Why Preservation: Definitions, Treatment Types, Benefits and Challenges

Prepared for the 12th ISAP Conference
By Dr. R. Gary Hicks P.E.
June 5, 2014
Preservation is becoming more a part of this conference

In the past the primary focus was on

- Binders
- Mixes
- Materials characterization
- Structural design
- Performance

Two sessions dealt with preservation issues at this conference along with this plenary lecture
Presentation Outline

- History
- Definitions
- Treatments
- Benefits
- Challenges
- The road ahead
- Conclusions and recommendations
Most current preservation treatments were used prior to 1992—called maintenance. Since then:
- Materials have changed
- Equipment has changed
- Design practices have not changed as much

Maintenance treatments perceived primarily as reactive, not preventive
- Often considered for low volume roads
- Designed by art not science

Used worldwide by federal, state and local agencies
Formation of current Foundation for Pavement Preservation (FP2) occurred in 1992

Cooperative agreement between FHWA and Industry in 1997

Lead for FHWA was Jim Sorenson

Leads for industry were Mike Buckingham (ISSA) and Bill Ballou, Michael O’Leary, and Jim Moulthrop (Koch Materials)

Academic lead was Gary Hicks (OSU)

Current FP2 Inc reorganized in 2006
Leadership in the FP2 Inc.

- Bill Ballou, Koch Materials, 1st President
- Mike Buckingham, former President
- Gerry Eller, former FHWA and FP2 Executive Director
- Jim Moulthrop, Current Executive Director
Early Challenges

- Preservation did not fit the highway bill as it was more than maintenance.
- Many HMA contractors did not support it because it took market share from them.
- Persistence paid off.
Current Efforts

- Lobbying to raise the bar for pavement preservation
- Support for the National Center
- Carrying the message to the states through the AASHTO TSP–2 program and national conferences
Concept for Pavement Preservation
Pavement Preservation – What is it?

- Sum of all activities to provide and maintain serviceable roadways
- Includes
  - Corrective & Preventive Maintenance
  - Minor rehabilitation
- Does not include
  - Reactive maintenance
  - Major rehabilitation or reconstruction
Defining Pavement Preservation

- Planned strategy of cost effective treatments
- Maintains or improves functional condition
- Does not increase structural capacity!!

*Keeping Good Roads Good*
Philosophy

Right Treatment

Right Pavement

Right Time

Also needs to be designed and constructed in the right way
Pavement Preservation – Concept

Condition

Original Pavement

Optimal Timing

Preventive Trigger

Rehabilitation Trigger

Time or Traffic

6/9/2014
Proactive approach to maintain our existing highways

Consists of

- Minor rehabilitation
- Preventive maintenance
- Routine maintenance

Does not include

- Corrective maintenance
- Catastrophic maintenance
- Pavement rehabilitation
Preservation Treatments Commonly Used for Asphalt Pavements

- Crack Sealing
- Fog seals
- Chip seals
- Scrub seals
- Slurry surfacings
- Cape seals (also 3 layer systems)
- Thin bonded wearing courses
- Thin HMA overlays
- In-place recycling (CIR and HIR)
Fog and Rejuvenating Seals

- **Purpose**: enriches dry pavement surfaces, reduces raveling, and locks in chips on chip seals (flush coat)
- **Materials**: generally diluted asphalt emulsions or a specialty product
- **Design considerations**: application rate a function of surface condition
- **Construction**: applied using a distributor truck in diluted form
- **Expected life**: 1 to 3 years or more
Potential Problems

- Using excess emulsion for the existing pavement surface
- Placing in wet and/or cool weather
- Over or under dilution
- Incompatible water for dilution
- Skid issues
Chip Seals

- Purpose – waterproof the existing surface and improve texture
- Materials – application of emulsions or hot binders followed by crushed aggregate
- Design – application rates need to be determined
- Construction – asphalt is applied followed by an application of aggregate
- Expected life – 5–7 years or more
Causes of Problems

- Improper surface preparation
- Applying in cool and/or wet weather
- Using dirty rock
- Not accounting for new patches or flushed surfaces
- Not taking traffic into account
- Over spreading or under spreading binder or aggregate
Scrub Seals

- Chip seal with a polymer modified rejuvenating emulsion (PMRE)
- A scrub broom is used to push the emulsion into the cracks
- Rejuvenates aged binder as it seals the pavement surface
The size of wave is a function of the number and severity of cracks.
Existing pavement

After emulsion applied with the scrub broom
Slurry Seals

- Purpose—seals minor cracks, restores surface texture, mitigates raveling
- Materials—a mixture of graded aggregate, emulsion (generally polymer modified), and setting agents
- Design—special mix design is needed
- Construction—applied using a special paver mounted on a truck
- Expected life—5 to 7 years or more if placed on sound pavements
# Slurry Seals

<table>
<thead>
<tr>
<th>Type</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crack Filling</td>
<td>General Seal</td>
<td>Rough - Textured Surface</td>
</tr>
<tr>
<td></td>
<td>Fine Seal</td>
<td>Medium-Textured Surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parking Lots</td>
<td>Urban Streets</td>
<td>Primary Highways</td>
</tr>
<tr>
<td></td>
<td>Residential Streets</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Airfield Runway</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Causes of Problems

- Improper surface preparation or placing on unsound pavements
- Placing in cool and/or wet weather
- Not following the mix design or calibrating the equipment
- Too much or too little additive
- Improper maintenance of spreader box and drag
- Adding too much water
- Not allowing enough cure time prior to traffic
- Inadequate QC or inspection testing
Micro Surfacing

Purpose – seal the surface, fill minor wheel ruts and surface irregularities, and can be placed at night

Materials – a mixture of graded aggregates, polymer modified emulsion, and set additives

Design – requires a mix design to determine the proportion of components

Construction – applied using a special truck mounted mixing/paving machine. For long straight jobs a continuous machine is recommended

Expected life – lasts 8–12 years depending on the surface it is applied too
Micro Surfacing - Where is it used?

Interstates

Arterials

Quick Traffic

Cool Climates
Causes of Problems

- Improper surface preparation or placing on badly cracked pavements
- Not following the mix design
- Construction in wet weather
- Equipment not calibrated
- Poor workmanship, including too much water in the mix
- Insufficient applications rate
- Inadequate QC and acceptance testing
Cape Seals

- Purpose— seal the surface and provide a smooth hard wearing surface
- Materials— a chip seal followed by a slurry seal
- Design considerations— mix designs for both products
- Construction— application of a chip seal followed by a slurry seal
- Expected life— 8–12 years or more
What is a Cape Seal?

Chip Seal Followed by a Slurry

Slurry
Chip Seal

Slurry Seal

Finished Surface
Causes of Problems

- Improper surface preparation
- Not following the mix designs
- Applying in cool and/or wet weather
- Over application of binder in either course
- Using conventional or polymer modified chip seals over cracked surfaces.
Application of polymer modified binder immediately followed by a thin HMA overlay
Total thickness has been about 25 mm
Applied with a spray paver
Expected life; 8–12 years
Thin HMA Overlays

- Types
  - Conventional
  - Polymer modified asphalt
  - Asphalt Rubber
  - Terminal Blends

- Thickness of 25–37.5 mm
- May be used with warm mix additives in cold weather construction
Reported Benefits of Pavement Preservation

- Cost effectiveness
- Energy savings
- Reduced emissions
- Reduced user costs
- Life extension
- User satisfaction
- Safety
Costs

Condition

Excellent

Failed

$1 to $5/\text{yd}^2$

Pavement preservation

$5 to $70/\text{yd}^2$

Rehabilitation or reconstruction

Time or Traffic
Energy Savings

- Use of emulsions can provide energy savings because there are smaller amounts of materials placed at lower temperatures.
- Use of warm mix technology can produce savings by placing hot asphalt materials at lower temperatures.
- Faster construction times can save equipment operating costs and user costs.
Reduced Emissions

- Emulsions have fewer emissions than hot applied binders
- Warm mix additives allow for cooler temperatures and fewer emissions
- Quicker construction cuts emissions from both users and contract activities.
Reduced User Costs—Maintenance vs. rehabilitations

- Maintenance projects generally have shorter traffic queues
- Any detours are of shorter duration
- Shorter construction times reduce user delays and user costs
Life Extension

- Very Good
- Good
- Fair
- Poor
- Very Poor

Life Extension

Treatment Life

Time (Years)
Life Extension

- Pavement preservation treatments can extend pavement life by 2 to 7 years or more
- Minimum costs compared to rehabilitations
- In many cases, maintenance can be repeated multiple times for added pavement life
  - Fog seals every 2–3 years
  - Chip seals every 3–7 years
  - Thin blankets every 5–10 years
- Major rehabilitation at 20 years of service instead of 12 years of service
Challenges

- Clearly documenting the benefits
- Shift from worst first to preserving good pavements
- Getting agencies to perform proper strategy selection
- Maintaining quality construction and acceptance testing
- Lack of performance related specifications for most products
- Keeping a preservation champion
Updating Pavement Preservation Design and Construction Practices

- Structural design
  - Not required
  - But is it needed?

- Mix design
  - Based on art not science
  - Lack of precision and bias statements
  - Need improved performance tests

- QC and acceptance testing
  - Does not follow practices like for HMA
  - Tests are not always performed on the mix
  - Agency’s get what they inspect and test
More Challenges

- Convincing the public that preservation is a good thing
- Getting agency’s management to buy into spending maintenance $ on good roads
- Understanding the effects that various maintenance strategies have on user costs
- Understanding the safety benefits of maintenance treatments
In 2013, the DOJ and FHWA developed a joint technical assistance document which defines the difference between an alteration and maintenance.

This could have a substantial impact on how agencies do business in U.S.
Maintenance vs. Alterations*

Crack Filling and Sealing
Surface Sealing
Chip Seals
Slurry Seals
Fog Seals
Scrub Sealing
Joint Crack Seals
Joint Repairs
Dowel Bar Retrofit
Spot High-Friction Treatments
Diamond Grinding
Pavement Patching

Addition of a new layer of asphalt
Reconstruction
Rehabilitation
Resurfacing**
Widening
Open-graded Surface Course
Micro surfacing
Thin Lift Overlay
Cape Seals
In-Place Recycling

* Alterations trigger wheelchair ramps in most circumstances;
** from one intersection to another, includes overlay of additional material, with or without milling
FP2 Inc., CCSA, and the CP2 Center have conducted a survey on the potential impacts (cost and availability of treatments)

The results should be available soon

HMA contractors should be concerned as well
Factors Affecting the Performance of Pavement Preservation Treatments

- Existing pavement condition
- Construction process and workmanship
- Materials quality and selection
- Climate and Traffic
### Percent Reduction in Life for a Thin HMA Overlay

<table>
<thead>
<tr>
<th>Treatment Life Reduction Percentage, %</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretreatment Pavement Condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>36%</td>
<td>18%</td>
</tr>
<tr>
<td>Poor</td>
<td>64%</td>
<td>18%</td>
</tr>
<tr>
<td>Materials Selection and Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginal</td>
<td>36%</td>
<td>22%</td>
</tr>
<tr>
<td>Poor</td>
<td>57%</td>
<td>20%</td>
</tr>
<tr>
<td>Construction and Workmanship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginal</td>
<td>45%</td>
<td>21%</td>
</tr>
<tr>
<td>Poor</td>
<td>61%</td>
<td>21%</td>
</tr>
<tr>
<td>Mix and Structural Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginal</td>
<td>35%</td>
<td>19%</td>
</tr>
<tr>
<td>Poor</td>
<td>57%</td>
<td>20%</td>
</tr>
<tr>
<td>Traffic Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>22%</td>
<td>22%</td>
</tr>
<tr>
<td>Poor</td>
<td>45%</td>
<td>25%</td>
</tr>
<tr>
<td>Climate during and immediately after construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginal</td>
<td>33%</td>
<td>24%</td>
</tr>
<tr>
<td>Poor</td>
<td>50%</td>
<td>24%</td>
</tr>
</tbody>
</table>
Percent Cost Increase from Good Conditions
The preservation community has to do better. There are still too many failures with some of the treatments.

- We need to control the factors affecting the field performance.
- We need to document the performance of the treatments using:
  - Test tracks like NCAT and MnRoad
  - FHWA plans to develop a LTPP program for preservation treatments

- Let's hope this information will help answer some of the major issues related to pavement preservation.
Conclusions

- We have come a long way in the past 20+ years. However, we still have much to do.
- Preservation is now a common practice in the USA largely in part due to FHWA, FP2 Inc, AASHTO, the National Center at Michigan State University, and the regional Centers at Chico State and University of Texas at Austin.
- Many agencies throughout the world have established pavement preservation programs for both asphalt and concrete pavements.
- However, it will be difficult to do more with less funding. The fiscal cliff we are in needs to be resolved soon.
Best Recommend Concrete Preservation Treatment
Recommendations

- Documenting the performance of preservation treatments
- Improving the technology for mix design and performance testing for many of the treatments
- Developing performance based specification for these treatments that include Superpave binder testing
- Improving the QC and acceptance testing practices for preservation treatments
- Providing continuous education on how to place successful treatments
Resources for Asphalt Pavement Preservation

- FP2 Inc. – www.fp2.org
- FHWA— www.fhwa.dot.gov/pavement/pres.cfm
- PPRA— www.ppralliance.org
- NAPA— www.asphaltpavement.org
- NCPP— www.pavementpreservation.org
- AASHTO— www.tsp2.org
- CP2 Center— www.cp2info.org/center
Recent Conferences on Pavement Preservation

- **2010. 1st International conference in Newport Beach, CA**
  - Over 600 attendees
  - Deliverable—Proceedings of the papers
  - Included exhibitors and some field demonstrations

- **2012. 1st National conference in Nashville, TN**
  - Over 600 attendees
  - Deliverables—Copies of presentations
  - Included exhibitors and field demonstrations

- **2015. 2nd International conference in Paris France, Feb 22–25**
Questions

rghicks@csuchico.edu
530-588-4446