THIN ASPHALT OVERLAYS FOR PAVEMENT PRESERVATION
Why Thin Asphalt Overlays?

- Shift from new construction to renewal and preservation
- Functional improvements for safety and smoothness are needed more than structural improvements — Perpetual Pavements
- Material improvements
  - Binders — Superpave binder spec and polymers
  - SMA, OGFC, and Dense-Graded
  - Superpave volumetric mix design
  - Warm Mix Asphalt (WMA)
  - Reclaimed Asphalt Pavement (RAP)
  - Reclaimed Asphalt Shingles (RAS)
Thin Asphalt Overlays are the Most Popular Treatment for Pavements

1999 AASHTO Survey

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. of States</th>
</tr>
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<tbody>
<tr>
<td>Mill &amp; Overlay</td>
<td>36</td>
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<tr>
<td>Asphalt Overlay</td>
<td>37</td>
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<tr>
<td>Chip Seal</td>
<td>30</td>
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<tr>
<td>Crack Treatment</td>
<td>29</td>
</tr>
<tr>
<td>Microsurfacing</td>
<td>28</td>
</tr>
<tr>
<td>CIPR</td>
<td>23</td>
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<tr>
<td>HIPR</td>
<td>16</td>
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<tr>
<td>Whitetopping</td>
<td>7</td>
</tr>
<tr>
<td>Full Depth CIPR</td>
<td>2</td>
</tr>
</tbody>
</table>
Benefits of Thin Asphalt Overlays

➢ Long life and low life-cycle cost!

➢ Safety / User
  • Minimize traffic delays
  • Staged construction
  • Smooth surface
  • Restore skid resistance
  • No loose stones & minimizes dust
  • Lower noise

➢ Structural
  • Maintain grade & slope
  • Withstands heavy traffic
  • Easy to maintain

➢ Sustainable
  • Recycled materials
  • Seals surface & no binder run-off
Topics

• Project Selection
• Materials Selection and Mix Design
• Construction and Quality Control
• Performance
• Conclusions
PROJECT SELECTION

Avoid Projects Needing Structural Rehabilitation!!
Basic Evaluation

➢ Visual Survey
➢ Structural Assessment
  ▪ No structural improvement required
➢ Drainage Evaluation
  ▪ What changes are needed
➢ Functional Evaluation
  ▪ Ride quality
  ▪ Skid resistance
➢ Discussion with Maintenance Personnel
Visual Survey

➢ Part of a good Pavement Management System
➢ Get current project-specific data
➢ Need to know:
  ▪ Type of distress
  ▪ Extent
  ▪ Severity
➢ Visit the site and validate the data
Types of Distress

- Raveling
- Longitudinal Cracking (not in wheelpath)
- Longitudinal Cracking (in wheelpath)
- Transverse Cracking
- Alligator Cracking
- Rutting
Raveling
Longitudinal Cracking
(not in wheelpath)
Longitudinal Cracking (wheelpath)

Temporary Fix for Minor Distress
Transverse Cracking
Alligator (Fatigue) Cracking

Temporary Fix for Minor Distress
Rutting or Shoving

Severe Structural Failure

Surface Failure – Milling Required
Ride Quality and Skid Resistance

Rough surfaces should be milled

Skid problems can be milled, but not required
Noise Can Be Reduced

NCAT Noise Trailer

![Bar chart showing noise level in dB(A) for different aggregate sizes.

- 9.5 mm (Rt. 50)
- 12.5 mm (I-270)
- 12.5 mm (I-495)
- 19 mm (I-83)

Smaller Aggregate = Less Noise]
Drainage Evaluation
How do you select the mix type for a thin overlay?
Recommended Mix Types

Surface Courses

Low Traffic

Medium Traffic

High Traffic

Min Lift Thick Range, mm

DFG 4.75
DFG 9.5
DFG 12.5
DFG 19
SMA 9.5
SMA 12.5
SMA 19.0
OGFC 9.5
OGFC 12.5
DCG 9.5
DCG 12.5
DCG 19.0

Mix Type

NAPA
National Asphalt Pavement Association
If a Thin Overlay is the answer, you need to decide:

- **Surface Preparation**
  - Distresses
  - Roughness
  - Considerations for Curb Reveal and Drainage

- **Materials**
  - Traffic
  - Availability
  - Climate

- **Thickness**
  - NMAS
  - Geometrics
## Surface Preparation

<table>
<thead>
<tr>
<th></th>
<th>Mill</th>
<th>Fill Cracks with Mix</th>
<th>Clean and Tack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raveling</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Transverse Crack</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Alligator Crack</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rutting</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Materials & Mix Design

- Materials Selection
- Mix Design for Dense-Graded Mixes
- Other Mix Types
Materials Selection — Aggregate

➢ Thin overlays need small NMAS
  ▪ Thin overlays ≤ 1.5 inches thick
  ▪Aggregate size between 4.75 and 12.5 mm NMAS
  ▪Ratio of lift thickness to NMAS range 3:1 to 5:1

➢ Quality
  ▪ LA Abrasion: 35–48 maximum
  ▪ Sodium Sulfate: 10–16 maximum
  ▪ CA Fractured Faces (does not apply to 4.75 mm)
    • 2 or More: 80–90
    • 1: 10–100
  ▪ Sand Equivalent: 28–60
  ▪ FA Angularity (Uncompacted Voids): 40–45
Example Gradations

North Carolina
Maryland
Utah
North Carolina
Most specifications use PG system to select binder grade based on climate and traffic

- Minnesota — Unmodified binder
- Ohio — Polymer modified PG 64–22 or PG 76–22
- New York — PMA for 6.3 mm & special situations for other mixes
- New Jersey — PG 76–22 for high performance mix
- North Carolina — depends upon traffic level
Materials Selection — RAP

- Small NMAS mixes should utilize fine RAP
- RAP or RAS will help
  - Stabilize cost by reducing added asphalt and added aggregate
  - Prevent rutting
  - Prevent scuffing
- Use maximum allowable while maintaining gradation and volumetrics
Mix Design

➢ Laboratory Compaction
  ▪ Low Volume — 50 gyrations in MD and GA
  ▪ Medium Volume — 60 to 75 in MD, NY, AL
  ▪ High Volume — 60 (AL) to 125 (UT)
  ▪ Needs to be enough compaction for interlock without fracturing aggregate

➢ Volumetrics
  ▪ Void Requirements — Mixes are relatively impermeable
  ▪ VMA — Should increase as NMAS decreases
  ▪ Asphalt Content — Should depend on voids and VMA
# Mix Design Requirements

<table>
<thead>
<tr>
<th>NMAS</th>
<th>12.5 mm</th>
<th>9.5 mm</th>
<th>6.3 mm</th>
<th>4.75 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>AL</td>
<td>NC</td>
<td>NV</td>
<td>UT</td>
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<tr>
<td>Comp. Level</td>
<td>60</td>
<td>50–125</td>
<td>75</td>
<td>50/65</td>
</tr>
<tr>
<td>Design Voids</td>
<td>3–6</td>
<td>3.5</td>
<td>4.0</td>
<td>4.0–7.0</td>
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<tr>
<td>% VMA</td>
<td>15.5 min</td>
<td>12–22</td>
<td>16 min</td>
<td>15 min</td>
</tr>
<tr>
<td>% VFA</td>
<td></td>
<td>70–80</td>
<td>70–78</td>
<td>50–80</td>
</tr>
<tr>
<td>% AC</td>
<td>5.5 min</td>
<td>4.6–5.6</td>
<td>6.0 min</td>
<td>5.0–8.0</td>
</tr>
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</table>
Permeability
CONSTRUCTION & QUALITY CONTROL
Construction — Production

➢ Aggregate
  ▪ Proper stockpiles
    • Slope and Pave
    • Cover, if needed
  ▪ Moisture content

➢ Plant operations
  ▪ Slower because
    • More time to coat
    • Higher moisture content
    • Thicker aggregate veil
  ▪ Aggregate moisture management
  ▪ WMA can help coat aggregates — lubricity
Construction — Production

➢ RAP — Process for size and consistency
  ▪ Max size $\leq$ NMAS

➢ Storage and Loading
  ▪ Follow normal best practices

➢ Warm Mix
  ▪ Increase haul distance
  ▪ Pave at cooler temperatures
  ▪ Achieve density at lower temperatures
  ▪ Extend paving season
  ▪ Pave over crack sealer
Construction — Paving Surface Preparation

➢ Milling
  ▪ Remove defects
  ▪ Roughen surface
  ▪ Improve smoothness
  ▪ Provide RAP
  ▪ May eliminate need for tack
  ▪ Size machinery properly

➢ Tack
  ▪ Emulsion or hot asphalt
  ▪ Polymer emulsion or unmodified
  ▪ Rate: 0.10 to 0.15 gal/sy (undiluted emulsion)
Construction —
Paving Placement and Compaction

➢ Paving
  ▪ Best to move continuously
  ▪ MTV or windrow can help
  ▪ Cooling can be an issue
    ▪ 1” cools 2× faster than 1.5”
  ▪ Warm mix

➢ Compaction
  ▪ Seal voids & increase stability
  ▪ Low permeability
  ▪ No vibratory on < 1”
Quality Control — Plant

➢ Aggregate
  ▪ Gradation
  ▪ Moisture Content

➢ Mix Volumetrics
  ▪ Air Voids
  ▪ VMA
  ▪ Asphalt Content
  ▪ Gradation
Quality Control — Field

➢ Field Density
  - Thin-lift NDT gauges OK for > 1” mat
  - Cores may not be representative
  - Permeability not as big an issue

➢ Ride Quality
  - Depends on
    • Condition of existing pavement
    • Surface preparation
    • Overlay thickness
  - Specification should be based on existing condition
Performance

➢ Immediate Benefits
➢ Pavement Life
➢ Economics
Immediate Benefits

➢ Pavement Condition (Labi et al., 2005)
  ▪ 18 to 36% decrease in roughness
  ▪ 5 to 55% decrease in rut depth
  ▪ 1 to 10% improvement in condition rating

➢ Noise
  ▪ Corley-Lay and Mastin (2007): 6.7 dB reduction on overlaid PCC
  ▪ FHWA (2005): 5 dB reduction on overlaid PCC in Phoenix

➢ 3 dB reduction = ½ traffic volume
### Pavement Life

<table>
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<th>Underlying Pavement</th>
<th>Performance, yrs.</th>
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<td></td>
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<tr>
<td>North Carolina</td>
<td>—</td>
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<td>6–10</td>
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Economics

➢ Chou et al. (2008):
  ▪ Thin overlays on asphalt — almost always most cost effective
  ▪ Thin overlays on PCC — not as cost effective, but greater deterioration prior to overlay

➢ 2008 NAPA Survey of State Asphalt Associations

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Expected Life, yrs</th>
<th>Range</th>
<th>Cost, $/SY</th>
<th>Range</th>
<th>Annual Cost, $/lane-mile</th>
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<tbody>
<tr>
<td>Chip Seal</td>
<td>4.08</td>
<td>2.5–5</td>
<td>2.06</td>
<td>0.50–4.25</td>
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<td>Slurry Seal</td>
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<td>1.78</td>
<td>1.00–2.20</td>
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<tr>
<td>Micro-surfacing</td>
<td>4.67</td>
<td>4–6</td>
<td>3.31</td>
<td>2.30–6.75</td>
<td>4,989.81</td>
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<tr>
<td>Thin Surfacing</td>
<td>10.69</td>
<td>7–14</td>
<td>4.52</td>
<td>2.40–6.75</td>
<td>2,976.69</td>
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</table>
Economics

Annual Cost of Preservation Treatment

- Chip Seal
- Slurry Seal
- Microsurfacing
- Thin Overlay

Annual Cost, $/lane-mile

- 0.00
- 1,000.00
- 2,000.00
- 3,000.00
- 4,000.00
- 5,000.00
- 6,000.00
Conclusions — Benefits

➢ Thin Overlays for Pavement Preservation
  ▪ Improve Ride Quality
  ▪ Reduce Distresses
  ▪ Maintain Road Geometrics
  ▪ Reduce Noise
  ▪ Low Life Cycle Costs
  ▪ Provide Long Lasting Service

➢ Place before extensive rehab required

➢ Expected performance
  ▪ 10 years or more on asphalt
  ▪ 6 to 10 years on PCC
Conclusions — Check-list

 ✓ Evaluate
   ✓ Candidate for thin asphalt overlay?
   ✓ Distresses

 ✓ Determine Mix Type

 ✓ Proper Surface Preparation

 ✓ Materials

 ✓ Thickness

 ✓ Production, Construction, and Quality Control
Thin asphalt overlays are a popular solution to pavement preservation. They are economical, long-lasting, and effective in treating a wide variety of surface distresses to restore ride quality, skid resistance, and overall performance.
Resources

- NCAT website: [www.ncat.us](http://www.ncat.us)
- NAPA Publication: [www.thinlayasphalt.com](http://www.thinlayasphalt.com)
  – IS-135: Thin Asphalt Overlays for Pavement Preservation
- Transportation Research Record:
  – Labi et al., 2005.
- Ohio DOT:
  – Chou et al., April 2008.