Impact of Thin Overlay on Top-Down Crack Resistance of Aged Pavement

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Outline

• Background & Motivation
• Mix Design
• Construction
• Performance
• Findings
Background and Motivation

- Previous ALF research inspired the study
- The “Absence of Preservation” Scenario
Background and Motivation

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- The “Absence of Preservation” Scenario
• Embrittlement of In-Situ Asphalt Binder
Background and Motivation

• TSP RD&I Roadmap
  – Materials #01 – Mechanical Binder Properties to Predict Surface Treatment Performance.
Background and Motivation

- TSP RD&I Roadmap
  - Performance #03 - Quantify Performance and Benefits of Various Pavement Preservation Treatments and Develop Pavement Preservation Treatment Performance Models.
  - Performance # 04 - Quantifying the Benefits of Pavement Preservation Treatments.
- Embrittlement of In-Situ Asphalt Binder

![Graph showing embrittlement of asphalt binder over time.](image-url)
Preservation Treatment Options?

- Chip Seal?
- Microsurfacing?
- Fog Seal?
- Thin Overlay?
4.75mm HMA Contents

- 44% Fine Agg. Screenings (#10)
- 26% Sand (Manufactured)
- 20% RAP (Fine)
- 10% Sand (Natural)

- Virgin Asphalt Binder
  PG 76-22
- Extracted Binder
  PG 82-22
Construction
Construction

Rutting Test
Fatigue Test
Completed Fatigue Test
Completed Rutting Test
ALF1
ALF2
4.75 mm Mix Tests
Construction
Construction
Construction
Construction
Construction
Construction

- **28 mm +/- 4 mm** Thickness achieved
- Tack coat of CRS-1 @ 0.07 gallons/s.y.

- **Warm Mix Asphalt Mix**
  - 45 mile haul distance in congested area
  - Delivered about 255°F (124°C)
  - Mix was foamed (water)
  - Workable, with no clumps and easy hand-work
Construction

• Rolling and Achieving Density
  – Initial rolling was 2 vibratory and 1 static
  – 15,000 lb roller (DD 70-HF) as breakdown
  – 8,000 lb (DD 34-HF) as finish
  – 13% air voids rather than 10% air void target
  – VaDOT & contractor identified 27,000 lb roller is ideal
Construction

12 foot

44 foot

22 foot
Historical Sequences

1. Lane 8 with Unaged Overlay
2. Lane 10 with Aged Overlay
Historical Sequence – Unaged Overlay
Historical Sequence – Unaged Overlay

3-inch lift

3-inch lift

Structure Built in 2002

Site 3 Fatigue loading
Dec 2005 – May 2006 +
Feb-March 2008
Historical Sequence – Unaged Overlay

Site 4 Reserved and left untouched

Natural aging and weathering from 2002 construction up to June 2010
Historical Sequence – Unaged Overlay

4 weeks of accelerated aging via radiant heaters
April - May 2010
Historical Sequence – Unaged Overlay

Milling
1-inch 4.75mm NMAS inlay
Installed June 2010
4 weeks of accel. aging Jun–Jul. 2010

BUT ONLY AGING ON THE HALF-SECTION WITHOUT THE 4.75mm Inlay.

The 4.75mm treatment was left unaged.
Historical Sequence – Unaged Overlay

Reserved site 4 is loaded
September 2010 to April 2011
Historical Sequence – AGED Overlay

...lets review one more time...
Historical Sequence – Unaged Overlay

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8 weeks of accelerated aging via radiant heaters
June-August 2010
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Development of Fatigue Cracks under APT Loading

The development of fatigue cracks within loaded wheel paths are illustrated.
A1:B = Effect of Aging on
Conventional HMA
(no preservation treatment)

A2:C = Effect of
"New" unaged
4.75mm on Aged
Pavement
Lane 10
Air Blown

A1:B = Effect of Aging on Conventional HMA (no preservation treatment)

A2:C = Effect of “Old” Aged 4.75mm on Aged Pavement

Site 3    Site 4
Vertical Crack Profiles

• Cores taken across the width of the wheel path
Vertical Crack Profiles
Vertical Crack Profiles

L10S3

101'

107'

113'

119'

L10S4

101'

103-106'

107'

113'

119'

124'
Findings

• Superpave 4.75mm NMAS mixture designed with 20% RAP content and WMA production

• Large rollers recommended to achieve density even though fine mix and higher binder content

• Aged pavements developed top-down cracking rather than bottom-up
Findings

• Thin overlay allows 8-year-old-PLUS structure to perform like a 3-year-old structure
  – 425,000 - 500,000 passes to first crack

• While without milling-and-overlay the structure performed significantly less
  – 50,000 passes to first crack

• When the overlay was aged, the overlay provides little benefit
Thank You.
Questions?
Comments?

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• Kevin McGhee
  Kevin.McGhee@VDOT.Virginia.gov
  434-293-1956
Characteristics of Accelerated Loading

- 16,000 lb single wheel load
- 425 super single tire
- 120 psi inflation
- 19°C temperature control
- Lateral wheel wander (normal distribution)
<table>
<thead>
<tr>
<th></th>
<th>CHIP SEAL</th>
<th>THIN OVERLAY</th>
<th>SLURRY SEAL</th>
<th>MICROSURFACING</th>
<th>CHIP SEAL</th>
<th>THIN OVERLAY</th>
<th>SLURRY SEAL</th>
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## Virginia DOT Mix Design

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<th>Sieves #</th>
<th>Bealton sand</th>
<th>#10</th>
<th>RAP</th>
<th>Nat. Sand</th>
<th>Bag House</th>
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<td>#4 (4.75mm)</td>
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<td>86</td>
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## Virginia DOT Mix Design

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<th>From Contractor: 2.584</th>
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<td><strong>VFA</strong></td>
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<td><strong>$V_{be}$</strong></td>
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<td><strong>Dust to Binder</strong></td>
<td>1 – 2</td>
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<th>Virginia DOT Formula</th>
<th>Contractor’s aggregate $G_{SB}$ = 2.789</th>
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<td>$G_{SB}$</td>
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1.98

2.11
Background and Motivation

- Embrittlement of In-Situ Asphalt Binder