NEW APPLICATIONS FOR THIN CONCRETE OVERLAYS – THREE CASE STUDIES

Shiraz Tayabji, Fugro
Andy Gisi, Kansas DOT
Jason Blomberg, Missouri DOT
Dan DeGraaf/Andy Bennett, MCPA/MIDOT

National Conference on PRR of Concrete Pavements
St. Louis, Missouri – April 2009
A Most Serious Need
- PRR of Our Highway System

- Majority of pavements in the US were designed for a 20- to 25-year service life.
- Many miles of these pavements are still in service after 35 to 40 years. These older pavements are exhibiting poor performance and need to be treated.
- The treatments include concrete overlays.
- Concrete overlays can extend pavement service life with the least life-cycle costs.
Why Concrete Overlays

- Long performance lives (15 to 40+ years)
- Increases load-carrying capacity
- Low life-cycle costs
- Can be used over deteriorated AC, PCC and composite pavements
- Results in improved surface friction, noise, and ride
Family of Concrete Overlays

Concrete Overlays

- Bonded
  - Thin
    - Bonded Concrete Overlay of Concrete Pavements
    - Bonded Concrete Overlay of Asphalt Pavements
    - Bonded Concrete Overlay of Composite Pavements
      - Short joint spacing

- Unbonded (directly placed)
  - Unbonded Concrete Overlay of Concrete Pavements
  - Unbonded Concrete Overlay of Asphalt Pavements
  - Unbonded Concrete Overlay of Composite Pavements

Bond is integral to design
Old pavement is base
**Bonded Concrete Overlays**

Concrete resurfacing of existing AC, PCC or composite pavement

**Common items**
- **Thin**
- Bonded to AC or PCC
- Smaller panels if bonded to AC surface
**Unbonded Concrete Overlays**
*(of existing AC, PCC or composite pavement)*

**Common items**

– Thicker
  • > 6 in. over AC
  • > 4 in. over PCC or composite

– Joint spacing
  • 6 by 6 ft for t ≤ 6 in.
  • Conventional for t > 6 in.

– All placed directly over AC surface or other interlayer

– Bonding not “encouraged”
Concrete Overlays – Service Life Expectations

- Thickness of 2 to 6 in. – 15+ years
- Thickness > 6 in. – 20 to 40+ years

Overlay service life is dependent upon:
- Sound overlay structural design - compatible with expected traffic and site conditions, and
- Good construction practices
New Applications for Thin Overlays

Recently three unique applications of thin concrete overlays were implemented:

- Bonded concrete inlay - Kansas
- Unbonded concrete overlay using a “thick” geotextile interlayer – Missouri
- Unbonded overlay of a composite pavement - Michigan
Kansas Case Study: I-35 Bonded Overlay - 2008

- Original PCCP – 1985 – 9 in. JRCP (30 ft slabs), over CTB
- Distress – extensive spalling – 2 in. deep
- Bonded overlay – mill 2 in., shot blast, apply slurry, place 2 in. bonded inlay
Unbonded Overlay
Separator Layer

- Required for good performance
  - Isolate overlay from existing pavement
    - Prevent reflection cracking
    - Prevent bonding/mechanical interlocking
  - Provide level surface for overlay construction

- Recommended interlayer material:
  - 1-2 inch dense-graded HMA
  - GEOTEXTILE ?? (Missouri Demo)
Missouri Case Study: Unbonded Overlay with Fabric Interlayer

Missouri 2008

Original JPCP - 8 in., 1986
Overlay: 5 in. & 6 by 6 ft
Michigan Case Study – Gratiot Ave

Unbonded overlay of a composite pavement – Detroit area
PCCP Bonded Inlay

35-46 KA-1106-01
I-35 at Jct with I-435
Johnson County

Andrew Gisi, P.E.
Location
Existing Pavement

- Constructed in 1985
- Nine inches PCCP
- Reinforced with wire mesh
- Dowel jointed
- Thirty foot joint spacing
- Four inches PCTB
- Six inches LTSG
**Distress**

- Joint spalling
- Cracked slabs
- IRI of 107 ipm
Observations and Tests

- Longitudinal and Transverse joints are spalled
- Several inches wide and **about two inches deep**
- Distress indicative of “D”-cracking
- DF of 0.65 after twenty-two years of service
- Flexural strength of 680 psi (Equiv Comp 7200 psi)
- Hardened concrete air system results
  - Spacing factor 0.006”
  - Content 8.2% (4.8%)
Alternates Considered

- Partial Depth Patches
- Reconstruction
- HMA Overlay with RCI
- Concrete inlay
Selected Design

- Slab replacement
- Mill two inches to remove spalls
- Place two inches of concrete inlay
- Diamond grind surface
- Seal joints
Specifications/Work Plan

- Ten weeks for patching and inlay
- Four weekends for milling and inlay
- Surface preparation (milling): 63,125 SY*
- Concrete pavement: 3,706 CY*
- Placement: 57,913 SY
- Grinding: 54,461 SY
- Open to traffic at 340 psi flexural strength
Surface Preparation
High Steel/Shot Blast
Overlay Placement
Overlay Placement
Summary

- Completed on time
- Did not need to grind for smoothness
- Preserved median safety barrier section
- Extended life of long life pavement
5-inch Unbonded PCCP “Big Block” Overlay

Rte D (Holmes Rd)

Cass/Jackson County, Missouri
Rte D – Project Description

- Project length: 3.7 miles
- 2-lanes, minor route classification
- 9300 AADT (465 trucks)
- 8-in PCC, 30-ft joints w/ 1-in dowels
- Only 22 years old; (1986)
  - Severely deteriorated by D-cracking
  - Estimated 25% of area required full depth repair prior to conventional HMA overlay
Unbonded PCCP Overlay System Selected for Rte D

- Needs to bridge over the structural deterioration and carry the traffic loads.
- Pavement repairs are minimal.
- Does not act monolithic with the existing pavement, which requires a debonding/separator layer.
- Thick enough to handle the traffic loads with the appropriate joint design.
Route D Design and Specifications

- 5-inch minimum thickness
- 6-foot square panels (‘Big Block’)
- No steel or fibers
- Separator/interlayer options
  - Geotextile interlayer ($1.50 - $2.50 sy)
  - 1-inch bituminous layer
Purpose of the Interlayer

➢ Separation.
   - To prevent bonding between concrete layers which keep cracks and joints from reflecting upward.

➢ Drainage. (Geotextile Fabric Only)
   - To channel water that infiltrates away from the center and to the edge of the pavement.

➢ Bedding.
   - To reduce bearing stresses and the effects of dynamic traffic loads.
Fabric Specifications

- Fabric Type: Non-Woven Geotextile
- Mass per Area: > 14.8 oz/sq. yd.
- Thickness under a Load Requirements
- Tensile Strength and Maximum Elongation Requirements
- Water Permeability Requirements
- Chemical and Weathering Resistance
Fabric mass specification changed to a minimum of 16 oz./Sq. Yd.
Consist of bituminous, cementitious, or other materials meeting approval.
Placing Fabric
No placement issues reported.

- Sweep surface prior to placement
- Avoid wrinkles
- Overlap by 8”
- Avoid 3 layers
Securing Fabric

- Fasten with nails and ~ 2” galvanized washers at minimum 6-foot spacing
- Avoid excessive trafficking on fabric
Fabric should be damp, but not saturated, prior to concrete placement
Placing Overlay

- No Placement Issues
- Establishing vs. Matching Existing Profile
Finishing Surface

- Increased surface bleed water
- Sawing Joints in 6 ft. x 6 ft. Pattern
Post Construction
Looks Good - Rides Good!

- Continued Performance Monitoring w/ Pavement Surveys
- Upcoming 5-inch Big Block Projects this season on Rte 61 in Jefferson & Ste. Genevieve Counties.
Thank You!
Questions?
Thin Concrete Overlay Demonstration Project
Gratiot (M-3); I-75 to I-94, Detroit TSC
Thin Concrete Overlay History

- Nationally, most experience has been with underlying flexible pavements.
- M-46 in Bay Region in the late 90’s.
- Local projects; Wayne and Washtenaw Counties.
- I-75 in the North Region in 2003.
- Gratiot is Metro’s first project.
The team started work in October 2003, met monthly through April 2004. Plans were turned in June 22nd.

- Non MDOT Contributors: Ryan Rizzo (FHWA), Bob Risser, Dan DeGraff and Kari Sutton (MCPA), Jason Nault, Bob Kangas and Ken Mazurek (Tetra Tech)
- Lansing C&T Contributors: John Staton, Curtis Bleech, Tom Hynes, Mike Eacker and Andy Bennett.
- Detroit TSC Contributors: Rita Screws, Roger Teale, Abel Sahlool and Georgina McDonald.
- Metro Region Contributors: Cedric Dargin, Mark Grazioli, Chris Burnell and Ashok Punjabi
Proposed Pavement Section

- 4 inch (minimum) Plain Concrete Pavement sawed into 6’ by 6’ panels without load transfer.
- 1 inch (uniform) HMA separator – 2 mix types.
- Profile cold milling, 1.5” minimum depth.
- Normal conditioning repairs as needed.
Pavement History

- 1939-40 Sheet Asphalt on Concrete with Brick on the outside. Orig. Construction?
- 1956 Bituminous Resurfacing.
- 1985 Bituminous Resurfacing.
- 2001 N.B. Distress Ind. 13 to 34 (24 Avg.)
Exact Project Limits

- North limit is just south of I-94 (McClellan).
- South limit, Railroad structure about 400’ south of St. Aubin. New bridge approach slab will be built.
Initial Concerns

- Brick Pavers in the parking lanes.
- Insufficient structural support, especially in the parking lanes.
- Sheet (Deteriorated) Asphalt layers from initial cores.
- Existing insufficient curb face.
- Concrete repairs up to roadway surface.
- Existing rails underneath the surface.
Parking Lane Remedies

- Cores revealed brick pavers placed on a solid concrete base. Paver removal in most cases because of depth.
- FWD testing indicated a subgrade support value of 5,000 psi on average (2,500 to 13,000 psi). The other lanes had higher values.
- Normal full depth concrete along with partial depth HMA repair were used as needed.
Other Remedies

- Sheet (Deteriorated) Asphalt layers. This solidified the need for an HMA separator.
- Existing insufficient curb face. Partial removal and replacement is planned.
- Concrete repairs up to roadway surface
- Existing rails underneath the pavement surface. Ground Penetrating Radar investigation revealed the depths, this information was displayed on the plans. A special provision was written to handle the removal.
Special Elements

- P1 Mod. Shilstone Dense Graded Concrete mix. Smaller aggregates.
- Two different HMA separator mixes were used. Normal 13A mix and a more Open Graded mix.
- Sealed (1/4” wide) and Un-sealed (1/8” wide) joints were constructed.
- Carpet drag surface texture was used.
- Special urban ride quality spec. was included.
Maturity meters were used to determine opening to traffic strength.
Isolation joints were required at the structures showing full depth concrete.
Contractor was required to develop a jointing scheme at each intersection for approval by MDOT before paving.
Pavement Preparation
Pavement Preparation

- Local cross streets more challenging.
Pavement Preparation

- Cold milling revealed sound pavement, consistent with coring investigation during development.
Asphalt Separator Paving

- Open Graded mix
Concrete Paving
Gratiot Avenue - Completed