Value Proposition/Proven Technology

The Story About Concrete Overlays

Tuesday, July 12, 2022

The Challenge to Pavement Owners

- Existing infrastructure is continually deteriorating
  - Weather
  - Traffic
- Demands are increasing
  - Traffic
  - Ride quality
  - Continuous access
- Funding is decreasing
  - Maintenance costs often exceed Agency revenue

Concrete Overlays: Today's Talking Points

- The Challenges
- The Value Proposition
- Addressing Barriers to Implementation
- Getting Started
- Resources
- Proven Technology
- Case Histories

Maintaining Existing Pavements

- We can toss them out and start again
  - A long term solution
  - Creates a disposal headache
  - Takes energy to move them out of the way
  - Takes time = traffic delays
Maintaining Existing Pavements

- We can patch them – buy a few years
  - Limited materials usage, energy and traffic impact
  - Effective
  - A shorter term solution

Maintaining Existing Pavements

- We can overlay them with concrete
  - Use existing equity
  - Minimize sustainability impacts
  - Long term solution
  - Lower life cycle cost
  - Elevations / connections are tricky

Another Tool in the Toolbox

- Concrete Overlays - Concrete placed over an existing paved surface to:
  - Extend life
  - Restore ride
  - Increase structural capacity
Concrete Overlays

Concrete on Asphalt  Concrete on Concrete

Proven Applications for Concrete Overlays

Urban Arterials  Rural Secondary Roads  Urban Freeway/Interstates

Airport Runways  Urban Arterials  Rural Primary/Interstates  Parking Lots

The Value Proposition

- Costs
- Environmental impacts
- Resiliency
- Effectiveness

Costs

- Initial costs depend on
  - Competition
  - Local contractor experience
  - Local materials availability
- Can be competitive with other solutions
- Annual ownership costs are reduced
  - Longer life
  - Less maintenance
- Overall network condition is raised
Environmental Impacts

- Long life and low maintenance reduces environmental impacts
- Improved fuel efficiency
- Low albedo, reducing the heat island effect
- Concrete is 100% recyclable
- Absorbs CO₂
- PCA: Roadmap to Carbon Neutrality by 2050

Resiliency

- Flooding saturates and weakens a pavement’s underlying foundation
- Concrete overlays reduce the stress at the top of the asphalt layer
- Sensitivity to softening is reduced

Effectiveness

- Performance
  - Depends on thickness
  - Condition of existing layer
  - Detailing
  - Life can be up to 35 years

Effectiveness

- A long history
  - As early as 1901
  - A number of overlays built in the 1970s remain in service today
Effectiveness

- **Versatility**
  - Can be applied to all surface types
  - Many degrees of distress can be accommodated
  - Used for a range of applications:
    - Roadways
    - Streets and Intersections
    - Parking lots
    - Airfields

Effectiveness

- **Rapid Construction**
  - Depends on preparation effort
  - Placement is fast with thinner sections

Effectiveness

- **Traffic Impact**
  - Maintenance of traffic is simpler than reconstruction
  - Construction under traffic is possible
  - Early opening is possible (Maturity)

Effectiveness

- **New technologies improve everything**
  - New design methodologies
  - Performance Engineered Mixtures (PEM)
    - Reduced CO₂ footprint
  - Stringless machine control
  - Larger paving machines
  - Vibrator monitoring
  - Real time smoothness
  - Fiber reinforcement
Effectiveness

- Safety
  - Reduced frequency of closures

Effectiveness

- Efficiency
  - Similar practices to conventional concrete paving
  - Simple plan sets are possible
  - Guide specifications available
  - Guidance documents available

Challenges

- Exclusion from Agency Project Management System
  - Most PMS reflect local institutional experience and practices
  - Innovation is hard
  - Alternative solutions are not considered

  - Change needs to come from above

Challenges

- Technical Experience
  - Lack of technical competency of SHA staff can be a concern.
    - Building technical competency is not difficult.
    - Help is available from CP Tech Center and recently, the FHWA EDC-6 program

  - Lack of concrete paving contractors with experience may also be a concern.
    - Help is available from ACPA
Challenges

- Agency Focus on Surface Condition Only
  - Pressure to "cover as much as possible"
  - Unsustainable short term fixes
  - Ignores traffic disruptions and safety impacts

  *Diamond grinding can be a cost-effective surface treatment*

- Difficulty Identifying Candidate Projects
  - Suitable overlay type for the existing system
  - Elevation issues
    - Bridges
    - Connections
    - Services
  - A range of solutions are available

- Traffic Management/Detour Options
  - An overlay can be built faster than a reconstruct
  - Construction under traffic is possible

  *Experience has proven that communication and planning are the key…*

- Perceived Federal Funding Limitations
  - Concrete overlays can be considered preventative maintenance, qualifying them for use of federal aid funds.
Getting Started

- Start with a simple project
- Get help
- Evaluate performance
- Build competency and confidence
- Integrate the process into a mix of fixes

The Process

- Identify the type of pavement to be overlaid
- Assess the condition of the existing pavement
- Design
- Build
- Repeat

CP Tech Technical Guides on Overlays

And if that isn't enough info on overlays . . . . .
Concrete Overlay Case Studies for EDC6-TOPS

(Targeted Overlay Pavement Solutions)
Performance History of Concrete Overlays

Concrete Overlay Performance Studies

- Concrete overlays have become increasingly common and more agencies have adopted asset management and performance monitoring practices
- These practices have allowed for publication of a number of concrete overlay performance studies in recent years

Review of Concrete Overlay Types

- The two main criteria for classifying concrete overlays are the existing pavement surface type and bonding condition:
  - Concrete on Asphalt: Concrete on asphalt (CMA) overlays can be designed to address a broad range of existing pavement conditions. A high-quality concrete overlay can be designed to improve the friction characteristics of existing asphalt pavements. However, CMA overlays can also be designed with lower friction characteristics.
  - Concrete on Concrete: Concrete on concrete (COC) overlays can be designed for applications on both existing paved surfaces. COC overlays can be used to improve the ride quality of existing concrete pavements. The performance of COC overlay designs is similar to that of CMA overlays. The performance of COC overlays is typically lower than that of COC overlays.

Concrete Overlays on Existing Asphalt-Surfaced Roads

- Unbonded concrete overlay
- Bonded concrete overlay
- Existing asphalt
- Existing concrete pavement

Boone County, Iowa
- Constructed 1977
- Pictured 2016

Tuscola, Illinois
- Constructed 1999
- Pictured 2012
Concrete Overlays on Existing Concrete Pavements

Measuring Concrete Overlay Performance

- Common methods for measuring pavement condition:
  - Automated pavement condition data collected by vans
  - Common metrics:
    - IRI (Int’l Roughness Index)
    - Cracked Slabs
    - Faulting
    - Friction
    - Joint Spalling
    - Patching

Measuring Concrete Overlay Performance

- Common methods for measuring pavement condition:
  - Index calculation to characterize overall condition or remaining service life

National Project Review (2014)

- Case studies on PCC overlay projects in OK, MT, IL, CO, UT, IA, IN, MI, NC,
- Covers a variety of design types and contexts (traffic levels, rural, urban, interstate, etc.)
- Good, detailed reviews of individual projects, limited data
National Project Review (2021–2022)

• An updated national project review from the CP Tech Center will be published soon
• FHWA's EDC-6 TOPS website also contains a number of great case studies for concrete overlay projects

Illinois

• 2014: Review of COA–B projects
  • Illinois was one of the earliest adopters
  • Survey-driven study with limited data, but good sample size
• 2018: Review of concrete overlays on interstate highways
  • Full project condition ratings with 20+ years of data on older projects

COA–B Projects in Illinois (2014)

Illinois

• COA–B
  • Many projects on track for 15 to 20 year service life
  • Use of fiber-reinforced concrete helped improve performance and mitigate distresses observed on earlier overlays
• Interstate Highways
  • Good long-term performance for thicker COC–U projects, including CRCP overlays
  • 30-year projection to “poor” rating

Figure 2. Unbonded concrete overlays condition rating survey returns to “poor”

Source: Heckel and Wienrank (2018)

Iowa

• Most extensive history of concrete overlay construction in the U.S.
  • Includes all types of concrete overlays – 506 total projects through 2015
  • 96 of these were constructed before 1990
• Most of these overlays are on rural county highways
  • 81/99 of Iowa’s counties have built a concrete overlay!

Mitchell County, IA, Constructed & Pictured 2017
Iowa

- 2017 CP Tech Center study
  - Used condition data collected for local agencies to characterize concrete overlay performance in Iowa
  - Very comprehensive data set, and lots of data for older projects with 30+ years of service life

Key findings and trends:
- Good performance from all types of overlays
  - Thicker overlays performed better for all overlay types
  - E.g. for COA–B, 6 in. > 5 in. > 4 in.
- Transverse joint spacing
  - Good early performance for short slab designs
  - Older designs with conventional joint spacing performed well over longer periods of time

Lessons learned from Iowa performance history:
- Based on performance to date, concrete overlays can be designed to achieve a 35+ year service life
- Concrete overlays are very well-suited to county highways
- Good success to date on other types of highways as well

Minnesota

- For many years, thick COC–U projects have been employed as a long-term rehab solution in MN
  - More recently, wider-scale adoption of thinner COA–B overlays as well
- Pair of recent studies (2019–2020) to establish predictive performance curves for both types of overlays
**Minnesota**

- COA–B study:
  - Tended to be on lower-volume roads
  - Good early performance for many projects through about 9 years, projected for approx. 20-year service life based on IRI
  - Faulting developed on some higher-traffic COA–B projects

  ![Graph](image)

  Source: Burnham et al. 2019

- COC–U study:
  - Service life projection of approx. 35 years obtained from modeling of ride quality data

  ![Graph](image)

  Source: Izevbekhai et al. 2020

**Missouri**

- 2020 study: 41 projects including all types of concrete overlays
  - Good performance from thicker COC–U overlays, especially in terms of ride quality
  - Performance of thinner overlays sensitive to variation in thickness
  - Important for design thickness to be site-specific
  - Improved performance when using geotextile separation layer

  ![Map](image)

  Image: Espinoza-Luque et al. 2022

**Key Takeaways on Concrete Overlay Performance**

- To date, performance studies have been helpful to understanding and improving design and construction practices
- Projects have succeeded in a variety of contexts:
  - High-volume interstate highways to rural highways
  - Shorter-term thin overlays to long-life thick overlays
  - Innovative designs and materials: fibers, short slabs, geotextiles
- With continued growth of concrete overlay construction, available data for characterizing performance continues to grow
- Versatility of concrete overlays helps make them an excellent tool for pavement preservation and fostering an economical and sustainable pavement system