The Hot Mix Asphalt Industry – The Next Five Years
If I really knew where the industry is going to be in five years, would I be in this job?
Where are we?

- Mature infrastructure
- Increasing congestion
- Decreasing materials availability
- Increasing costs
- Shifting responsibility
- Industry consolidation
- Increasing environmental awareness
Congestion

• 1980 – 1999: Road miles increased 1.5%
• 1980 – 1999: Vehicle-miles increased 76%
• Work Zones – 482,000,000 hrs of delays each year
Material Supply and Cost
Florida Asphalt Cement

FDOT ASPHALT CEMENT INDEX

PRICE PER TON

2002 2003 2004 2005 2006
Caltrans

HMA & PCC Annual Cost Data (Caltrans)

Cost ($) vs Year

- AC ($/ton)
- PCC ($/cu yd)
Aggregate Industry

- The industry has been opening about **5,800 to 6,000** aggregate mines every 10 years. *(70’s, 80’s, & 90’s)*
- We did not keep up with closings.
- The industry has been opening about **1,400 to 1,700 crushed stone** mines every 10 years.

Some gains in active mines in last 5 years.
Aggregate Demand

Number of counties that need more aggregates is growing

Percent of counties in each category

Year | Surplus | In Balance | Deficit
--- | --- | --- | ---
1980 | 25% | 45% | 30%
1990 | 25% | 45% | 30%
2000 | 25% | 45% | 30%
Current Non-Attainment Areas

FIGURE 3: Counties not attaining the National Ambient Air Quality Standards (NAAQS) of the Clean Air Act, April 2005.
Needed Technical Focus

- Perpetual pavements
- Cleaner production
- Increased recycling
- Rapid construction
- Increased technical expertise
- Environmental design
Perpetual Pavements

<table>
<thead>
<tr>
<th>Depth</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-75 mm</td>
<td>40-75 mm SMA, OGFC or Superpave</td>
</tr>
<tr>
<td>100 mm</td>
<td>Zone Of High Compression</td>
</tr>
<tr>
<td>150 mm</td>
<td>Rut Resistant Material (Varies As Needed)</td>
</tr>
<tr>
<td>75 - 100 mm</td>
<td>Durability Layer</td>
</tr>
</tbody>
</table>

Max Tensile Strain

Pavement Foundation
Long-life (perpetual) pavements

• What they are: Flexible pavements designed to last 50 years or more without major rehabilitation or reconstruction.

• Why are they important:
  – Reduced life cycle cost
  – Reduced traffic congestion
  – More sustainable – reduced material consumption
Perpetual Pavement Analysis

- 4-Lane Highway
- 5 Mile Project
- 50 Year Analysis
- 20,000 AADT (initial)
  - 20% Trucks
  - 2% growth

Alternative 1
- Conventional Design (8” HMA; $50/ton)
  - 12 years between rehab with reconstruction in year 36
    • Mill 4”, replace with 6”

Alternative 2
- Perpetual Design (12” HMA; Base $50/ton, Surface $60/ton)
  - 15 years between rehab – no reconstruction
Cost Summary

Initial Construction Cost

NPV

Average Agency Cost Component

Average WZUC

Conventional

Perpetual
Summary

• Compared to conventional pavements, perpetual pavements can have:
  – Higher initial cost
  – Lower life cycle cost
  – Lower user cost
  – Longer rehabilitation cycles
  – Higher performance

• Major Advantage in most cases
  – User Cost

• Also need to consider
  – Noise
  – Ride
  – Environmental Issues
High Modulus Base

40-75 mm SMA, OGFC or Superpave

Normal Modulus
~3 MPa
(150-200 mm)

High Modulus
~30 MPa
(100-150 mm)
Design for stormwater mitigation

• Porous pavement
  – Completely pervious to water
  – Destroys a paradigm
  – Creates a solution

• Why is it important?
  – Reduce runoff
  – Recharge groundwater
  – Mitigate pollution
  – Reduces costs!
What are Porous Pavements?

Open-Graded HMA ~ 2 ½"

½” Agg. (#57) ~ 1 – 2” Thick

Clean Uniformly Graded 2”-3” Crushed Agg. (#2) – 40% Voids

Non-Woven Geotextile

Uncompacted Subgrade
Shared Medical Systems
Malvern, PA
1982
Porous Pavements

• What needs to be done:
  – Performance monitoring
  – Alternative to aggregate bed
  – Structural design
Warm Mix Asphalt

• Warm Mix Asphalt
  – Processes or products allowing reduced production and placement temperatures.

• Why is it important?
  – Reduced energy consumption
  – Reduced odors and emissions
  – Better work environment
  – Reduced binder aging
  – Potentially improved workability and compaction
Hot Mix (155 °C)

311 °F

WAM (110 °C)

230 °F
Late Season Paving

For $\Delta T = 125^\circ F$

HMA Time = 14 min.

WMA Time = 29 min.
Limestone - SGC

Compaction Temperature, F

Air Voids, %

Samples mixed 35F above compaction temperature
APA Rut Depth for PG 64-22 - Granite

Control Zeolite Sasobit Evotherm

Rut Depth, mm

300F 265F 230F 190F
Failure Modes

Adhesive

Cohesive
## Granite Hamburg Stripping Inflection Point

<table>
<thead>
<tr>
<th>Additive</th>
<th>SSD+ in Bucket Mixer at 250F</th>
<th>Bucket Mixer With Anti-Strip</th>
<th>Anti-Strip Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA</td>
<td>6500*</td>
<td>NA</td>
<td>0.75% LOF 6500</td>
</tr>
<tr>
<td>Zeolite</td>
<td>3975</td>
<td>8500*</td>
<td>1.5% Lime</td>
</tr>
<tr>
<td>Sasobit</td>
<td>3450</td>
<td>&gt;10,000</td>
<td>0.4% Magnabond</td>
</tr>
<tr>
<td>Evotherm</td>
<td>&gt;10,000</td>
<td>NA</td>
<td>Evotherm</td>
</tr>
</tbody>
</table>

* One of two samples did not have striping inflection point in 10,000 cycles
Field Sections

More than 16 U.S. sections to date
World wide in dense-graded, SMA and OGFC
Things We Need to Go Forward

• Larger trials
• A robust product evaluation protocol
• **WE NEED A PERFORMANCE TEST!**
• Better understanding of effect on rutting and moisture damage
• Procedures for mix design and QC/QA (Do they need to be different?)
• A way for Agencies to specify
  – Temperature reduction?
  – Binder grade?
What is the State of WMA?

• Not ready for prime time – yet!
• Driving forces could accelerate implementation
  – Energy costs
  – Emissions requirements
• The time is *now* to develop and learn how to use
Recycling Hot Mix Asphalt

• Reclaimed Asphalt Pavement (RAP)
  – HMA removed from a pavement and introduced into a new mixture for reuse
  – Standard practice since ~1980

• Why is it important?
  – Saves money
  – Saves resources
  – Saves landfill space
RAP in State Mixes - Surface

- % Allowed
- % Used
- % Potential

Avg. Potential = 26
Avg. Allowed = 20
Avg. Used = 12
The Survey Says. . .

- We can do more recycling under the existing specs. Need to consider how it’s handled.
- Not much consistency between states on what’s allowed.
- We need to work with agencies to get RAP percentages increased, especially in surface mixes.
How to become a RAPPER.

• View RAP as a valuable resource.
• Treat RAP as you would other ingredients.
• Offer yourself maximum flexibility in using RAP.
• Learn what’s in RAP.
• Monitor process and materials continuously – keep it consistent.
Effect of RAP Binder on Virgin Binder Grade

- Guidelines
  - Up to 15-20% - Don’t change PG grade
  - 20 to 25 or 30% - Use 1 temp grade lower
  - Above 25 or 30% - Test RAP Binder

- Alternative – Conduct regional studies on RAP binder properties
WRI Study

![Graph showing the log viscosity of different asphalts over pavement age.](image)
Summary

• Still 5 to 10% RAP that can be used under existing specs. We can go further!
• Need to work with agencies to increase allowable RAP, especially where it is not allowed.
• Two biggest obstacles in mix design:
  – Binder characteristics
  – No. 200
• Mix design procedure not too different.
Summary

• Consistency is key to increasing RAP. Consider separate stockpiles. Testing is needed.
• We still need a suite of performance tests – especially for cracking.
• Don’t compromise quality.
Workforce

Larry Kokkelengerg
MARKET CONDITIONS

• Constructions jobs to grow by 9% by 2008;

• The U.S. will be short 10 million positions by 2010;

• Almost 50% of construction workers will be eligible for retirement by 2012
MARKET CONDITIONS

• A decreasing number of 18-24 year olds seek jobs within construction;

• Average age of new hires is 28-32;

• The overall average age of all construction workers is 40 years old;
MARKET CONDITIONS

• 70% of companies say they are experiencing a shortage of skilled workers.
  – Impacts ability to complete jobs
  – They had the contracts, the equipment, the money, but not the labor.
• Construction worker image is poor – out of 250 career choices, construction worker ranked:
  • 248
  • 249 - Insurance Actuary
  • 250 – Migrant Worker

National Business Employment Weekly
Companies with better retention were:

- more profitable,
- completed more projects on time or ahead of schedule
- experienced better project safety.
TRAINING

• Companies that spend more on training had higher earning’s per employee.

• Companies that spent $900/employee had 57% higher return than those spending $275.00/employee.

• Companies that spend more on training had a 37% higher profit margin per employee and their companies performed 29% higher on Wall Street than average.
TRAINING

• Spend $250 per employee turnover increased to 15%
• Spend $499 per employee turnover dropped to 6%
• Spend $999 - $1,999 per employee and turnover dropped to 1%.
Summary

• Industry will continue if innovation continues.
• Technical solutions are needed for improvements.
• Fundamental research needed on selected topics.
• Need funding of research program, not earmarks.
• Industry needs graduates familiar with the material.