Concrete Pavement Overlays on US 58
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Outline

• Project description
• Construction experience
• Test results
• Cost
• Lessons learned
• Conclusions
• Recommendations
Project Description

• US 58 WB, Southampton County near Courtland
• 4-in bonded: 2.6 miles
• 7-in unbonded: 2.2 miles
• 11-in JPCP: 0.30 miles

• Existing pavement 8-in CRCP
  – 1988
  – 2008 AADT: 8,300 with 14% truck
  – Avg. IRI: 110 to 163 in 2012
Project Description

Elevation for Bonded and New JPCP Unbonded Concrete Overlay on Concrete Pavement

1. See ACOT-1 Detail
2. 4" Bonded Concrete Overlay
3. Bonded Concrete Overlay 4" to 8"
4. 1" Asphalt Separation Layer
5. 7" Unbonded Jointed Plain Concrete Overlay
6. Full Depth Reconstruction (11" JPCP)
7. 10" Aggregate Base Type I, size 21 B
8. Existing 8" CRCP
9. Existing 6" CTA
10. Subgrade

Transition 45ft/in 4" = 180'
8" = 360'
Unbonded OL is 6'x6' panels

A. Unbonded overlay and 10" JPCP transition to be constructed with traffic on east bound lanes.
B. Sequence and typical section west of the transition may be modified to accommodate maintenance of traffic, access to private property and drainage concerns.
C. Transition construction steps
   i. Remove existing JRCP
   ii. Excavate to top of final subgrade, grade and compact.
   iii. Place 10" aggregate base
   iv. Place concrete pavement.

Not to Scale
Construction Phases

1. Unbonded – 2.2 miles
2. Bonded – 2.6 miles
3. RC-0.3 mi

Westbound

Eastbound
Construction Phases

1. Unbonded – 2.2 miles

- No Traffic
- Crossovers
- Concrete Barrier
- Eastbound

Speed reduced from 60 mph to 50 mph
Construction Phases

2

Bonded – 2.6 miles

No Traffic

Concrete Barrier

Crossovers

Eastbound

Speed reduced from 60 mph to 50 mph
Pavement Condition
before and after overlays

• Distress Survey
  – Video imaging
  – Visual survey

• IRI values

• FWD deflection data
Video Imaging
Visual Survey

• GPS coordinates
• Observed cracks, spalls, and patches.
Construction of Overlay

• Concrete Plant
• Surface Preparation
• Paving Operation
  – Workability of the mixture
  – Concrete in front of the paver
  – Tie bar insertion (unbonded overlay)
  – Curing
• Concrete Mixture and Properties
  – Loss of air and slump from plant to jobsite
  – Strength and permeability
Concrete Plant

Chiller to cool concrete

Aggregates on concrete slab
Surface Preparation (Unbonded)

1 inch Porous Friction Course (PFC)
Surface Preparation (Bonded)
Paving Operation

Concrete in front of the paver

Stringless paving
Workability of the Mixture

- High slumps make edge difficult to form. The insertion of the tie bars also affects the edge.
Tie Bar Insertion and Surface Disturbance

a) middle

b) edge

Disturbed surface

c) 

d) hole
Mixture

- 596 lb/yd³ cementitious material
- 25% Class F fly ash
- w/cm: 0.43, 0.45
- #57 coarse aggregate
- Natural sand
Air and Slump Loss

Air: 4 to 8%
Air loss of 1 to 2.5%

From plant to jobsite
Loss of air; however, AVA indicated satisfactory void system at the jobsite

Slump: 0 to 3-in
Slump loss of 1 to 1.5 in.
## Test Results

<table>
<thead>
<tr>
<th>Property</th>
<th>Sublots</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength, psi</td>
<td>71</td>
<td>4878</td>
<td>418</td>
</tr>
<tr>
<td>Permeability, coulombs</td>
<td>70</td>
<td>596</td>
<td>189</td>
</tr>
</tbody>
</table>

Design 28 day compressive strength ≥ 4000 psi  
Design 28 day permeability ≤ 2500 coulombs  
18,088 cubic yards; subplot = 0.1 mi or 270 yd³
The graph compares the average International Roughness Index (IRI) (in/ mile) for Inside Lane - LWP, Inside Lane - RWP, Outside Lane - LWP, and Outside Lane - RWP, under different construction conditions:

- Bonded Before Construction
- Unbonded Before Construction
- Bonded After Construction
- Unbonded After Construction

The IRI values for each condition are as follows:

- Inside Lane - LWP: Bonded Before Construction (115), Unbonded Before Construction (122), Bonded After Construction (111), Unbonded After Construction (93)
- Inside Lane - RWP: Bonded Before Construction (110), Unbonded Before Construction (75), Bonded After Construction (59), Unbonded After Construction (71)
- Outside Lane - LWP: Bonded Before Construction (146), Unbonded Before Construction (78), Bonded After Construction (62), Unbonded After Construction (56)
- Outside Lane - RWP: Bonded Before Construction (162), Unbonded Before Construction (73), Bonded After Construction (56), Unbonded After Construction (59)
Bonded Surface After Construction

Average bond strength = 335 psi
Unbonded Surface After Construction
<table>
<thead>
<tr>
<th>Unbonded HCC</th>
<th>Bonded HCC</th>
<th>Asphalt Overlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2 miles</td>
<td>2.6 miles</td>
<td>9.75 miles</td>
</tr>
<tr>
<td>1” PFC: $155/ton</td>
<td>Concrete Patch: $130/SY</td>
<td>Concrete Patch: $155.5/SY</td>
</tr>
<tr>
<td>Cost: $8.53 / SY</td>
<td>Area: 10.6%</td>
<td>Area: 12.4%</td>
</tr>
<tr>
<td>7” HCC</td>
<td>4” HCC</td>
<td>3” SMA 19.0: $100/ton</td>
</tr>
<tr>
<td>Cost: $27.00/ SY</td>
<td>Cost: $19.00/SY</td>
<td>2” SMA 12.5: $105/ton</td>
</tr>
<tr>
<td>Total¹: $35.53/SY</td>
<td>Total¹: $32.74/SY</td>
<td>Total¹: $47.42/SY</td>
</tr>
</tbody>
</table>

¹ Cost for the maintenance of traffic is not included in Total.

- Note: Asphalt (SMA or PFC) = 110 lb/ inch/ SY
## Total Costs, million dollars

<table>
<thead>
<tr>
<th>Project</th>
<th>HCC</th>
<th>Asphalt Overlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length, miles</td>
<td>5.1</td>
<td>9.75</td>
</tr>
<tr>
<td>Bid total</td>
<td>7.89</td>
<td>8.65</td>
</tr>
<tr>
<td>Paid to date total</td>
<td>8.37</td>
<td>9.88</td>
</tr>
<tr>
<td>Paid Cost per mile</td>
<td>1.64</td>
<td>1.01</td>
</tr>
<tr>
<td>Traffic Control per mile</td>
<td>0.346</td>
<td>0.024</td>
</tr>
<tr>
<td>Concrete Barriers, mile</td>
<td>0.252</td>
<td>None</td>
</tr>
<tr>
<td>Crossover Prep., mile</td>
<td>0.179</td>
<td>None</td>
</tr>
<tr>
<td>Paid Cost – TC, mile (difference)</td>
<td>1.115</td>
<td>0.986</td>
</tr>
</tbody>
</table>

Note: Paid Cost – TC, mile (difference) is calculated as the difference between Paid to date total and Bid total.
Lessons Learned

• One traffic shift (could save $400,000 & one month)
• Barrels instead of barriers by reducing speed limit
• Smooth track lines
  – PFC separation layer for unbonded section
  – Asphalt shoulder in two layers; bottom layer track line for bonded section
  – Mill shoulder 2-in bonded sect., 6-in white topping
• For overlays pay by cubic yard
  – Specify max and min limits on thickness
• Prepaving meeting
  – Attendance by all parties clarify expectations
I85 4-in Bonded Overlay 1995
paved one lane at time with barrels
I295 2-in Bonded Overlay 1995
paved one lane at a time with barrels
I-85 4-in Bonded Overlay 1995

Good condition after 17.5 years
I81 Full Depth Reclamation

Group 2 Devices
Conclusions

- Overlays were constructed on schedule.
- Concrete was of high quality (good strength, low permeability, bond strength very good).
- Ride quality is good (unbonded IRI = 56 to 71 in/mile) when smooth PFC track line is constructed and fair when existing shoulder is track line (bonded IRI=73 to 93).
- Concrete overlays can be an economical alternative to asphalt overlays when traffic control costs similar.
Conclusions

• Concrete for bonded overlay cost less than asphalt overlay.
• Patching costs are very high.
• Bonded and unbonded costs are similar due to high patching cost for bonded overlay.
• Asphalt overlay was more expensive than unbonded overlay because of high patching cost.
• Unbonded overlays are more economical when existing pavement is in poor condition (requiring > 7.7 per cent patching).
Recommendations

• Install overlays before extensive patching is needed.

• Specify bonded overlays as an alternative to asphalt overlays as preservation treatments.

• Specify unbonded overlays as an alternative to asphalt when more than approximately 7.7 percent of the pavement must be patched.

• Identify and specify traffic control strategies for concrete overlays that are similar to those used for asphalt overlays.
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