Bonded Wearing Course and Bonded Pavements
A Solution
For Lower Life Cycle Cost, Longer Lasting Roads

Problems:
- Noisy pavements
- Overhead clearances, curb reveal
- Backspray visibility
- Loss of macro-texture
- Long construction delays
- Need for cost effective surfacing

Solution: Bonded Wearing Course
What is BWC?

Hot mix asphalt surface treatment
- Preventive maintenance
- Corrective maintenance
- Surface for new pavements
- Over PCC or asphalt pavements
  - ~50% of projects over PCC, ~50% over asphalt

Single pass system
- Polymer modified emulsion membrane
- Thin gap graded hot mix
- Placed with spray paver
A Little History...

1988 - First Trial in France
1992 - Introduced in U.S
1992 - Projects in TX & AL
1993 - Projects in NJ & PA
1993-97 - Projects in Northeast
1998 - Process adapted & spread throughout U.S.

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Spray Paver

3 Processes
- Spray emulsion
- Lay hot mix
- Smooth the mat
Spray Paver

- Thin mat overlay
- 60-100 ft/min
- Minimum of stops
- Uniform application of emulsion
Polymer Modified Emulsion

Special polymer membrane
Controls migration into mix
Superior bonding
- Allows thin lifts without
delamination
Seals existing pavement
The Hot Mixed Asphalt

High quality aggregate
- Durable macro-texture & skid resistance

Gap graded
Mix designed for process
The HMA Binder

PG binders
Polymer modified asphalt binders
- Less draindown
- Quicker traffic return
- Improved adhesion
- Less water sensitivity
- Better cracking resistance
- More durable
Gap Graded

- Similar to Stone Matrix Asphalt gradation
- Enough space for polymer modified asphalt emulsion membrane
- Insures stone on stone contact
- Allows moisture to drain off
- Fines are part of asphalt binder mastic
Other Typical Gradations

12.5 mm Nominal Sieve Size

Percent Passing

Type A

Type A Max

Type A Min

Sieve Size (mm) Raised to 0.45 Power

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Other Typical Gradations

12.5 mm Nominal Sieve Size

- Type C
- Type C Max
- Type C Min

Percent Passing

Sieve Size (mm) Raised to 0.45 Power

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Other Spray Paver Mixes

Open Graded Friction Courses (OFGC)
- Permeable friction course
- Porous friction course
- Wet process crumb rubber open graded and gap graded mixes
- Terminal blend crumb rubber open graded and gap graded mixes
## Typical Coarse Aggregate Specifications

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles abrasion value, % loss</td>
<td>35 max</td>
</tr>
<tr>
<td>Soundness, % loss</td>
<td>18 max</td>
</tr>
<tr>
<td>Magnesium Sulfate or Sodium Sulfate</td>
<td>12 max</td>
</tr>
<tr>
<td>Flat &amp; Elongated Ratio at 3:1</td>
<td>25% max</td>
</tr>
<tr>
<td>% Crushed, single face</td>
<td>95 min</td>
</tr>
<tr>
<td>% Crushed, ≥ 2 mechanically crushed faces</td>
<td>85 min</td>
</tr>
<tr>
<td>Micro-Deval, % loss</td>
<td>18 max</td>
</tr>
</tbody>
</table>

1 LA & Soundness targets for selection
Not sole basis for rejection
## Typical Fine Aggregate Specifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sand Equivalent</strong></td>
<td>45 min</td>
</tr>
<tr>
<td><strong>Methylene Blue</strong></td>
<td>10 max</td>
</tr>
<tr>
<td>(materials passing 200)</td>
<td></td>
</tr>
<tr>
<td><strong>Uncompacted Void Content</strong></td>
<td>40 min</td>
</tr>
</tbody>
</table>
The emulsion membrane “wicks up” around the HMA aggregates.

The emulsion cures, bonding the mix & pavement.

- 5/8” minimum depth of mix
- 3/8” nominal aggregate size
- 3/16” emulsion membrane depth

9-12 µm coating on aggregates

Existing Pavement

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Performance

US 281 San Antonio, TX after 12 years
Reduced Tire Splash

Backspray from dense graded surface

Reduced backspray on Bonded Wearing Course

Results depend upon quality and gradation of aggregates used.
I-81 Virginia

Dense graded surface

Ultrathin Bonded Wearing Course

Results depend upon quality and gradation of aggregates used

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Open Mix Surfaces

Reduce noise
Minimize backspray
Increase visibility

Courtesy Asphalt Institute
How Do We Quantify Noise?

The Decibel Scale

Sound Pressure, N/sq. m.

Hearing Threshold

Conversation

Discomfort

Logarithmic scale

Courtesy Asphalt Institute

Road Science, LLC™
The Decibel Scale

67 dB(A)

50 ft

Courtesy Asphalt Institute

Road Science, LLC™
Reduction of 3 dB(A) is like doubling distance from the noise.

67 dB(A) - 3 dB(A) = 64 dB(A)

A 3 dB(A) reduction corresponds to:
- Doubling the distance
- Reducing traffic volume by 50%
- Reducing traffic speed by 25%

Courtesy Asphalt Institute
# Reduced Tire Noise

<table>
<thead>
<tr>
<th>Garden State Parkway New Jersey (150,000 ADT)</th>
<th>Reduction in measured noise level by NovaChip surfacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over PCC</td>
<td>3.2 – 4.1 dB</td>
</tr>
<tr>
<td>Over bituminous pavement</td>
<td>1.4 – 2.1 dB</td>
</tr>
</tbody>
</table>

Schmidt & Fischer, TRB, 1994
NCAT Noise Study for Michigan DOT

Average of measurements at 60 mph
12 pavement surfaces in Michigan
2 types of tires

NCAT Report to MDOT, 2003
## Durable Skid Resistance

### PA SR 422
(28,000 ADT, 8% trucks)

<table>
<thead>
<tr>
<th>UTBWC Over PCC</th>
<th>Pavement Skid Friction - Pennsylvania SR 512</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>When tested</strong></td>
<td><strong>NB</strong></td>
</tr>
<tr>
<td>Before</td>
<td>27</td>
</tr>
<tr>
<td>After</td>
<td>46</td>
</tr>
<tr>
<td>+ 1 yr</td>
<td>56</td>
</tr>
<tr>
<td>+ 2 yrs</td>
<td>54</td>
</tr>
<tr>
<td>+ 5 yrs</td>
<td>57</td>
</tr>
</tbody>
</table>

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PennDOT Reports
Other Benefits

Protects pavement
- Seals out water
- Resists wear & rutting
  - Projects have lasted 10+ years with crack sealing
- Resists top-down cracking

Thin lift retains clearances, curbs
Fast construction reduces user delays
Night construction
Lower life cycle costs

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Bonded Wearing Course Over Reconstruction

I-35, north of Albert Lea, MN
Seals and protects construction joints

Centerline construction joint protected by BWC seal

Cracks forming in unprotected construction joint on adjacent highway without BWC

I-35 after 2½ years

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Field Trial Research Reports

Caltrans Technical Advisory Guide
Louisiana Transportation Research Center (LTRC) at LSU
Texas Transportation Institute (TTI) at Texas A&M
National Center for Asphalt Technology (NCAT) at Auburn University
Pennsylvania DOT
Mississippi DOT
New Jersey Garden State Parkway
Transportation Research Board (TRB) Record 2001
Residential neighborhood construction
NCAT Test Track
Restoring Skid Resistance
1st Maintenance Treatment

Polished surface prior to surfacing

UTBWC surface

“Excellent performance after 2,400,000 ESALs, and still going”
US 24
Colorado Springs, CO
Hanging Lake Tunnel, I-70
Glenwood Springs, CO
Clark County Nevada
Ultrathin Bonded Wearing Course
Over New Construction

Surface characteristics
- Open graded
- Bonded

Durability
- Longest lasting surface treatment

Polymer emulsion membrane seals & protects
- Seals surface imperfections
- & cold joints

Structural addition
- Structural layer coefficient = 0.45
US 50 Lake Tahoe, CA
After 2 Years of Chains, Traffic & Snowplows

With Bonded Wearing Course

Without Bonded Wearing Course

Road Science, LLC™
Night Paving

San Antonio, Texas
I-35E Denton, Texas
I-85 North Carolina
after 1 year
Stiles Rd Savannah, GA

After 1 year

After 2 years
I-40 North Carolina

After 4 years
I-440 & I-64 North Carolina
Over PCC After 3 years
Rt. 422 Pennsylvania

After 10 years
Where do you place BWC?
Site Selection Guidelines over Asphalt Pavements

Structurally sound pavement
Rut depth < 12.5 mm or ½ inch
Minor to moderate severity transverse & longitudinal cracking
Minor to moderate severity patches & bleeding
Raveling & polished aggregate to high severity
Where do you place BWC?
Site Selection Guidelines over PCC

Structurally sound pavement
Low severity "D" cracking
Minor to moderate transverse & longitudinal cracking
Minor to moderate severity corner breaks
Minor to moderate severity joint spalling
Map cracking < 10 m² in any 100 m² area
Faulting < 9.5 mm
No blowups, water bleeding or pumping

I-40 North Carolina

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Poor Candidates for Maintenance BWC
Possible candidates for Rehab Bonded Pavement

High severity alligator cracking

High severity block cracking

Rutting

High severity “D” cracking
Pavement Preparation

Clean pavement
Seal existing cracks > ¼ inch
  ■ Don’t overfill
Fill surface deformities > ½ inch deep
Protect manhole covers, drains, etc.
Remove pavement markings if possible (for best ride quality)
Preventive Maintenance
I-70 Kansas
Rte. 288 Virginia
Over New Construction After 1 Year
Summary

Thin lift
Fast construction

Cost effective

Hot mix
Minimal user delays

Quiet - high macro-texture

Waterproofs Preserves
Thank you.

Questions?