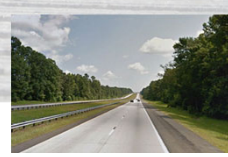
Value Proposition/Proven Technology

The Story About Concrete Overlays



Tuesday, July 12, 2022

IOWA STATE UNIVERSITY
Institute for Transportation

National Concrete Pavement Technology Center

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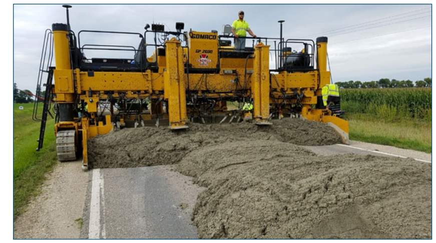
Concrete Overlays: Today's Talking Points

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



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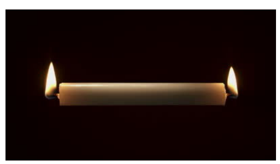
The Challenge to Pavement Owners

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



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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

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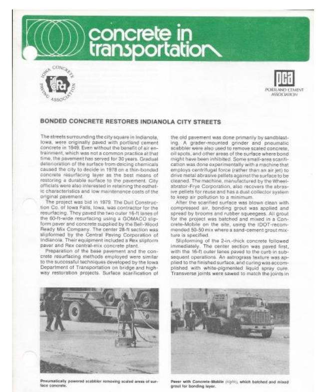

concrete in transportation

BONDED CONCRETE RESTORES INDIANOLA CITY STREETS

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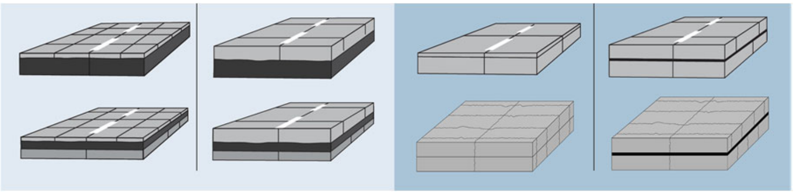
Concrete Overlays

Concrete on Asphalt

Concrete on Concrete



Proven Applications for Concrete Overlays

Intersections

Rural Secondary Roads

Urban Freeway/Interstates

Airport Runways

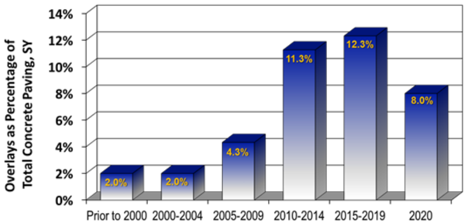
Urban Arterials

Rural Primary/Interstates

Parking Lots

The Value Proposition

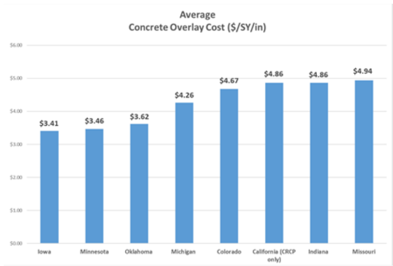
- Costs
- Environmental impacts
- Resiliency
- Effectiveness



ACPA

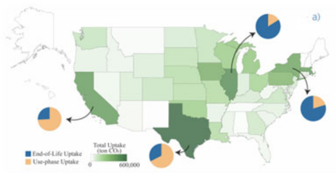
Costs

- 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

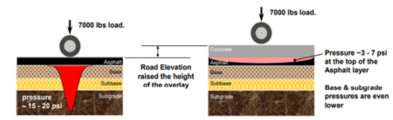
- Long life and low maintenance reduces environmental impacts
- Improved fuel efficiency
- Low albedo, reducing the heat island effect
- Concrete is 100% recyclable
- Absorbs CO_2
- PCA: Roadmap to Carbon Neutrality by 2050



MIT CSHub

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

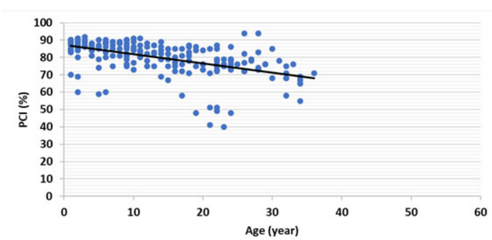


Concrete overlay increases both the height and the structural strength of the roadway

FHWA

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
    - . . . .

SGL[4

Effectiveness

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

Effectiveness

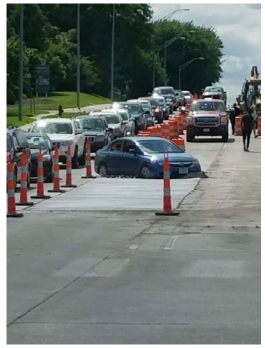
- Traffic Impact
  - Maintenance of traffic is simpler than reconstruction
  - Construction under traffic is possible
  - Early opening is possible (Maturity)

Effectiveness

- New technologies improve everything
  - New design methodologies
  - Performance Engineered Mixtures (PEM)
    - Reduced CO_2 footprint
  - Stringless machine control
  - Larger paving machines
  - Vibrator monitoring
  - Real time smoothness
  - Fiber reinforcement

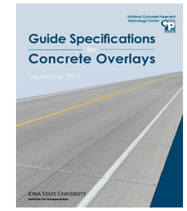
Effectiveness

- Safety
  - Reduced frequency of closures



Effectiveness

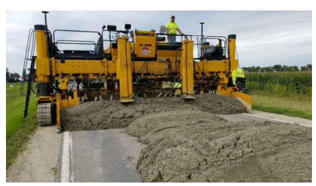
- Efficiency
  - Similar practices to conventional concrete paving
  - Simple plan sets are possible
  - Guide specifications available
  - Guidance documents available



Challenges

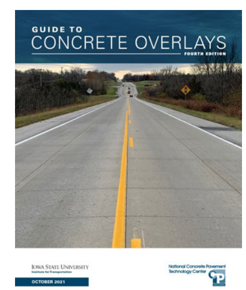
- Exclusion from Agency Project Management System
  - Most PMS reflect local institutional experience and practices
    - Innovation is hard
    - Alternative solutions are not considered

- *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*

Challenges

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

Challenges

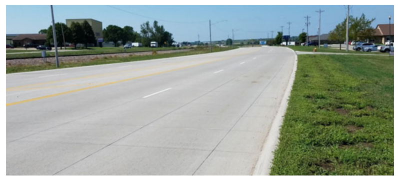
- Traffic Management/Detour Options
  - *An overlay can be built faster than a reconstruct*
  - *Construction under traffic is possible*
- *Experience has proven that communication and planning are the key…*

Challenges

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

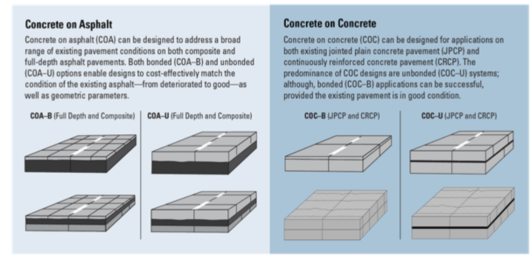
Getting Started

- 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

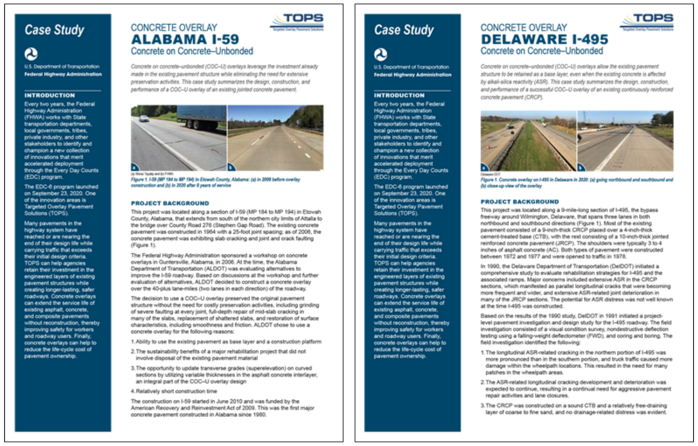


CP Tech Technical Guides on Overlays

And if that isn't enough info on overlays . . . . .

Concrete Overlay Case Studies for EDC6-TOPS

(Targeted Overlay Pavement Solutions)



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Performance History of Concrete Overlays

Concrete Overlay Performance Studies

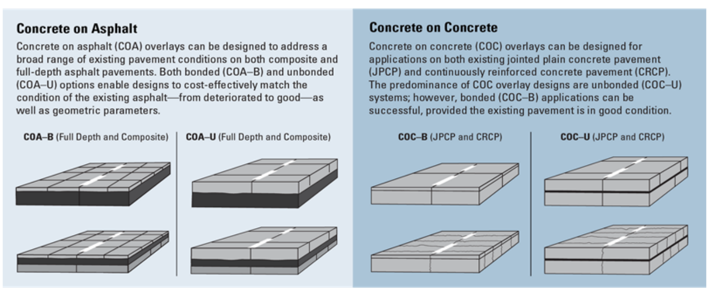
- Concrete overlays have become increasingly common and more agencies have adopted asset management and performance monitoring practices
- These practices have allowed for publication of a number of concrete overlay performance studies in recent years

Boone County, Iowa
Constructed 1977
Pictured 2016

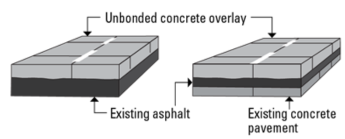
Tuscola, Illinois
Constructed 1999
Pictured 2012

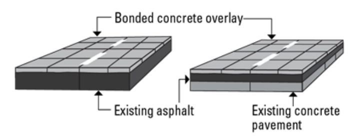
Review of Concrete Overlay Types

- The two main criteria for classifying concrete overlays are the existing pavement surface type and bonding condition:



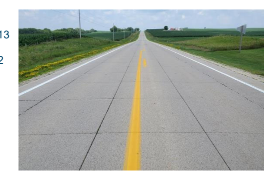
Concrete Overlays on Existing Asphalt-Surfaced Roads





I-35
OK
2004

SH 13
IA
2002



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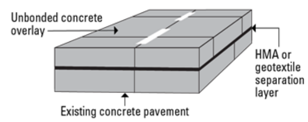
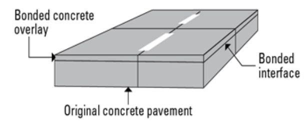
Concrete Overlays on Existing Concrete Pavements






2007 before overlay in 2008


Route D, MO in 2020


Milling 2" of concrete


3 ½" on I-70, KS in 2013

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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

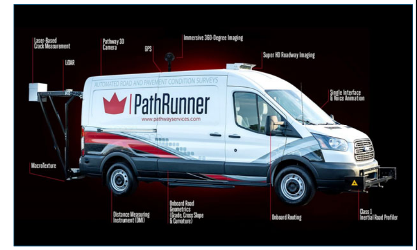


Image: Pathway Services

Measuring Concrete Overlay Performance

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

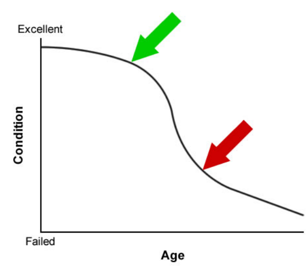
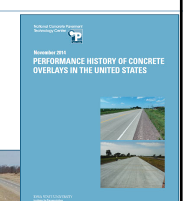


Image: Pavement Interactive

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

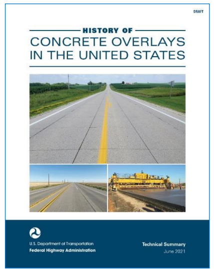


Pittsburg County, Oklahoma
Constructed 2001

Image: OK/AR-ACPA

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

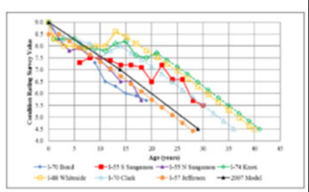
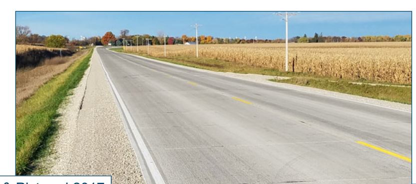


Figure 2. Unbonded concrete overlays condition rating survey values vs. age.

Source: Heckel and Wienrank (2018)

Iowa

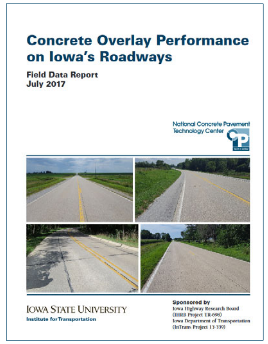
- Most extensive history of concrete overlay construction in the U.S.
  - Includes all types of concrete overlays – 506 total projects through 2015
  - 96 of these were constructed before 1990
  - Most of these overlays are on rural county highways
    - 81/99 of Iowa's counties have built a concrete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



Mitchell County, IA, Constructed & Pictured 2017

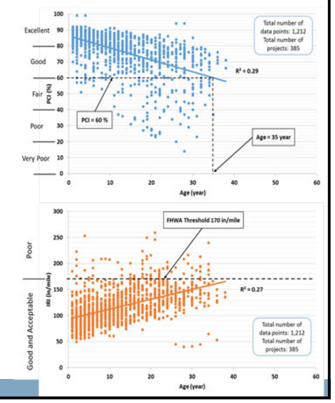
Iowa

- 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



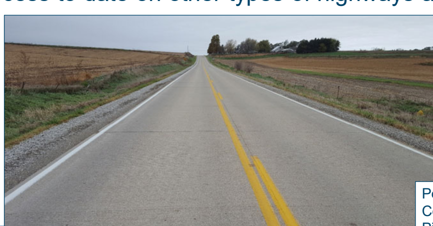
Iowa

- 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



Iowa

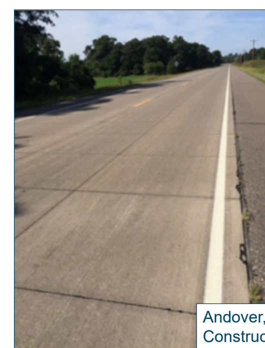
- Lessons learned from Iowa performance history:
  - Based on performance to date, concrete overlays can be designed to achieve a 35+ year service life
  - Concrete overlays are very well-suited to county highways
  - Good success to date on other types of highways as well



Pottawattamie County, IA
Constructed 1993
Pictured 2016

Minnesota

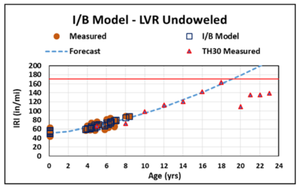
- For many years, thick COC–U projects have been employed as a long-term rehab solution in MN
- More recently, wider-scale adoption of thinner COA–B overlays as well
- Pair of recent studies (2019–2020) to establish predictive performance curves for both types of overlays



Andover, MN
Constructed 2011
Pictured 2016

Minnesota

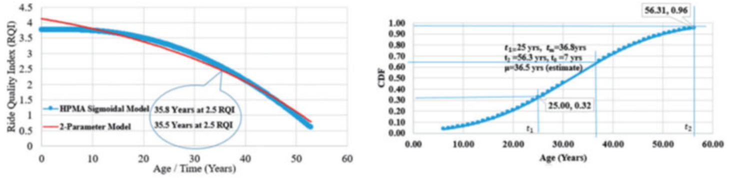
- COA–B study:
  - Tended to be on lower-volume roads
  - Good early performance for many projects through about 9 years, projected for approx. 20-year service life based on IRI
  - Faulting developed on some higher-traffic COA–B projects



Source: Burnham et al. 2019

Minnesota

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



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

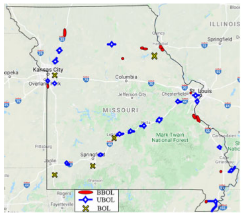


Image: Espinoza-Luque et al. 2022

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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