asphaltic Concrete”
HOT MIX ASPHALT TRIVIA...

1) How many tons of HMA are placed/yr?
675-750 Million Tons or 2.25-2.50/person

2) How many miles of roads in USA?
4 Million Miles of Roads

3) How many miles are paved?
2.4 Million Miles

4) How many of those are paved w/ Asphalt?
2.3 of the 2.4 Million Miles are paved w/ HMA

5) How many tons HMA on roads today?
About 18 Billion tons
RESIDENTIAL ROOFING - SHINGLES
Main Goals of Using Recycled Asphalt Shingles

• **50% Waste Diversion**
• **Increased disposal standards**
  – Increased environmental protection;
  – Increased disposal costs; and
  – Increased diversion
• **Regional cooperation**
  – To reduce costs
  – Take advantage of economies of scale
• **Economic opportunities**
  – Example: Value added products from asphalt shingles
WHY USE SHINGLES?

• Economic benefits
• Cost savings per ton of HMA ranges from $2.15 to $3.30
• Tipping fees and handling costs vary
• Actual savings more likely to be $1.25 to $1.85 per ton.
SHINGLES

• Up to 5% (manufactured waste) or 3% (post consumer use) of asphalt shingles may be substituted in lieu of mineral aggregate. Asphalt shingles is included in the total amount of recycled materials allowed.

• Asphalt shingles may contain a maximum of 3.0 percent deleterious material.

• A maximum of 1.5% wood shall be allowed. Shingles containing asbestos shall be handled in accordance with applicable regulations.
GOING TOWARDS GREEN-RECYCLED AWARENESS

RECYCLED SHINGLES IN HMA

<table>
<thead>
<tr>
<th>Tons</th>
<th>2005</th>
<th>2006</th>
<th>2007 YTD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>610</td>
<td>9,800</td>
</tr>
</tbody>
</table>

- 2005: 20 tons
- 2006: 610 tons
- 2007 YTD: 9,800 tons
FACTS OF ASPHALT ROOFING SHINGLES

• Asphalt Roofing Shingles Are One Of The Major Components Of Debris Generated From Construction Projects.

• Asphalt Roofing Shingles Are The Most Common Roofing Material And Account For More Than 60% Of Residential Roofing Market In USA.

• Approximately 11 Million Tons Of Asphalt Shingle Waste Is Generated In The USA And Most Of It Goes To Landfills.
FROM ROOF TO ROAD

- Roofer is dropping tear-off shingles only directly into trailer.
- Plastic, wood and metal debris is piled separately on the tarp spread out on the ground nearby.
SHINGLES PROCESSING

- Shingles are loaded at the bottom of the trailer.
- Scrap wood and other debris are loaded on top of the shingles.
PROCESSING OF ASPHALT SHINGLES
SHINGLE GRINDING

SOURCE NAPA-1997
SHINGLE GRINDING OPERATION
ASPHALT SHINGLE RECYCLING

RECYCLING

LANDFILLING
WHY USE SHINGLES AND ROOFING MATERIAL IN “HOT” ASPHALT?

- Assume $500/ton for new bitumen feedstock.
- Prices rising as oil costs rise.
- Shingle replaces sand at equal cost (1 cent/lb).
- Shingle also provides 1% bitumen content for “free” benefit of $1.00/lb.
BENEFITS

• Counties charge a $40 per ton disposal fee for waste shingles. Asbestos testing is $12 per ton plus another $18 per ton for processing for profit of $10 per ton.

• Substantial reduction in the volume of garbage to be buried in the landfill.

• Effective dust control - The asphalt shingles bind the crushed stone granular surfacing material together.
RECYCLED ASPHALT SHINGLES (RAS) IN HMA...HOW LONG?

• About 10 States have a spec allowing RAS in HMA
• About 25 contractors in North America run RAS in HMA as standard practice
• Alabama allows post consumer shingles (tear offs) in HMA (3%). However at present contractors are using factory waste (5%) in the HMA.
SHINGLE MANUFACTURERS IN ALABAMA

• Birmingham
• Tuscaloosa
• But Alabama has been using factory waste hauled as far as from Dothan for use in hot mix asphalt.
PROPERTIES AND SPECIFICATIONS OF RECYCLED ASPHALT SHINGLES (RAS)

**Shingle Aggregate Gradation**
- 100% Passing the 1/2 inch sieve
- Gradation of RAS—**Free of Metal, Glass, Paper, Rubber, Wood, Plastics, Soil, Brick, Sand, Tars and other contaminating substances**
- Asbestos Limitations

**AASHTO SPECIFICATIONS**
- AASHTO PP 53
- AASHTO MP 15-06
- AASHTO M29
- AASHTO T2
- AASHTO T30
TYPICAL COMPOSITION OF AN ASPHALT SHINGLE

- 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</td>
<td>2-15%</td>
<td>2-15%</td>
</tr>
<tr>
<td>Mineral granules/aggregate</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>
DO THE MATH

- An available 11 million tons of shingle waste, containing 20% liquid AC
- 2.2 million tons of reclaimable liquid AC
- At $300.00 per ton that’s **$660 million** worth of liquid asphalt every year
ADDING TEAR-OFFS FROM RE-ROOFING HAS ITS CHALLENGES

- Tear-offs usually contain various contaminants – nails, wood, demolition debris, household refuse, and in very rare occasions asbestos...
- Some state DOTs require pavement standard for non-road applications.
- Hot-mix plant operator preference for adding recycled asphalt shingles varies.
- Logistics to collect and transfer re-roofing tear-offs to hot-mix plants lacks widespread workable infrastructure.
PROBLEMS TO OVERCOME

• Tear-offs
  ▪ Intensive pre-processing
  ▪ More contamination than manufacturer rejects
  ▪ Smell from mold

• Environmental Issues
  ▪ Dust control
  ▪ E.P.A. regulations concerning stockpile locations and size
POSSIBLE EXPOSURE PATHWAYS

Release of Asbestos?

PAH Release of Asbestos? missions?

PAH leaching?

Grinding → HMA → Pavement, mulch, etc.
HEALTH IMPACTS

• Asbestos
  – Lung cancer
  – Mesothelioma

• Hot mix shingles manufactured after 1973 pose no environmental problem.

• Unfortunately, asbestos fibers were used in a very small percentage of hot mix asphalt shingles produced between 1940 and 1973.
ASPHALT SHINGLE TESTING FOR ASBESTOS

• Data from processors in Maine, Iowa, Florida, Missouri, Minnesota, and Massachusetts.

• Data available for 27,694 samples collected
  – 18 detections asbestos content <1%
  – 408 detections asbestos content >1%
  – Overall, asbestos detections in 426 samples
    • Approximately 1.53%

• Analytical results of over 27,000 asphalt shingle samples indicated that about 1.5% of all samples detected asbestos.
• Asphalt shingles naturally contain PAHs.

• A leaching study on discarded asphalt shingles indicated that PAHs did not readily leach PAHs.

• Related studies on virgin roofing asphalt, reclaimed asphalt pavement, and run-off from asphalt pavement indicated PAH concentrations below the laboratory detection limits.
PAH EMISSIONS IN HMA PRODUCTION HAS NOT YIELDED ANY DATA TO DATE

• PAHs are emitted during HMA production
  – Pollution control equipment reduces PAH concentrations

• A study in Texas investigating the issue of PAH emissions in HMA production has not yielded any data to date.
RAP-ANOTHER RECYCLED APPLICATION

• Reclaimed asphalt pavement (RAP) is the term given to removed and/or reprocessed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction, resurfacing, or to obtain access to buried utilities. When properly crushed and screened, RAP consists of high-quality, well-graded aggregates coated by asphalt cement.
RAP IS MORE ENVIRONMENTALLY FRIENDLY

- Majority of producers use a minimum of 20% RAP in HMA production
- Reclaiming & on-site crushing (for aggregate base) is becoming more popular
- As AC & aggregate prices increase, the value increases
- RAP Use is Environmentally Friendly
- Reduces construction materials to the landfills
- Reduces demand for aggregates from mining operations
- Reduces demand for asphalt binder.
WHEN TO RECYCLE

• Distressed Pavement at End of Design Life
• Fatigue (Alligator) Cracking
• Large Oxidized Thermal Cracks
• Surface Maintenance No Longer Effective
• Excessive Raveling & Potholes, Safety is a Concern
• Life Cycle Costs Dictate
WHEN TO RECYCLE ASPHALT

- Thermal Cracking
- Fatigue Cracking
- Poor Ride ability
- Patched
# ALLOWABLE USE OF RAP AND RAS

Maximum Allowable Percent of RAP and RAS in Total Aggregate Content

<table>
<thead>
<tr>
<th>Type of Mix</th>
<th>Maximum RAP Content</th>
<th>Maximum RAP and RAS Content **</th>
</tr>
</thead>
<tbody>
<tr>
<td>327, Plant Mix Bituminous Base</td>
<td>25 %</td>
<td>20%</td>
</tr>
<tr>
<td>327, Permeable Asphalt Treated Base</td>
<td>10%</td>
<td>RAS NOT ALLOWED</td>
</tr>
<tr>
<td>420, Open Graded Friction Course</td>
<td>10% RAP shall not contain chert</td>
<td>RAS NOT ALLOWED</td>
</tr>
<tr>
<td>423, Stone Matrix Asphalt 424, Superpave</td>
<td>Surface Layers: 20 % with no more than 15 %</td>
<td>Surface Layers: 15 % *; All Other Layers: 20 %</td>
</tr>
</tbody>
</table>

Source: ALDOT Specifications for Highway Construction
FULL DEPTH RECLAMATION-ALDOT 428 (UNDER DEVELOPMENT)-100% ENVIRONMENTAL FRIENDLY

Assessment for FDR

• Historic Information
• Pavement Distress
• Structural
• Material Properties
• Geometric Considerations
• Traffic
• Constructability
• Economic

WHERE ARE WE GOING TO USE FDR?
Energy Use and Materials

**Full-Depth Reclamation vs. New Base**

- **Number of Trucks Needed**: 12 (New Base), 180 (Full-Depth Reclamation)
- **New Roadway Material (metric tons)**: 300 (New Base), 330 (Full-Depth Reclamation)
- **Material Landfilled (cubic yard)**: 0 (New Base), 2,100 (Full-Depth Reclamation)
- **Diesel Fuel Consumed (gallon)**: 500 (New Base), 1,900 (Full-Depth Reclamation)

Based on 1 mile (1.6 km) of 24-foot (7.3-m)-wide 2-lane road, 6-inch (150-mm) base
A CLOSER LOOK AT THE NUMBERS

• The volume of recycled asphalt pavement is …
  • 13 TIMES greater than recycling of newsprint
  • 27 TIMES greater than recycling of glass bottles
  • 89 TIMES greater than recycling of aluminum cans
  • 267 TIMES greater than recycling of plastic containers

• More recycled products are used in making asphalt pavement
  • Old tires
  • Slag aggregate
  • Foundry sand
USING SCRAP TIRE AND CRUMB RUBBER
ASPHALT PAVEMENTS ARE SMOOTH AND QUIET
REFERENCES

- http://www.alasphalt.com/
- http://www.dot.state.al.us/docs
- http://www.shinglerecycling.com/
REFERENCES

• http://www.dykespaving.com/MOVrecycling.html
• http://www.rubberpavements.org/
ANY QUESTIONS????
ACKNOWLEDGEMENT

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