Improving Intersections with Concrete

Andy Johnson, Ph.D., P.E.
Pavement Design Engineer
Portland Cement Association – SE Region

Georgia Concrete Pavement Conference
September 22, 2015
Why pave intersections with concrete?

• Concrete is the longer lasting pavement solution, can last 30 or more years with minimal maintenance.
• Concrete can be the cheaper solution when long-term maintenance and user costs are figured.
• Get in, get out, stay out…
What are the concrete options?

• Remove 5 to 12 inches of existing pavement and replace with concrete. (Unbonded Overlay)
• Remove 3 to 5 inches of existing pavement and overlay with concrete. (Bonded Overlay)
What’s the distinction between the options?

• An unbonded overlay with concrete is designed in a similar manner to a traditional pavement.
• It may depend on the material underneath for support, but does not depend on being bonded.
• However, bonding does improve performance.
Concrete pavement design principles

- PCC pavements are rigid
- Vehicle loads are distributed over large areas (beam strength) (15-20 ft)
- Minor deflections
- Low subgrade pressures
- Subgrade uniformity is more important than strength
Asphalt pavement design principles

- Asphalt pavements are flexible
- Distribution of loads depends largely on pavement thickness
- Load on subgrade is more concentrated
- Deflections are much higher
- Subgrade strength/stiffness is very important
Thin bonded overlay design principles

• Asphalt surface is unable to resist traffic braking or accelerating forces.
• Hybrid structure is sufficient to carry traffic loads.
Thin bonded overlay design principles

- Maintaining bond is critical to keeping the two layers acting as a single unit. If bond is lost, stresses in concrete layer will increase greatly.
Suitable candidates for bonded overlay

• Stable support conditions (localized weak areas can be strengthened)

• Surface distresses
  – Rutting/shoving of surface layer (not deep)
  – Top down cracking (mostly age-related)

• Minimum of 3 inches of asphalt remaining after milling.
Preconstruction activities for concrete overlay

• Gather available records
  – Original plans
  – Design data
  – Traffic data
  – Historical performance data
  – Maintenance and repair history
Preconstruction activities for concrete overlay

• Site visit
  – Identify and record distresses
  – Note vertical clearance issues
  – Note restrictions on grade
    • Curb and gutter elevations to be maintained?
    • Inlets and drainage structures?
Preconstruction activities for concrete overlay

• Coring of existing pavement
  – Pavement thickness
  – Visual evaluation of stripping or raveling
  – Possible geotechnical evaluation of subgrade
Preconstruction activities for concrete overlay

• FWD testing
  – Nice to have, but not mandatory
  – Backcalculate overall pavement stiffness
  – Evaluate structural adequacy of existing pavement
  – Can estimate based on visual evaluation of cracking
Poor candidates for bonded overlay

- Significant structural deterioration
  - High severity fatigue cracking
  - Rutting of base and subgrade
- Stripping of asphalt layers
- Poor drainage
- Inadequate or uneven support
- Inadequate base structure
Selection of thickness

• Several methodologies available
  – ACPA StreetPave
  – University of Pittsburg BCOA-ME
    • FHWA Pooled Fund Study 5-165
    • Developed by Professor Vandenbossche
BCOA-ME

• Available online
  – Search for “BCOA concrete asphalt”
• Software runs at University of Pittsburgh over the web from data input online.
• No cost to use
• Site contains lots of background information and documentation.
BCOA-ME

(Last site update Aug. 2015/Last guide update April 2015)

The bonded concrete overlay of asphalt mechanistic-empirical design procedure (BCOA-ME) was developed at the University of Pittsburgh under the FHWA Pooled Fund Study TPF 5-165. This pavement structure has been referred to as thin and ultra-thin whitetopping. This site is a repository for all information relating to the BCOA-ME. The information has been sorted based on its intended use and can be retrieved by clicking on the appropriate tab below. The BCOA-ME can be run directly from this site by clicking on the “Design Guide” tab below.
Joint layout

- Avoid placing longitudinal joints in wheelpath.
- Smaller slab sizes (less than 6’ x 6’) sometimes (but not always) reduce overlay thickness.
- Need to balance reduction in thickness with increase in joint sawing and potential maintenance, if sealed.
Joint layout

- Things to do
  - Match existing joints or cracks
  - Cut at the proper time
  - Place joints to meet in-pavement structures
  - Adjust spacing to avoid small panels or angles
  - Intersect curves perpendicular
Joint layout

• Things to avoid
  – Slabs < 1 ft. wide
  – Slabs > 15 ft. wide
  – Angles < 60º (90º is best)
  – Creating interior corners
  – Odd Shapes (keep slabs square)
  – Offset (staggered) joints
  – Isolation joints in traffic areas
Blockout with perimeter expansion joint

Reinforcement

Adjust joint to meet inlet

Adjust joint

Telescoping manhole
Boxing out fixtures

Square
- Isolation joint
- Reinforcing bars recommended to hold cracks tight

Diagonal
- Isolation joint

Circular
- Isolation joint around perimeter

Square with Fillets
- Isolation joint

None
- No boxout or isolation joint necessary

Telescoping Manhole
- Inlet - Round
- Isolation joint
Material considerations

• Concrete
  – May use high-early strength to facilitate construction.
  – Consider using fibers in concrete when overlay thickness is 4 inches or less.
  – Fiber type and quantity should be selected to achieve a minimum residual strength of 20%.
Construction considerations

• A milled surface enhances the bond, especially for overlays 4 inches or less.
• Milling depth should:
  – Remove surface distortions > 2 inches deep
  – Match curb or adjacent structure elevations
  – Account for changes in cross slope prior to placement of surface layer. (But, don’t mill too much!)
Construction considerations

• Ensure the milled surface is clean
  – Sweep the surface thoroughly
  – Remove dust with compressed air

• Mist the surface prior to concrete placement
  – Reduce surface temperatures
  – Reduce moisture absorption from concrete
  – No standing water
Examples
US-501 and 378, Conway, SC - 2004
US-501 and 378, Conway, SC - 2004

- Extremely severe rutting
- Pavement was approximately 15 inches thick
- Coring revealed that a layer about 10 inches down was the source of instability
US-501 and 378, Conway, SC - 2004

- Decided to mill 10” to 14” to restore cross slope.
- 10” thick overlay of plain jointed concrete with 1.5” dowels and 15’ joint spacing.
US-501 and 378, Conway, SC - 2004
US-501 and 378, Conway, SC - 2004
US-501 and 378, Conway, SC - 2004
US-501 and 378, Conway, SC - 2005

• Scope of work
  – Work was done in February during low season
  – Had to maintain traffic in one direction
  – Could have 24-hour closures from Sunday at 8 PM to Friday at 6 AM.
  – Had to finish concrete paving in two weeks.
US-501 and 378, Conway, SC - 2005
US-501 and 378, Conway, SC - 2005
US-501 and 378, Conway, SC - 2005
US-501 and 378, Conway, SC - 2004
US-82 and US-84, Waycross, GA

• Thin bonded overlay
• 4 inches thick (?)
• Let July 2003
US-82 and US-84, Waycross, GA
US-82 and US-84, Waycross, GA
US-82 and US-84, Waycross, GA
SR-196/SR-119, Hinesville, GA
SR-25 at Brampton Rd, Garden City, GA
SR-25 at Brampton Rd, Garden City, GA
Blossom Street at Assembly, Columbia, SC
Blossom Street at Assembly, Columbia, SC
Harden Street at Gervais, Columbia, SC
Harden Street at Gervais, Columbia, SC
For detailed information, refer to the Guide to Concrete Overlays, Third Edition, published by the National Concrete Pavement Technology Center. This publication provides sustainable solutions for resurfacing and rehabilitating existing pavements, with a focus on practical approaches to understanding and successfully using concrete overlays, from selection to opening.
Thank you!

Andy Johnson
PCA – SE Region
ajohnson@cement.org
803-556-2889