DESIGN AND REHABILITATION OF LOCAL ROADWAYS FOR OHIO’S COUNTIES

Concrete Resurfacing of Asphalt Pavement

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System of Concrete Overlays

Concrete Overlays

Bonded Overlay System

Concrete Pavements

Asphalt Pavements

Composite Pavements

Unbonded Overlay System

Concrete Pavements

Asphalt Pavements

Composite Pavements

Bond is integral to design

Old pavement is subbase
Why Concrete Overlays?

1. Because of the wide range of overlay thicknesses that can be used, combined with minimal pre-overlay work required, concrete overlays provide **cost-effective** solutions for almost any pavement type and condition, desired service life, and anticipated traffic loading.

2. The **existing pavement does not need to be removed**. In fact, it is factored into the overlay design to continue to help carry some of the traffic load.

3. Concrete overlays are **easy to maintain**.

4. Thin overlays constructed **without reinforcement** can be easily and economically **milled out and replaced** with a new concrete surface. **Small panels** can be replaced much easier than conventional concrete.
Concrete Overlays
Service Life Expectations

• Thickness of 2 to 6 in. – 15 to 25 years
• Thickness > 6 in. – 20 to 30+ years

Overlay service life is dependent upon:
• Sound overlay structural design - compatible with expected traffic and site conditions, and
• Good construction practices
The real challenge is identifying the right treatment at the right time.
Concrete Overlays in the U.S.

- Existing compilations of project details:
The National Concrete Overlay Explorer

Instructions

MAP VIEW • TABLE VIEW • DETAILS VIEW

1147 Items

658 results out of 1147 cannot be plotted.
Iowa US18 – Under Traffic
Concrete Overlay Field Application Program

Expert Team Approach

An expert team consisting of DOT professionals, industry representatives, and consultants will be assigned to each state to share knowledge of and experiences with:

- overlay technology,
- project evaluation and selection,
- design details,
- construction traffic control suggestions, and
- constructability issues.
Lessons Learned from Recent Concrete Overlay Projects

Overview of Concrete Overlay Phase 2 Field Application Program
(Concrete Overlay Technical Assistance for State & Local Highway Agencies)

The need for engineered preservation and rehabilitation strategies for maintaining the nation’s highway pavements has never been greater. To advance the use of concrete overlays as cost-effective solutions for a wide variety of pavement conditions, the Federal Highway Administration (FHWA) and the National Concrete Pavement Technology Center (CP Tech Center) are implementing the second phase of the Concrete Overlay Field Application Program.

Program Objective
The overall objective of this program is to increase awareness and knowledge and strengthen confidence in concrete overlay applications among state DOTs, cities, counties, contractors, and engineering consultants.

A lot was accomplished in Phase I of the Field Application Program and it is important to continue to increase the awareness and knowledge of concrete overlay applications. In the Phase I program a total of 24 states where given either workshops, site visits to evaluate potential overlay candidates, or consultation on projects on design or early construction.

States’ Involvement
Each participating state agency will have an opportunity to develop in-house expertise on overlays with these steps if they so desire:

- Meetings with state DOT upper management regarding the benefits of concrete overlays and to answer state DOT’s questions on issues they perceive.
- An initial 6 hour workshop on concrete overlay best practices.
- Site visits and remote meetings with an expert team who will provide ongoing recommendations and guidance on the states’ candidates for a concrete overlay. A visit report would be prepared by the expert team for each site.

Sharing Experiences
Following the site visit, the team will provide a written summary with recommendations. The findings of each site visit, as they occur, will also be sent to each of the NC2 state DOTs for their information. This will go a long way in sharing information with 24 states throughout the country.
Guide to All Types of Concrete Resurfacing

- Overlay types and uses
- Evaluation & selection
- Design guidance
- Miscellaneous design details
- Overlay materials selection
- Work zones under traffic
- Key points for overlay construction
- Accelerated construction
- Specification considerations
- Repairs of overlays

- Free download at: www.cptechcenter.org
- Spots of distress that aren’t visible can be determined through evaluation such as the stiffness of the asphalt pavement and subgrade support conditions.

- Localized areas of weakness can be strengthened through patching. Milling can remove a number of asphalt surface distresses.
Bonded versus Unbonded

**Bonded:** Use to eliminate surface defects; increase structural capacity; and improve surface friction, noise, and rideability.

**Unbonded:** Use to restore structural capacity and increase pavement life equivalent to full-depth pavement. Also results in improved surface friction, noise, and rideability.
General Feasibility—Bonded PCC Overlays

• Bonded Concrete of HMA & Composite
  – “Good” to “fair” HMA pavements with:
    • Limited structural (fatigue) cracking
    • No stripping/raveling in HMA layers
    • HMA thick > 3-4 inches (after milling)

BCOA is primary focus of today’s webinar
How Do Bonded Overlays over Asphalt Work?

- Concrete bonds to the asphalt
  - Lowers the neutral axis
  - Decreases stresses in the concrete
- Short joint spacing
  - Controls cracking
  - Slabs act as paver-blocks
- Fibers improve concrete toughness
Pavement Condition Evaluation

• Identify Types of Distress
  – Fatigue (Alligator) Cracking
  – Rutting
  – Transverse or Longitudinal Cracking
  – Etc.

• Identify Severity of Distress
  – Low, Medium, High

• Identify Quantity of Each Type/Severity
  – \( \text{ft}^2, \text{in.}, \text{ft}, \text{etc.} \)
Analysis of Evaluation Data

• Combine Information From:
  – Visual Distress Survey
  – FWD and Profile (IRI)
  – Cores, Soils, etc.
  – Drainage Survey and Grade Restrictions

• Determine Structural Adequacy of Existing Pavement

• Make Decision: Bonded or Unbonded?
  – Bonded: Identify Areas for Repair (Full or Partial Depth, Sealing, Milling Depth, etc.)
  – Unbonded: Identify Areas of Repair or Consider Total Reclamation
Preoverlay Repairs on Existing Asphalt Pavement in Preparation for Bonded Overlay

<table>
<thead>
<tr>
<th>Existing Pavement Distress</th>
<th>Spot Repairs to Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutting ≥ 2 in. (50 mm)</td>
<td>Mill</td>
</tr>
<tr>
<td>Rutting &lt; 2 in. (50 mm)</td>
<td>None or mill</td>
</tr>
<tr>
<td>Shoving, slippage</td>
<td>Mill</td>
</tr>
<tr>
<td>Crack width ≥ maximum coarse aggregate size used in the concrete overlay mixture</td>
<td>Fill with flowable fill.</td>
</tr>
<tr>
<td>Crack width &lt; maximum coarse aggregate size used in the concrete overlay mixture</td>
<td>None</td>
</tr>
<tr>
<td>Low- to medium-severity pothole</td>
<td>Remove loose material and fill integrally with the concrete overlay.</td>
</tr>
<tr>
<td>High-severity pothole and/or areas needing full-depth repair</td>
<td>To prevent a single overlay panel from bonding to both asphalt and concrete, make full-depth repairs across a full lane width with concrete and adjust the transverse joint spacing in the concrete overlay to match the location of the underlying patch. The full lane width prevents trying to match a longitudinal joint for a partial lane patch.</td>
</tr>
</tbody>
</table>
Bonded Over Asphalt

Keys to Success

• Bonding is critical
• Small square panels reduce curling, warping, & shear stresses in bond (1.5 times thickness).
• Mill to remove surface distresses, or improve bonding.
• Be sure to leave 3” to 4” of HMA after milling.
• HMA surface temperature below 120 F before paving.
• Joints in the overlay should not be placed in wheel paths, if possible
• Application of curing compound is critical
Concrete Overlay Materials & Mixture

- **OPTIMIZE GRADATION** for improved workability for a given water content (W/CM)
  - Portland cement = 293 lb/yd$^3$
  - SCMs, Fly ash or Slag = 158 lb/yd$^3$ (35% replacement)
  - W/CM = 0.42 (22.7 gal/yd$^3$)
  - Mid-Range WRA
  - Fibers?
Structural Fibers Bonded Overlays

Residual strength ratio = 24%

Straight synthetic:

Crimped synthetic:
Structural Fibers Considerations

- No increase in concrete’s strength, but in fatigue capacity
- Increases toughness
- Increases post-crack integrity
  - Helps control plastic shrinkage cracking
- Macro Synthetic most common (0.26% by volume).
- $0.70/sq yd for 4lb dosage per cu.yd
- 3 to 5# min. mixing with 2”+ Slump loss
Fiber-Reinforced Concrete

• Structural Fiber reinforcement should be considered in any of the following situations:
  ▪ The project has specific vertical restrictions
  ▪ The asphalt lift is very thin (and thus may not readily bond with the concrete)
  ▪ The base thickness and/or condition is inadequate
  ▪ The design thickness makes conventional reinforcement difficult to use
  ▪ The design life needs to be increased
  ▪ An increase in heavy-truck traffic is planned or anticipated
Pre-Paving

• Milling to:
  – Remove distortions of 2” or more
  – Match adjacent lanes
  – Enhance bond of overlay
  – Restore profile
  – Reduce high spots to insure minimum overlay thickness
  – Milling should be minimized to retain structural support of pavement (excessive milling)
  – Meet vertical elevation requirements
  – Grade corrections should be made in the thickness of the concrete overlay

• Bonded on asphalt must maintain a min of 3” sound asphalt after milling
Pre-Paving

- Surface cleaning
  - Power sweeping
  - Air blasting
Construction

• Place concrete when surface temperature is <120°F.
• Conventional fixed-form or slip form placement used.
• Shotblast or mill (if needed) and clean surface thoroughly.
• Grout or epoxy bonding agents are not required (however local conditions and experience will dictate).
• Texture Pavement for friction.
• Curing material must be placed as soon as possible (<30 minutes). Full coverage is essential.
• Begin sawing as soon as possible (use of early entry saw is recommended).
• Test mix throughout placement for QC.
Paving

- Maintenance of traffic
  - Depends on concrete overlay thickness
    - If edge drop-off criteria is exceeded, then MOT is just like full depth PCC reconstruction
    - Otherwise, similar to MOT for asphalt projects
  - Options include:
    - Construction adjacent to traffic (lane at a time)
    - Positive separation or cones
    - Pilot car operation for two lane roadways
    - Crossovers and construct full width
    - Staged intersections or full closure with accelerated opening (48 to 72 hr)
  - All concrete overlays are accelerated construction!
Curing of Overlays

• Cure as soon as practical
• Even and complete coverage
• Consistent operating speed
• Edge covered also
• Even and complete cover
• Adjust for dry and/or wind
• Clean/adjust nozzles
• Keep it wet, keep it warm: for durability
Cure System

• Too often it is the last thing on our minds

• More critical with admixtures in use today
  – less bleed water
  – more critical with low water cement ratio
  – concrete can dry out and not hydrate

• We need to keep the moisture in the concrete to reduce curl effects
  – Poly-alpha-methylstyrene is worth the premium PAMS
  – Lithium silicate reported to reduce cracking
BCOA
Design Details and Joints
Joint Design

• Panels should be cut square as possible.

• Panel size should be limited to 1½ - 2 times the concrete thickness in feet.

• Joints should be cut early with thin blades.

• Joint sealing is usually not required or needed.
Longitudinal Joint Layout

- 2 ft x 2 ft
- 3 ft x 3 ft
- 4 ft x 4 ft
- 6 ft x 6 ft

Traffic

12 ft
FHWA pooled fund TPF-5(165)
Typical Design Inputs: Streets & Roads

- Current and Future Traffic Loading
- Location (For Temperature Thermal Gradient Calculation)
- Reliability
- Concrete Strength
- Fibers (Residual Strength Ratio)
- Underlying (Existing) Pavement Thickness/Strength
- Soil Strength
- Slab Dimensions
- Bond Condition
Pitt BCOA-ME Web App

http://www.engineering.pitt.edu/Vandenbossche/BCOA-ME/
Pitt BCOA-ME Web App

Annual Mean Daily Average Temp

ACPA k-value web app
## Joint Spacing for Concrete overlays

<table>
<thead>
<tr>
<th>Bonded Overlay of Asphalt</th>
<th>Restriction</th>
<th>Typical Range</th>
<th>Transverse Joint Depth</th>
<th>Longitudinal Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length &amp; width (in feet) at 1.5 times the thickness (inches)</td>
<td>3’ – 8’</td>
<td>T/3 min.</td>
<td>T/3</td>
</tr>
</tbody>
</table>
How Thin Concrete Overlays Work

Sawn Control Joints with Shorter Spacing

Larger Joint Spacing - More Random Cracks

Short joint spacing allows the slabs to deflect instead of bend. This reduces slab stresses to reasonable values. Joint load transfer is improved by decreased joint openings from reduced slab movements and thin saw cuts.
Lake Ave Overlay Medina County
5” Unbonded Concrete Overlay

Amherst, Ohio
Sprague Rd, No Royalton
Footville-Richmond Rd
Archbold, Ohio Overlay Project 2014
2010 Overlay Cost Survey

- Based on 33 projects in 6 states in 2009
- Includes concrete, placing overlay, and jointing
- Excludes pre-overlay repair and separate layer (if used)

Lots of Guidance Available...
Questions?

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