Thinlay Asphalt for Pavement Preservation

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APAO
The Need

- Focus nationwide has shifted from construction to preservation
- Lane miles increased only 8% 1980-2009
- The value of our highway and road system estimated at $1.75 trillion
- Preservation of the existing system is the primary challenge for pavement managers
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 surface distresses

- Cracking
- Rutting
- Ravelling
- Seal the existing pavement to prevent water intrusion
Preservation Treatments

• 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 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 5/8”
- Binders and gradations selected to optimize flexibility, durability and rut resistance
Thinlay Asphalt Family of Treatments

- Fine-graded dense-graded mixes for most applications
- Fine-graded permeable friction courses for improved wet weather skid and to address bleeding chip or other seals
- Fine-graded stone-matrix asphalt for high speed and very high traffic applications
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
  - \( V_a \), (4 =/- 1\%) VMA (15-17), VFA dust to effective (70-80), avoid low VMA high dust mixes
  - Minimum binder contents normally 6.0% or more.
Thinlay in Texas
40% RAP mix ¾” 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!
**Thinlay Asphalt Benefits**

- Correct functional (non-structural) pavement deficiencies
  - Benefit: Corrects surface distresses (i.e. raveling, minor cracking and deformation)
- Benefit: Improves skid resistance
- Benefit: Quiet – Low noise generation
Thinlay Asphalt Benefits

- True-up the pavement (i.e. restore cross-slope and profile)
  Benefit: Improves ride quality
  Benefit: Improves pavement drainage
  Benefit: Motorists’ safety is improved
SHRP SPS-3 STUDY

- Thin overlays significantly improved pavement smoothness after treatment.
- Chip seals and slurry seals improved pavement smoothness only slightly after treatment.
Thinlay Asphalt Benefits

- Provide structure (i.e. strength) through additional thickness
  - Benefit: Enhances or restores pavement strength
- Benefit: Can use in stage construction to build to Perpetual Pavement performance
Thinlay Asphalt Benefits

- Reduce cost of pavement maintenance
  Benefit: Ease of maintenance
  Benefit: Utilizes non-proprietary materials or processes
  Benefit: Provides for lower life cycle cost
  Benefit: Sustainability
  - Completely recyclable at highest and best use
  - Incorporates reclaimed materials (RAP, RAS, GTR)
Thinlay Asphalt Benefits

Other Benefits

Handles high traffic without surface degradation

No aggregate loss, dust generation or binder runoff from the pavement surface

Traffic impacts such as user delay is minimized since no cure time is necessary

Ease of maintenance for the pavement owner

Minimizes curb exposure loss

Engenders public support – high type pavement surfaces are preferred

Supports alternative transportation types such as biking, cycling and walking
Preservation Treatment Effects on Pavement Condition and Serviceability

New

Preventive Maintenance

Critical Condition

Corrective Maint, Rehabilitation, or Reconstruction

Time or Traffic

Pavement Condition

0
Figure 2. Life-extending benefit of preventive maintenance treatment.

Source: FHWA Pavement Preservation Compendium, Figure 2. Life-extending benefit of preventive maintenance treatment.
Pavement condition is assessed on a scale of 0 to 100. A rating of 100 indicates no distress exists or, in the case of a pavement rehabilitation, all distresses have been corrected.
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.
Pavement Condition Rating System – Distresses Rated (Flexible Pavement)

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.
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.
<table>
<thead>
<tr>
<th>Pavement Condition (PCI, PCR)</th>
<th>Time (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Very Good)</td>
<td>100</td>
</tr>
<tr>
<td>(Very Poor)</td>
<td>0</td>
</tr>
</tbody>
</table>

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.
Beyond their role in asset management, pavement condition rating systems are primarily tools for identifying distresses and developing rehabilitation strategies to correct them.
Condition ratings provide only part of the answer. “Serviceability” also needs to be considered. How well does the treatment meet the satisfaction of the user?
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.
Present Serviceability Index (PSI) uses a rating scale of 0 to 5, with 5 indicating the highest level of acceptability to the user. New asphalt pavements are typically 4.2-4.5.
Serviceability index (PSI)

Accumulated Traffic Over Life of Pavement

(Very Good) 5.0

(Very Poor) 0

Present Serviceability Index (PSI)

Serviceability of initial construction

Lowest acceptable level of serviceability (Terminal Serviceability)

Serviceability declines as a pavement deteriorates under the punishment of traffic. The lowest tolerable level of serviceability is called the “Terminal Serviceability”.

Asphalt.
Preventive maintenance treatments arrest the deterioration in service caused by traffic. Serviceability is restored to a level commensurate with the treatment type.
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.

Lowest acceptable level of serviceability (Terminal 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.

Lowest acceptable level of serviceability (Terminal Serviceability)
Preventive maintenance treatments differ widely in their ability to improve 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.
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
# What’s in an inch?
## Asphalt Thickness VS. Fatigue Life

<table>
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<tr>
<th>Thickness</th>
<th>Micro strain</th>
<th>Reps to failure</th>
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<tbody>
<tr>
<td>2</td>
<td>-652</td>
<td>30,234</td>
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<tr>
<td>3</td>
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<td>4</td>
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<td>5</td>
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<td>340,507</td>
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<tr>
<td>6</td>
<td>-242</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 then 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
Here is a simple example

An existing pavement 4 inches thick designed for 20 years will have consumed 50% of its fatigue life at year 10
Perpetual 1” at a time

- If you apply a chip seal at year 10 the strain at the bottom is unchanged and fatigue consumption will continue at the same rate.
- The pavement will develop full depth cracking over the next 10 years, roughness will increase and full depth repairs will be required.
Perpetual 1” at a time

- Alternatively if you apply a 1 inch overlay at year 10 you reduce the strain and extend the fatigue life to near 40 years (5 inch pavement has double the fatigue life of a 4 inch pavement)
- You now have only used up 25% of the life instead of 50%
- A second 1 inch overlay at year 20-25 would further extend the fatigue life to beyond 50 years
Thinlay Experience in Oregon

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

Washington County
Summer, 2001
Why Slurry Seals? (or micro-surfacing)

- Weathered Surface
- Very Minor Cracking
- Restoration of Skid Resistance
- Pavement Life Extension
Jamieson Road Micro-Surface
Evergreen Micro-Surface
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???
## Mix Design

- 12.5 mm --- 100%
- 9.5 mm --- 99%
- 6.3 mm --- 88%
- 4.75 mm --- 75%
- 2.36 mm --- 51%
- 600 um --- 25%
- 75 um --- 6.7%
- PG 64-22 --- 6.0%

**APA Rut Test Result - 4.6 mm**
Fischer Road

• ADT = 3,200 vehicles per day
Leahy Road

- ADT = 4,800 vehicles per day
Murray Blvd.

• ADT = 30,000 vehicles per day
9.5 mm mix
## Skid Test Results

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<th>Road</th>
<th>MP</th>
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<th>lane</th>
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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
Murray Blvd. ADT 30,000, 1” Thinlay placed in 2001, 2009 PCI = 88
Washington County
Murry Blvd. Life Cycle
Construction 1985
Thin O’lay 2001, 2001

Preventive Maintenance

Maintenance & Rehabilitation

Minimum Recommended Condition

Current PCI 95

Thin O’lay @ Age 16 Yrs

Project Life 15-18 Years

AGE (Years)

Pavement Condition Rating
Fischer Road Paved
2001, 2009 PCI 95
## Summary of Washington County Thinlay Current Condition

<table>
<thead>
<tr>
<th>Road Name</th>
<th>Paved</th>
<th>Age</th>
<th>Current PCI</th>
<th>Projected Life Extension</th>
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<tbody>
<tr>
<td>90th Ave</td>
<td>2001</td>
<td>12</td>
<td>75</td>
<td>14</td>
</tr>
<tr>
<td>Fischer Road</td>
<td>2001</td>
<td>12</td>
<td>76</td>
<td>14</td>
</tr>
<tr>
<td>Leahy Rd (1)</td>
<td>2001</td>
<td>12</td>
<td>71</td>
<td>12</td>
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<tr>
<td>Leahy Rd (2)</td>
<td>2001</td>
<td>12</td>
<td>76</td>
<td>14</td>
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<td>Murray Blvd (1)</td>
<td>2001</td>
<td>12</td>
<td>76</td>
<td>14</td>
</tr>
<tr>
<td>Murray Blvd (2)</td>
<td>2002</td>
<td>11</td>
<td>78</td>
<td>13</td>
</tr>
<tr>
<td>Walker Road</td>
<td>2002</td>
<td>11</td>
<td>81</td>
<td>14</td>
</tr>
<tr>
<td>Murray Blvd (3)</td>
<td>2007</td>
<td>6</td>
<td>80</td>
<td>10+</td>
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<tr>
<td>Murray Blvd (4)</td>
<td>2007</td>
<td>6</td>
<td>83</td>
<td>10+</td>
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</tbody>
</table>
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
Economics of Preventive Maintenance Treatments
Annualized Cost per SY (OHIO data) - no discount -
(Based on Ave. Years Between Treatment) (Sep 16 '10 to Sep 20 '12 data)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Life</th>
<th>Annualized Cost per SY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsurfacing (surface crse.)</td>
<td>5</td>
<td>$0.37</td>
</tr>
<tr>
<td>Single Chip Seal w/polymer</td>
<td>4</td>
<td>$0.40</td>
</tr>
<tr>
<td>AC Surface, Type 1 (1.25&quot; thick)</td>
<td>9</td>
<td>$0.52</td>
</tr>
<tr>
<td>Smoothseal Type B (3/4&quot; thick)</td>
<td>13</td>
<td>$0.28</td>
</tr>
<tr>
<td>Smoothseal Type A (3/4&quot; thick)</td>
<td>13</td>
<td>$0.29</td>
</tr>
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</table>
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
## Assessing Value

<table>
<thead>
<tr>
<th>Benefit</th>
<th>ThinLay asphalt</th>
<th>Micro.</th>
<th>Chip Seals</th>
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<tbody>
<tr>
<td>Corrects surface distress</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Increases skid resistance</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Minimizes curb loss</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Eliminates dust and loose aggregate</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Corrects minor rutting</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Increases structural strength</td>
<td>✔</td>
<td></td>
<td></td>
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<tr>
<td>Improves pavement drainage</td>
<td>✔</td>
<td></td>
<td></td>
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<tr>
<td>Improves ride quality and driver safety</td>
<td>✔</td>
<td></td>
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<tr>
<td>Provides quiet ride</td>
<td>✔</td>
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<tr>
<td>Engenders public support</td>
<td>✔</td>
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<tr>
<td>Longer life (low permeability)</td>
<td>✔</td>
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</table>
Thinlay Asphalt

Smooth, Strong, Durable

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