Spray Paver applied Bonded HMA

ND Asphalt Conference
April 5-6, 2016
Why are we here?

- TALK ABOUT WHAT SPRAY PAVING IS
- ADVANTAGES OF SPRAY PAVING
- RESEARCH PROJECTS
- QUESTIONS
Have you ever seen this?
Have you ever seen this?
ARE YOU GETTING WHAT YOU ARE PAYING FOR?

Pay Quantity

Effective Quantity
WHAT CAN YOU DO TO ASSURE THAT YOU ARE GETTING THE TACK COAT YOU WANT?

SPRAY PAVER
What is a Spray Paver?

Spray Paver = Paver + Distributor in one machine
Spray Paver

- 3 Processes
  - Spray emulsion
  - Lay hot mix
  - Smooth the mat
EBL applied with spray paver
- Undisturbed before HMA
- Much higher shot rate
- Higher polymer content
Application of Tack – Placement of Mix
CAT
Spray Pavers

- Due to the distributor plus paver in one,
  - Different types of emulsion can be used
  - Dilution of emulsion is not required
  - Application rates are not limited by construction
Why do pavements debond?

• Lack of or non-uniform application of tack
• No adjustment in rate for surface type or condition
• Dirt, debris and dust contamination of surface
Why do pavements debond?

- Construction practices necessitate driving on the tack coat to place the mix
- Tracking of the tack from the surface may result
Kansas DOT Experience

Paying for tack on equipment tires
Kansas DOT Experience

Increase in Fatigue Cracking

![Graph showing the increase in fatigue cracking over years from 1985 to 2013. The x-axis represents the years from 1985 to 2013, and the y-axis represents EQFCR (ft) from 0 to 35,000.]
Kansas DOT Experience

Loss of bond - reducing life of our overlays
Kansas DOT Experience

Ultrathin Bonded Asphalt Surface (UBAS)
Lane-Miles overlaid with UBAS

Cumulative Lane Miles

Year


0 1000 2000 3000 4000 5000 6000
Expectations for Dense Graded HMA placed with a Spray Paver

• Keep the tack on the road
• Better fatigue cracking resistance
• Seal off the roadway
• More flexible pavement
Concerns for Dense Graded HMA placed with a Spray Paver

- Effect on HMA volumetrics
- Is the EBL getting on the Pavement?
- EBL Break Time
- Trapped moisture
- Cost
- Industry Buy-In
Effect on HMA volumetrics

- Sample taken
  - Behind the Paver
  - From Truck Bed

- No statistical difference in volumetric properties
EBL Uniformly Placed?

- Look for shiny pavement completely across spray bar
- Have contractor move the spray paver forward shooting only EBL. Verify that spray pattern is uniform
EBL Break Time and Moisture

- Continue to observe

- Pavement Performance was not affected

- Modified Lottman Results not affected
Cost Comparison

• 2015
  ▫ 7 Projects with both EBL and SS-1H Bid
  ▫ Average EBL unit cost is $557/ton
  ▫ Average SS-1H unit cost is $576/ton

• 2012
  ▫ EBL cost $50/ton more than SS-1HP
  ▫ That’s a $7500 increase to project costs
HMA Placed with Spray Pavers

Length of Projects (Miles)

Fiscal Year


2 7 1 3 2 3 2

HMA

5

2

3

11

2

PCCP

7

2

3

2

7
Industry Buy-In

• KDOT is currently using Spray Paver on HMA overlays of PCCP

• Spray paving on HMA overlay of HMA pavements is done on a project basis with Research Test Sections included

• Data from the Research to determine if increased use of Spray Paver is warranted
How does applying a much higher rate of a polymer modified tack coat, undisturbed before the HMA placement, effect the cracking performance over time (vs a typical distributor applied tack coat)?
Field Performance Data
Route T, Franklin County, MO

- Constructed: October 2008
- Contractor: N.B. West
- Project length: 3.5 miles (test sections)
- Surface: Composite, HMA over PCC
- Mix: 1 ¾” Bonded BP-1 HMA w/ PG64-22
- Tack:
  - Test sections at 0.1, 0.15, and 0.2 gal/yd² PMAE at 65% AC
  - Test sections at 0.1 gal/yd² thru distributor and 0.1 and 0.15 gal/yd² CSS-1h thru SP-200
- Equipment: RoadTec SP-200 spray paver

June 2009
Route T Franklin Co Test Sections
Pre-paving Condition (no milling occurred)
MoDOT Route T – 2008 Construction

Longitudinal Crack Length at 6 years

1 ¾" BP-1 over HMA/PCC Composite

89.5% reduction
MoDOT Route T – 2008 Construction

Transverse Crack Length at 6 years
1 3/4" BP-1 over HMA/PCC Composite

31.9% reduction
MoDOT Route T Pavement Condition Surveys
1 3/4" BP-1 over HMA/PCC Composite
Reflective Cracking within First Two Years
Route T Franklin Co Test Sections 11/12
Pre-paving and 4 years later

2008
0.21 gal/yd2 (0.14 res) PMAE Tack

2012
Route T Franklin Co Test Sections 11/12
Pre-paving and 6 years later

2008
0.21 gal/yd² (0.14 res) PMAE Tack

2014
Pavement prior to paving - 2009
½” Mill, 1 ½ “ SR-12.5A, PG 58-28
**Transverse Crack** Length at 6 years

- **Conv Paving**: 0.08/gal/yd²
- **Spray Paver**: 0.20/gal/yd²

88% reduction

½” Mill, 1 ½ “ SR-12.5A, PG 58-28

Longitudinal Crack Length at 6 years

67% reduction
½” Mill, 1 ½ “ SR-12.5A, PG 58-28
Longitudinal Crack Length at 6 years (w/no tack)
Tack vs No Tack - a field experiment

2009 Washington KS project - US 36
- 0.12 gal/yd² EBL through spray paver
- Short section – shut off tack
  - Transverse tear from the mix sliding with no tack

No tack

0.12 gsy EBL

Direction of paving
No Tack over a Milled Asphalt Surface
US 36 Washington Co. KS 2009
No tack over a milled surface – 2 years later

- US 36 Washington County, KS
- Fatigue cracking in the inside wheel path
- Effect of unbonded overlay
1” Mill, 1” SR-9.5A, PG 70-28

**Transverse Crack** Length at 5 years

<table>
<thead>
<tr>
<th>Year</th>
<th>Conv Paving</th>
<th>Spray Paver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yr 1</td>
<td>0.05 gal/yd²</td>
<td></td>
</tr>
<tr>
<td>Yr 2</td>
<td>0.05 gal/yd²</td>
<td></td>
</tr>
<tr>
<td>Yr 3</td>
<td>0.05 gal/yd²</td>
<td></td>
</tr>
<tr>
<td>Yr 4</td>
<td>0.05 gal/yd²</td>
<td></td>
</tr>
<tr>
<td>Yr 5</td>
<td>0.05 gal/yd²</td>
<td>0.36 gal/yd²</td>
</tr>
</tbody>
</table>

82% reduction
1” Mill, 1” SR-9.5A, PG 70-28

Longitudinal Crack Length at 5 years

78% reduction
KDOT US 36 Marshall Co. (Const. 2010)

Transition from tack to polymer modified tack section

0.05 gal/yd² undiluted SS-1h tack through distributor

Centerline joint

0.14 gal/yd² undiluted polymer modified tack applied through spray paver
KDOT US-36 Nemaha Co – 2010 Construction
4” CIR, 1 1/2” SR-12.5A, PG 70-22

**Transverse Crack** Length at 5 years

- Conv Paving: $0.05/gal/yd^2$
- Spray Paver: $0.34/gal/yd^2$

90% reduction
KDOT US-36 Nemaha Co – 2010 Construction
4” CIR, 1 1/2” SR-12.5A, PG 70-22
**Longitudinal Crack** Length at **5 years**

- **Conv Paving**: .05/gal/yd²
- **Spray Paver**: .34/gal/yd²

99% reduction
Nemaha Co US-36
Paved in 2010
Picture from 2014
Crack in conventional paving
Stops at .34 EBL spray paver
Summary of Crack Reduction

- Transverse Cracking – 73% reduction
- Longitudinal Cracking – 83% reduction

(Projects that are at least 5 years old with research/control sections)

Projects had various lift thicknesses, mill/no mill, mix type, and binder grade
NCAT Results – Conventional vs Spray Paver

• 2009 PFC surface placed with conventional tack
  – Surface cracks after 2.2M (cracking/pumping at 6.5M)
• 2009 bonded PFC surface placed with spray paver
  – Surface cracks after 4.1M (very good at 6.5M)
Saturation at Interface Creates Voidless Height in HMA

- Higher tack rate creates an asphalt rich interlayer at the interface with the existing pavement

Bonded to existing pavement surface
REASONS TO USE A SPRAY PAVER

1. BETTER BOND THAN CONVENTIONAL TACK
2. CAN PERFORM UNDERSEAL AND OVERLAY IN ONE ACTION
3. BETTER CRACK PERFORMANCE IN FIELD TRIALS
4. AESTHETICS
5. ELIMINATES THE POTENTIAL FOR PUBLIC TO GET TACK ON THEIR VEHICLES
BETTER BOND
University of Illinois Research (I-35)
Better Bond

Consequences of Debonding

Bonded

Unbonded

Bonded Demonstration

- Up to 5 sheets (layers)
- 48” x 4” x 11/32”
- 60, 100, or 160 pound loadings
- Various Bonding Configurations

Courtesy of NCAT
Better Bond

**Bonded Demonstration**

- ½" Deflection, 60lb Load
- ¼" Deflection, 160lb Load

**Bonded Demonstration Highlights**

- 2 bonded layers had less deflection than 5 unbonded with the same loading (60#).
- 5 unbonded layers deflected 4x more than 5 bonded with the same loading (60#).
- 5 bonded layer with over 2½x the load deflected half as much as 5 unbonded.
CAN PERFORM UNDERSEAL AND OVERLAY IN ONE ACTION
AESTHETICS

Conventional Paving

Spray Paving
PROTECT PUBLIC IN URBAN SETTING

- Concerned about public driving across tack when leaving businesses or residences.
- No need to spray tack in front of paving train and wait for it to break.
- No complaints from public about getting tack on their vehicles.
- Still need to protect mat from traffic with flaggers until rolled.
- Much shorter time to flag entrances.
Cost of Early Cracking

- Crack Seal – Average $5,500/mile
- Chip Seal – Average $32,000/mile
- Striping – Average $6,000/mile
- Total = $43,500/mile
- $500,000 spent on 11.5 mile HG Co project within 1 year alone
- User delay cost
- Bad publicity
Where have spray pavers been used?

- Thousands of projects have been paved over the last 15 years in the US
- Almost every state has done a spray paver project
What type of HMA mixes and shot rates have been used?

- SuperPave/Dense graded, Open Graded, NovaChip (Gap graded)
- ½ inch to 2.5 inch lifts
- Shot rates have ranged from .15 to .46 gallons per square yard
- Have never seen flushing or rutting with dense graded mixes
Cost of Tack

• **Recent KDOT projects:**
  - Harvey I-135
    • SS-1HP – $479.47
    • EBL (like CRS-2P) - $445.18/ton
  - Miami Co US-69
    • SS-1HP – 575.00
    • EBL - $550.00
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Questions?