Advances and Challenges in Asphalt Paving

Jenny Liu, Ph.D., P.E.
Sheng Zhao, Ph.D.
Center for Environmentally Sustainable Transportation in Cold Climates
University of Alaska Fairbanks

February 12, 2015
Outline

• Background
• Material & design
• Construction
• Maintenance, preservation, and assessment
• Summary
Background

• Paving industry are constantly seeking to
  – Improve pavement performance, increase construction efficiency, conserve resources and advance environmental stewardship

• Innovations are continuously being developed

• Issues arising:
  – Performance, durability and compatibility
  – Material design, cost analysis, specifications and quality control
Materials & Design

• High RAP/RAS content
RAP Averaging Usage - State Practice

NAPA 2009-2013 survey
RAS Usage - State Practice

NAPA 2009-2013 survey
Performance of High RAP Mix

• Cracking resistance
  – Aged and stiff RAP binder can cause fatigue damage and low-temperature brittleness

• Water susceptibility
  – Generally positive: RAP aggregates already covered with asphalt; less chance of water penetration
  – However, if RAP already has a stripping problem, it can be transferred to new mix

• Rutting Resistance
  – Aged and stiff RAP binder improves rutting resistance
Performance of HMA containing RAS

- Pavements using RAS can be successfully produced
  - With RAS alone
  - In combination with: WMA, RAP, GTR and SMA
- Meet state agency quality assurance requirements
- Good rutting and fatigue resistance (four-point beading beam)
- No statistical change in Low temperature fracture resistance, with fibers that can be beneficial
• Field performance after two years
  – No signs of
    • Rutting
    • Wheel path fatigue cracking
    • Thermal cracking
  – Transverse reflective cracking were observed from the underlying jointed concrete pavement
    • More cracks for pavement containing coarsely ground RAS
    • Controversial observations:
      – Non-RAS pavement showed similar or more cracking: IA, IN, IL and WI
      – RAS pavement showed similar or more cracking: MS and CO
WMA containing High RAP/RAS

- Due to construction costs and environmental issues
- WMA with high RAP/RAS can be successfully produced and placed
- Mutual benefits
  - WMA: less aging, more workable
  - High RAP/RAS: increased rutting and moisture resistance
- Nation-wide study
  - Completed: NCHRP 9-46 (high RAP), NCHRP 9-47 (WMA)
  - Active: NCHRP 9-49 9-53 (WMA), NCHRP 9-55 (WMA-RAS)
Challenges for Use of High RAP/RAS

• Aged binder property
  – Recycled binder is too stiff, especially RAS
  – Cracking concerns still exist

• Blending efficiency
  – How much and how well the old and new binders blend?
  – Rejuvenators for RAS mixture seems necessary

• RAP aggregate
  – Excessive fines can be generated by milling and crushing, thus affecting further mix design
Challenges – Mix Design

- NCHRP 9-46 “Mix Design and Evaluation Procedure for High RAP Content in HMA” (*Completed, Report 752*)
  - Develop mix design and analysis procedure for High RAP mix
  - Propose changes to existing specifications
- However, state practices may vary
  - Texas, balanced RAP/RAS overlay mix design and performance evaluation system was proposed
- More experience needed for Mix design of RAS Mix
Construction

- Intelligent compaction (IC)
Why Use IC?

• Benefits of IC
  – Improved compaction quality of asphalt pavements
  – Increased quality control and reduced maintenance cost
  – Money-savings
  – Safer operations
How IC Works?

• GPS based compaction
How IC Works?
Current Status

- 12 DOTs had demonstrated 16 field IC projects before 2011

NCHRP 21-09, for subgrade soils
Transportation Pooled Fund #954, for embankment subgrade soils, Aggregate base and asphalt pavement material
Challenges in Implementation of IC

- Extensive professional training required
- Data standardization: parameters of each section may affect the IC data results
- Moisture content measurements and variation
- Poor correlation between density and modulus/stiffness
Pavement Preservation - “Strategy including all activities to provide & maintain serviceable roadways”

$1 for preventive maintenance here

Costs 6-10 times or more when it’s done as rehab
Types of Pavement Preservation Treatments

- Crack Sealing
- Patching
- Fog Seals
- Chip Seals
- Slurry Seals
- Microsurfacing
- Bonded Wearing Courses
- Interlayers
- Thin Overlays
- In-place Recycling
- Other treatments
- Asphalt Surface Treatment/
  Bituminous Surface Treatment (AST/BST)
• Pre-cut technique - control thermal cracks/build “better” thermal cracks
## Typical Lives and Costs of Treatments

<table>
<thead>
<tr>
<th>Preservation treatment</th>
<th>Estimated life, years</th>
<th>Estimated cost, $/yd²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crack Seals</td>
<td>3-8</td>
<td>--</td>
</tr>
<tr>
<td>Fog seals</td>
<td>2-5</td>
<td>0.40 to 0.60</td>
</tr>
<tr>
<td>Chip seals</td>
<td>3-10</td>
<td>2.00 to 4.00</td>
</tr>
<tr>
<td>Slurry Seals</td>
<td>3-7</td>
<td>1.00 to 2.00</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>3-9</td>
<td>1.50 to 3.00</td>
</tr>
<tr>
<td>Thin HMA Overlays</td>
<td>5-12</td>
<td>3.00 to 6.00</td>
</tr>
</tbody>
</table>
Is this Particular Practice Economically Worthwhile?

Sealant Use Noticed in Several Salt Lake City, Utah Parking Lots & Side Roads
Issues

• The right treatment on the right pavement at the right time
• Perception: the public will not support pavement preservation, but prefer the "worst-first" strategy
• Other issues than cost effectiveness speak for pavement preservation concept: sustainability, green products and technologies and traffic safety
Life cycle assessment (LCA) of asphalt pavement

Quantify the environmental impacts over the full life cycle of asphalt pavement
Purpose of LCA for Asphalt Pavement

• Identifying opportunities to improve the environmental performance of asphalt pavement in its life cycle.
• Informing and guiding decision makers
• Developing appropriate indicators of environmental performance of asphalt pavement; for example, if using RAS is environmental-friendly
Challenges of LCA

• Data collection
  – Availability of readily accessible and applicable data
  – the cost of data collection
  – A number of uncertainties in the data

• Data quality
  – Establishment of standards is required

• Issues with impact assessment methods
  – Can it be exclusive to pavement?

• Issues with weighting of impacts in decision-making
  – Different impact categories give conflicting impact rankings?
  – Which impact(s) is (are) more important?
Summary

• Advance innovative sustainable materials and design

• Effective design, management and preservation strategies during construction, operations and preservation

• Life cycle assessment
Upcoming Events

• International Symposium on Systematic Approaches to Environmental Sustainability in Transportation, August 2-5, 2015, Fairbanks AK
  – http://cem.uaf.edu/cesticc/symposium.aspx
  – Contacts
    • Jenny Liu: jliu6@alaska.edu
    • Sheng Zhao: szhao4@alaska.edu
QUESTION