Thinlay Asphalt for Pavement Preservation

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Executive Director
APAO
The Need

• Pavement Management Professionals are tasked with implementing strategies and treatments that will provide the highest level of service at the least cost over the life cycle.
Preservation Treatments need to correct minor surface

- Cracking
- Rutting
- Raveling
Preservation Treatments

- Should seal the existing pavement to prevent intrusion of water and air
Preservation Treatments should also improve serviceability

- Smoothness
- Surface friction
- Drainage issues
Preservation Treatments should last as long as possible

- Long life = low life cycle cost
- Long life = minimal user impacts
- Long life allows the Pavement manager to optimize the performance of the entire network
Preservation Strategies

• Should include an inventory of structural needs/limitations
• What is the structural capacity/life of this pavement?
• What is the impact of a fatigue (structural) failure?
• How will this treatment impact the fatigue life?
Thinlay Asphalt Treatments

• Are designed to address all of these important Preservation needs
  ✓ Correct Surface distress
  ✓ Seal the existing surface
  ✓ Improve Serviceability
  ✓ Provide long life
  ✓ Extend structural life
Thinlay Asphalt Treatments

- Asphalt mixes engineered specifically for pavement preservation
- Designed with aggregate gradations allowing placement as thin as $\frac{3}{4}''$
- Binders and gradations selected to optimize flexibility, durability and rut resistance
Thinlay Asphalt Treatments

• Can include recycled materials RAP, RAS, GTR to enhance performance, reduce costs, reduce demand for new raw materials (improve sustainability)
• Can be produced with warm mix technology to further enhance sustainable qualities
Thinlay Mix Design

- Mix design Criteria to optimize Preservation needs
  - Nominal Max =/< 1/3 lift thickness (for ¾” lift use 6.3 mm or smaller mix)
  - binder selected to optimize crack resistance (softest binder that passes rut test), polymers for highest demand areas
  - RAP and RAS combined with softer base binders to provide optimum value
Thinlay Mix Design

- Mix design Criteria to optimize Preservation needs
  - Gyrations levels to match traffic and local practice generally 65-80
  - Va, (4 +/- 1%) VMA (15-17), VFA (70-80), avoid low VMA high dust mixes
  - Minimum binder contents normally 6%, typically higher due to fine grading
Thinlay in Texas
40% RAP mix $\frac{3}{4}$” thick
Thinlay Asphalt Benefits

- Seal the existing pavement
- Correct functional (non-structural) pavement deficiencies
- Provide structure (i.e. strength)
- True-up the pavement (i.e. restore cross-slope and profile)
- Reduce cost of pavement maintenance
Reduced permeability improves pavement longevity by protecting the pavement from the damaging effects of air and moisture intrusion... SIMILAR TO A SHINGLE!

Source: NCAT
Thinlay Asphalt Benefits

• Improve ride and correct cross slope deficiencies
• MAP21 will require reporting pavement condition
• Primary condition measure will be IRI (smoothness)
SHRP SPS-3 STUDY

- Thin overlays significantly improved pavement smoothness after treatment

- Chip seals and slurry seals showed little or no pavement smoothness improvement after treatment
Thinlay Asphalt Benefits

- Reduce cost of pavement maintenance

  Properly designed thinlay asphalt requires very little maintenance and can last longer than the original surface
Thinlay Asphalt Benefits

- No need to program seals on a thinlay, they are impermeable
- If reflective cracks form seal the cracks, that is it.
Thinlay Asphalt Benefits

- Rapid construction and immediately open to traffic
- Public views the road as “like new” following thinlay paving
- No cure time or sweeping, or broken windshields
- Limited performance risk
- Preferred by cyclists and other non-auto traffic
Preservation Treatment Effects on Pavement Condition and

- New
- Preventive Maintenance
- Critical Condition
- Corrective Maint, Rehabilitation, or Reconstruction

Pavement Condition vs. Time or Traffic
Figure 2. Life-extending benefit of preventive maintenance treatment.

Source: FHWA Pavement Preservation Compendium, Figure 2. Life-extending benefit of preventive maintenance treatment.
The plot of pavement management system (PMS) data indicates the rate of deterioration in pavement condition as determined by measuring severity and extent of pavement distresses.
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Pavement Condition Rating System – Distress types rated for flexible pavements.

- Raveling
- Bleeding
- Patching
- Potholes/debonding
- Crack sealing deficiency
- Rutting
- Settlements
- Corrugations
- Wheel track cracking
- Block & Transverse cracking
- Longitudinal joint cracking
- Edge cracking
- Random cracking
With the application of a preventive maintenance treatment, pavement distresses are corrected and condition is improved. Pavement life is extended.
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Life Extension depends on (1) structural soundness of the pavement upon which the preventive maintenance treatment is to be applied, and (2) robustness of the treatment.
Generally, less robust treatments provide lesser life extension.
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<table>
<thead>
<tr>
<th>Time (Years)</th>
<th>Life Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(Very Poor)</td>
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<tr>
<td>25</td>
<td>(Very Good)</td>
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<tr>
<td>50</td>
<td></td>
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<tr>
<td>75</td>
<td></td>
</tr>
<tr>
<td>100</td>
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</table>

Pavement Condition (PCI, PCR)

(Very Good) 100
(Very Poor) 0

Life Extension
Less life

PMS Data Point
Life extension varies based on robustness of the preventive maintenance treatment. In general, ThinLay asphalt Treatments afford greater Life Extension.
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Beyond their role in asset management, pavement condition rating systems are primarily tools for identifying distresses and developing rehabilitation strategies to correct them.
How well does the treatment meet the satisfaction of the user?

Condition ratings provide only part of the answer. “Serviceability” also needs to be considered.
Serviceability is...

- A pavement performance measure developed as part of the AASHO Road Test, and
- A measure of the pavement’s ability to serve the type of traffic which use the facility, and
- A measurement of the users’ perceptions regarding the **acceptability of a pavement**, and
- Largely impacted by the user’s perception of ride quality.
Serviceability declines as a pavement deteriorates under the punishment of traffic. The lowest tolerable level of serviceability is called the “Terminal Serviceability”.
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Friday, January 31, 14
Preventive maintenance treatments differ widely in their ability to improve serviceability.
Preventive maintenance treatments differ widely in their ability to improve serviceability. 

Treatments that both repair pavement distresses and improve pavement profile can restore serviceability to new pavement levels.

Accumulated Traffic Over Life of Pavement

Present Serviceability Index (PSI)

(Very Good) 5.0

(Very Poor) 0

Lowest acceptable level of serviceability (Terminal Serviceability)
Preventive maintenance treatments differ widely in their ability to improve serviceability.
Preventive maintenance treatments differ widely in their ability to improve serviceability.

Treatments that primarily repair pavement distresses without improvement to pavement profile have minimal effect on serviceability.

Accumulated Traffic Over Life of Pavement

Present Serviceability Index (PSI)

(Very Good) 5.0

(Very Poor) 0

Lowest acceptable level of serviceability (Terminal Serviceability)
Preventive maintenance treatments differ widely in their ability to improve serviceability.
Preventive maintenance treatments differ widely in their ability to improve serviceability.

Performance more typical of Thinlay asphalt treatments.

Lowest acceptable level of serviceability (Terminal Serviceability)
Structural Benefits

- Preventive Maintenance treatments are typically non-structural
- Preventive Maintenance treatments should be applied to structurally sound pavements
- Slurry seals, Chips Seals, micro surfacing add no structure
- A 1 inch thinlay asphalt treatment does provide structural benefits
Structural Benefits

- Most in-service pavements were designed for 20 years with AASHTO design.
- They have finite bottom up fatigue life, meaning if thickness is not increased the pavement will eventually fail from bottom up cracking.

TENSILE STRAIN
Structural Benefits

- A seal type treatment applied on those pavements will have no impact on the tensile strain and therefore no impact on the structural life.
Structural Benefits

- Preventive seals on these pavements will only mask the impending structural distresses and eventually lead to full depth failures.
Timely Thinlay treatments can save your structure
Thinlay Structure?
## What’s in an inch?  
Asphalt Thickness VS. Fatigue Life

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<tr>
<th>Thickness</th>
<th>Micro strain</th>
<th>Reps to failure</th>
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<tr>
<td>2</td>
<td>-652</td>
<td>30,234</td>
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<tr>
<td>3</td>
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<td>5</td>
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<tr>
<td>6</td>
<td>-242</td>
<td>682,133</td>
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</table>
Perpetual Pavements

- The goal of a perpetual pavement is to achieve a thickness that will confine future distresses to the surface
- Full depth failures are prevented
- The pavement can than be managed at the surface indefinitely
Washington State - Top-Down in Asphalt Pavements > 150 mm
Structural contribution of 1”

- A 1 inch overlay of an existing 4 inch pavement will double the fatigue life.
- A second 1 inch overlay can extend the structural life beyond 50 years.
- Once you achieve a perpetual thickness you can focus on managing at the surface for functional attributes as your structural worries are over.
Thinlay Experience in Oregon

- We have over 15 years of good performance history with thin lift paving
- Oregon DOT recently has added thinlay to their preservation tool chest
- Several local agencies with ongoing success
Thinlay at ODOT

- ODOT to date has let 3 contracts
- One experimental test section with high polymer binder on I-5 near Medford
- Two larger projects this year, one on the Tillamook highway near Forest Grove and one on highway 101 North of Lincoln City
- They also have a short section on I-5 North of Eugene that is going on 5 years old
Thinlay at ODOT

- The highway 6 project is micro mill and pave 1 inch
Micro Mill

• Micro milling removed surface distress and provides a very smooth and uniform surface to place a 1 inch lift
Normal tack shot rates and materials
Many other Oregon success stories

Walnut Blvd. Corvallis
Walnut micro mill and thinlay
Happy Valley
Polk County
Economics of Preventive Maintenance Treatments
Thinlay Experience in Oregon

- Washington County Case Study
A Case Study
Rehabilitation Using
Thinlay Overlays

Washington County
Summer, 2001
Murray Blvd.

- ADT = 30,000 vehicles per day
Why Thinlay Overlays?
(1” fine graded mix)

• Minimize Lane Closures
• Appearance and Ride Quality
• Added Structural Life
• Limited Contractor Availability for Slurry Seals/Micro-Seals
• Reduced Risk
• Lower Life-Cycle Cost???
Cost

• Thinlay Treatment = $2.53 per square yard
• Micro-Surfacing = $1.92 per square yard
• 32% cost increase
Life Cycle Costs
Estimated in 2001

- 20 Years, I=4%
- Thinlay = $4.24 (based on estimated 10 year life)
- Micro Surface = $6.74 (based on experience of 5 year life)

Thinlay Saves $2.50/yd^2 in 20 Years and Adds 2” of Structure
Actual Life Cycle Costs

- 15 Years, $I=4\%$, Thinlay life = 15 year life
- Average micro surfacing life = 5 years
- Thinlay = $2.53$
- Micro Surface = $4.79$

Thinlay Saves $2.26/\text{yd}^2$ in 15 Years, adds structure, and provides high serviceability, far less user impact.
Cost Comparison on Murray Blvd. (no discount)

- Thin Lift Overlay = $2.53 per square yard
  - $0.18 per square yard per year of service

- Micro-Surfacing = $1.92 per square yard
  - $0.38 per square yard per year of service
New Developments

- APAO in conjunction with NCAT and NAPA conducting research to develop high performance high recycle content thinlay mixes for preservation
- Mixes designed to be placed as thin as $\frac{3}{4}$”
- Mixes designed to be flexible and provide excellent crack resistance
- Mixes that maximize recycle content to provide value
Approach

• Softer base binders are being used to improve crack resistance and to offset the stiffening effects of the RAP/RAS
• Mix tests for cracking are being used rather than blended binder properties because they better predict mix performance and model actual binder blending
**AGGREGATE & OTHER CONSTITUENTS (RAP, BL. SAND, LIME, ETC.)**

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<tr>
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<th>#4 - #8</th>
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<th>RAP/RAS</th>
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<td>STOCKPILE PERCENTAGE (P_{sp})</td>
<td>46.0%</td>
<td>24.0%</td>
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<td>0.0%</td>
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<td>1.000</td>
<td>2.777</td>
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Design developed with "dryback" Gmm (Y/N)?  [Y/N]  

**MIXTURE AT DESIGN ASPHALT CONTENT**

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<td>TSR Compaction Blows</td>
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**JOB MIX FORMULA**

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<th>Sieve</th>
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<tr>
<td>1/2&quot; (12.5 mm)</td>
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<td>No. 200 (0.075 mm)</td>
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Asphalt content, % (P_{a}) | 7.2  | |
RAM AC, % (P_{er})         | 7.75 | |
Antistrip, %                | N/A  | |
Agg. Treatment, %           | N/A  | |
Asphalt Brand               | McCall |
Asphalt Grade               | PG 64-22 |
Mixing temp. range          | 305-315 |
Placement temp. range       | 285-293 |
Asphalt SpGr (Gb) 77 °F     | 1.026 |
Asphalt SpGr (Gb) 60 °F     | 1.030 |
% Binder Replacement         | 32.3 |

**COMMENTS:** BLEN CHOSEN?  [Fine]
AGGREGATE & OTHER CONSTITUENTS (RAP, BL. SAND, LIME, ETC.)

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<th>STOCKPILE SIZES</th>
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<td>RBW</td>
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Design developed with "dryback" Gmm (Y/N)? **Y**

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Date: 7/18/2013
CMDT Signature: [Signature]
CMDT Card #: 42330

COMMENTS: BLEND CHOSEN? **Fine**

Asphalt content, % ($P_{at}$) | 7.0%
RAM AC, % ($P_{ac}$) | 7.75%
Antistrip, % | N/A
Agg. Treatment, % | N/A
Asphalt Brand | McCall
Asphalt Grade | PG 58-28
Mixing temp. range | 286-296
Placement temp. range | 267-275
Asphalt SpGr (Gb) 77°F | 1.031
Asphalt SpGr (Gb) 60°F | 1.035
% Binder Replacement | 44.3
Testing

• All mixes meet Superpave criteria and ODOT criteria for rutting, TSR and voids
• All mixes are being tested first in the Overlay Crack Tester
Testing

- The overlay crack test results will be used to “screen” the mixes for further testing
- Further testing includes IDT for fatigue and cold temperature properties
## Mixes and Preliminary Results for Oregon

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<tr>
<th></th>
<th>L3 ½” 30% RAP</th>
<th>L3 ¼” 30% RAP</th>
<th>L3 ¼” 40% RAP</th>
<th>L3 ¼” 50% RAP</th>
<th>L3 ¼” 20% RAP 3% RAS</th>
<th>L3 ¼” 20% RAP 5% RAS</th>
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<td><strong>Pb</strong></td>
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<td>7.2</td>
<td>7.0</td>
<td>7.0</td>
<td>7.7</td>
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<tr>
<td><strong>Pbr</strong></td>
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<td>7.75</td>
<td>7.75</td>
<td>7.75</td>
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<td>64-22 64-28</td>
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<tr>
<td><strong>Overlay test results</strong></td>
<td>160/430</td>
<td>205/365</td>
<td>350/605</td>
<td>-/65</td>
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<td>N/A</td>
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Friday, January 31, 14
Preliminary Overlay Crack Test Results

Friday, January 31, 14
Additional testing for Eugene Oregon

- Eugene job with 35% binder replacement ½” L2 mix using 58-28 overlay test result – 260 reps
- “Control” L2 ½” 30% RAP 70-22 result – 61 reps
- Both were plant produced mix, lab compacted at APAO lab
Findings from O’lay testing

• Low temperature grade has greatest influence on the overlay crack test results
• High temp grade has some influence
• Using softer binders can more than offset the stiffening effects of increased RAP binder up to a point
Findings from O’lay testing

• Results appear to be independent of NMAS
• These results relate to reflective type cracking (strain control) and not necessarily to fatigue
Next Testing Phase

• Phase 2 testing with IDT for fracture energy (fatigue) is underway
• We chose the L3 ½” control, the L3 ¼” 64-28, the L3 ¼” 40% RAP with both binders for Phase 2 testing
• We will also test one or both of the RAP/RAS samples
Expected outcomes

- Completed research by mid 2014
- Guide specification for material selection and mix design
- Will include ¼” and 3/8” nmas mixes
- We also plan to run a polymer modified binder through the test array to evaluate potential benefits
Thinlay Asphalt

Smooth, Strong, Durable

- Longest Life of all treatments
- Lowest life cycle cost
- Superior Smoothness
- Preferred by road users
- Maintains Structural integrity