

## Value Proposition/Proven Technology

### The Story About Concrete Overlays




Tuesday, July 12, 2022

**IOWA STATE UNIVERSITY**  
Institute for Transportation

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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



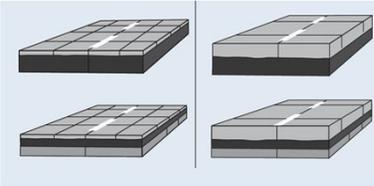
## Another Tool in the Toolbox

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

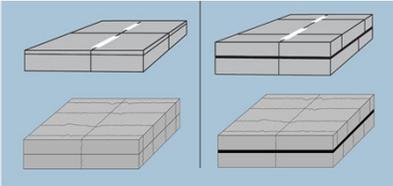


## Concrete Overlays

### 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

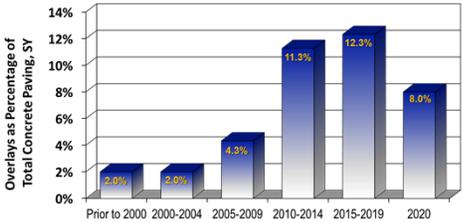


Parking Lots



## The Value Proposition

- Costs
- Environmental impacts
- Resiliency
- Effectiveness

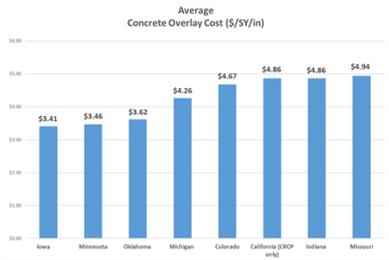


Period	Percentage
Prior to 2000	2.0%
2000-2004	2.5%
2005-2009	4.3%
2010-2014	11.3%
2015-2019	12.3%
2020	8.0%

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

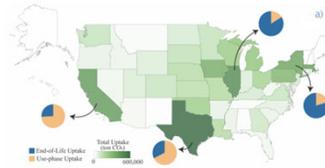


State	Average Cost (\$/SF/in)
Iowa	\$3.41
Minnesota	\$3.46
Oklahoma	\$3.62
Michigan	\$4.26
Colorado	\$4.67
California (CRCP only)	\$4.86
Indiana	\$4.86
Missouri	\$4.94

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## 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<sub>2</sub>
- PCA: Roadmap to Carbon Neutrality by 2050

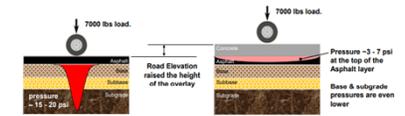


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MIT CSHub

## 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



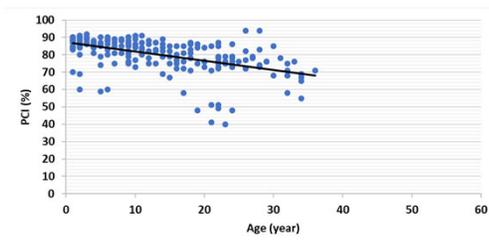
Concrete overlay increases both the height and the structural strength of the roadway

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FHWA

## Effectiveness

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



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## Effectiveness

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



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## 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
  - .....



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## Effectiveness

### ▪ Rapid Construction

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



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## Effectiveness

### ▪ Traffic Impact

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



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## Effectiveness

### ▪ New technologies improve everything

- New design methodologies
- Performance Engineered Mixtures (PEM)
  - Reduced CO<sub>2</sub> footprint
- Stringless machine control
- Larger paving machines
- Vibrator monitoring
- Real time smoothness
- Fiber reinforcement



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## Effectiveness

### ▪ Safety

- Reduced frequency of closures



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## Effectiveness

### ▪ Efficiency

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



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## 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*

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## 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*



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## 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*



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## Challenges

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



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## 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...*



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## Challenges

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



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## Getting Started

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



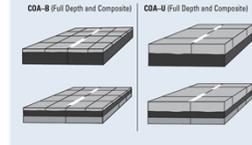
## The Process

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



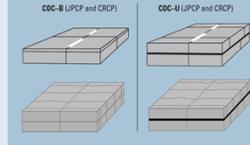
### Concrete on Asphalt

Concrete on asphalt (COA) can be designed to address a broad range of existing pavement conditions on both composite and full-depth asphalt pavements. Both bonded (COA-B) and unbonded (COA-U) options enable designs to cost-effectively match the condition of the existing asphalt—from deteriorated to good—as well as geometric parameters.



### Concrete on Concrete

Concrete on concrete (COC) can be designed for applications on both existing jointed plain concrete pavement (JPCP) and continuously reinforced concrete pavement (CRCP). The predominance of COC designs are unbonded (COC-U) systems; although, bonded (COC-B) applications can be successful, provided the existing pavement is in good condition.



## 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)

### Case Study

#### CONCRETE OVERLAY ALABAMA I-59 Concrete on Concrete-Indbonded

U.S. Department of Transportation, Federal Highway Administration

**INTRODUCTION**  
Federal and state DOT Federal Highway Administration (FHWA) and state DOT transportation departments, local governments, state agencies, and other stakeholders to identify and describe a wide range of innovative practices that meet transportation needs through the Every Day Counts (EDC) program.

The EDC-6 program launched on September 23, 2020. One of the innovative areas is Targeted Overlay Pavement Solutions (TOPS).

Many jurisdictions in the highway system have realized the need for targeted overlay pavement solutions. Concrete overlay can extend the service life of existing roadways, reduce maintenance and construction costs, improve safety, and reduce the life-cycle cost of pavement construction.

The decision to use a COC-U overlay preserved the original pavement structure without the need for depth preservation activities, resulting in many of the same performance characteristics and longer ALDOT service life as a concrete overlay for the following reasons:

1. Ability to use the existing pavement as base material and a construction surface
2. The sustainability benefits of a major rehabilitation project that did not involve disposal of the existing pavement material
3. The opportunity to update transverse grades (underdrain) on curved sections by adding parallel shoulders to the asphalt concrete structure, an integral part of the COC-U overlay design
4. Rapidly built construction time

The construction on I-59 started in June 2010 and was funded by the Annual Highway and Infrastructure Act of 2009. This was the first major concrete pavement construction in Alabama since 1980.

### Case Study

#### CONCRETE OVERLAY DELAWARE I-495 Concrete on Concrete-Indbonded

U.S. Department of Transportation, Federal Highway Administration

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1. The longitudinal ASR-related cracking in the northern portion of I-495 was more pronounced than in the southern portion, and both traffic caused more damage within the wheelpath tracks. This resulted in the need for many potholes in the wheelpath tracks.
2. The ASR-related longitudinal cracking development and deterioration was expected to continue, resulting in a continual need for aggressive pavement repair activities and lane closures.
3. The COC-U was implemented on a round CTB and a relatively free-draining layer of coarse to fine sand, and no drainage-related distress was evident.

## The National Concrete Overlay Explorer

[Instructions](#)

1147 Items

659 results out of 1147 cannot be plotted.

**apps.acpa.org**

MAP VIEW • TABLE VIEW • DETAILS VIEW

Map Satellite

**Search**

Concrete Overlay Type

- 85 Bonded on Asphalt
- 23 Bonded on Composite
- 147 Bonded on Concrete
- 385 Unbonded on Asphalt

Application

- 700 Highway
- 164 Airport
- 148 Street/Road
- 97 NA

State

- 1 AB
- 3 AL
- 12 AR
- 6 AZ

Overlay Thickness (in.)

- 1 0 - 1
- 3 1 - 2
- 4 6 2 - 3
- 7 8 3 - 4

Year Constructed

100%

## National Concrete Pavement Technology Center

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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

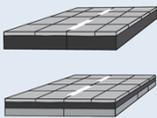
### Review of Concrete Overlay Types

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

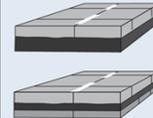
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##### COA-B (Full Depth and Composite)



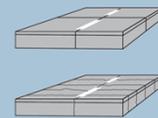
##### COA-U (Full Depth and Composite)



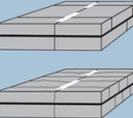
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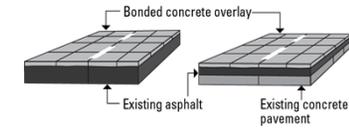
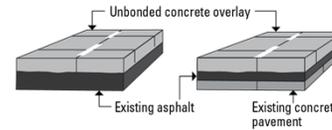
##### COC-B (JPCP and CRCP)



##### COC-U (JPCP and CRCP)



### Concrete Overlays on Existing Asphalt-Surfaced Roads

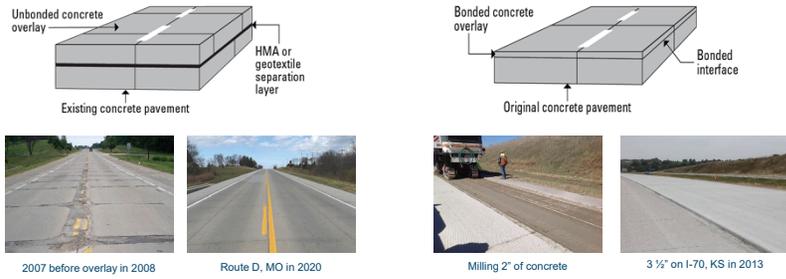


I-35  
OK  
2004



SH 13  
IA  
2002

### 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



Image: Pathway Services

### Measuring Concrete Overlay Performance

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

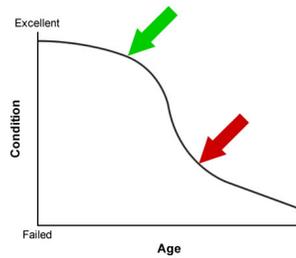
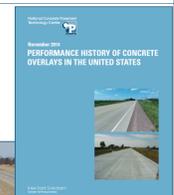


Image: Pavement Interactive

### 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

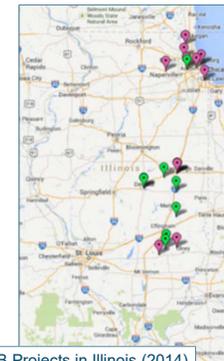
## National Project Review (2021–2022)

- 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

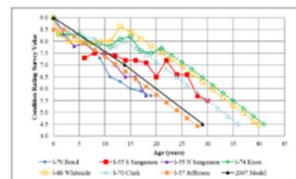


Figure 2. Unbonded concrete overlays condition rating survey values vs. age.

Source: Heckel and Wienrank (2018)

## Iowa

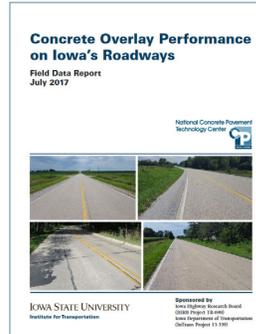
- Most extensive history of concrete overlay construction in the U.S.
  - Includes all types of concrete overlays – 506 total projects through 2015
  - 96 of these were constructed before 1990
  - Most of these overlays are on rural county highways
    - 81/99 of Iowa’s counties have built a concrete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



Mitchell County, IA, Constructed & Pictured 2017

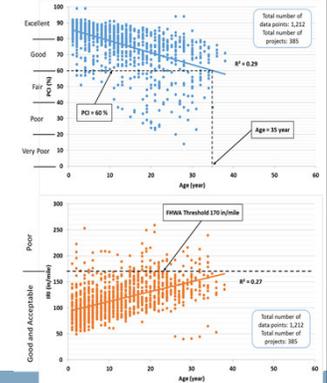
## Iowa

- 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

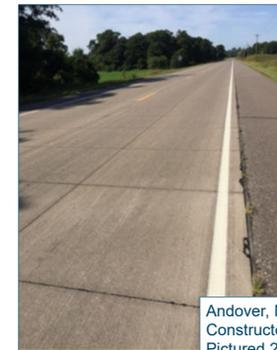
- Lessons learned from Iowa performance history:
  - Based on performance to date, concrete overlays can be designed to achieve a 35+ year service life
  - Concrete overlays are very well-suited to county highways
  - Good success to date on other types of highways as well



Pottawattamie County, IA  
Constructed 1993  
Pictured 2016

## Minnesota

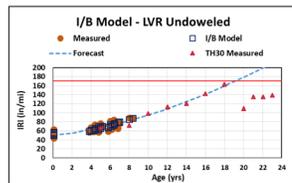
- For many years, thick COC-U projects have been employed as a long-term rehab solution in MN
- More recently, wider-scale adoption of thinner COA-B overlays as well
- Pair of recent studies (2019–2020) to establish predictive performance curves for both types of overlays



Andover, MN  
Constructed 2011  
Pictured 2016

## Minnesota

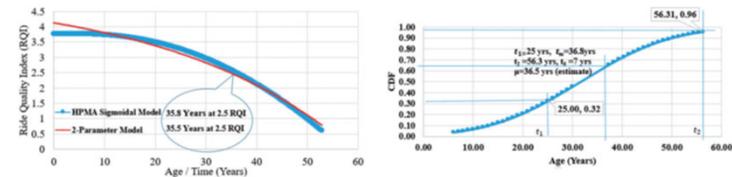
- COA–B study:
  - Tended to be on lower-volume roads
  - Good early performance for many projects through about 9 years, projected for approx. 20-year service life based on IRI
  - Faulting developed on some higher-traffic COA–B projects



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

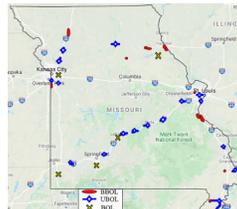


Image: Espinoza-Luque et al. 2022

## 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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[www.cptechcenter.org](http://www.cptechcenter.org)

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Transportation

The banner features a photograph of a long, straight concrete road stretching into the distance under a clear blue sky. The road is flanked by green fields and utility poles. The text and logos are overlaid on the image.