INTRODUCTION TO CONCRETE OVERLAYS


IOWA STATE UNIVERSITY
Institute for Transportation

National Concrete Pavement Technology Center

Who is supporting this webinar?

PCA Since 1916 America's Cement Manufacturers™

ACPA AMERICAN CONCRETE PAVEMENT ASSOCIATION

ICPA IOWA CONCRETE PAVING ASSOCIATION

IOWA DOT

Introductions

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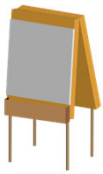
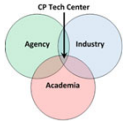
- Dr. Peter Taylor, ptaylor@iastate.edu
- Dan King, dking@concretestate.org

- **Questions are encouraged since we are practicing physical distancing!**



THE CP TECH CENTER

The National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University is a national hub for concrete pavement research and **TECHNOLOGY TRANSFER**.



MISSION:

- Help street and road agencies find answers to their concrete pavement-related questions.
- Identify critical concrete pavement research needs and discover sustainable solutions.
- Help agencies, industry, and businesses incorporate advanced, sustainable solutions and new technologies into their day-to-day practices.

The Concrete Overlay Webinar Series

I. Introduction to Concrete Overlays
II. Overview of Concrete Overlays / Existing Pavement Evaluation and Overlay Selection
III. Concrete Overlay Design
IV. Plans, Maintenance of Traffic and Construction
V. Maintenance of Concrete Overlays and Resources Available to you.

And throughout - examples of how concrete overlays are performing around the country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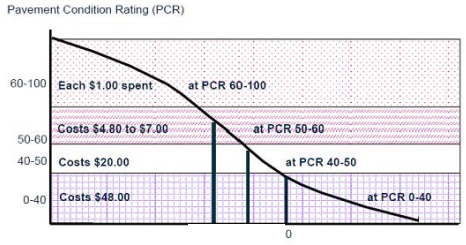
Today's Challenge: Fix now or pay more later



What's This All About and Why Bother?

- Our roads are getting old. 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

Why Bother?

- Our roads are getting old. We can:
  - Patch them – buy a few years
    - Limited materials usage, energy and traffic impact
    - Short term solution
    - Unreliable
    - Smoothness is poor

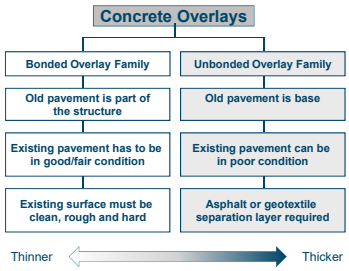
Why Bother?

- Our roads are getting old. We can:
  - Overlay them
    - Use existing equity
    - Minimize sustainability impacts
    - Long term solution
    - Elevations / connections are tricky

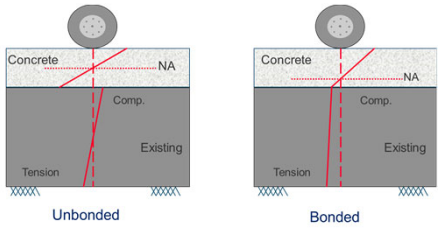
Why Bother?

- Another tool to consider

System of Concrete Overlays on Asphalt or Concrete



Bonded and Unbonded Concrete Overlays



Interface

- Unbonded
  - Must not bond to concrete
  - Some bonding to asphalt is OK
- Bonded – must bond to concrete
  - Existing asphalt must be
    - Thick enough
    - Fair condition

Expected Service Life

- 2 to 6 in. thick – 15 to 25 years
- > 6 in. thick – >20 years

- Assuming:
  - Sound structural design
  - Good construction practices

How, in simple terms?

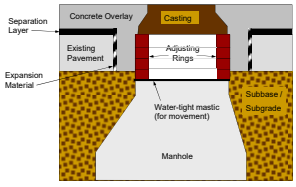
- Evaluate the pavement in place
- Design the overlay
- If needed – grind & repair damage
- Prepare interface
- Pave
- Cure and cut joints

Thickness Design

- ME Design includes option for overlays on asphalt based on BCOA method (Vandenbossche@Pitt)
- PavementDesigner.org
- AASHTO 93
- OptiPave

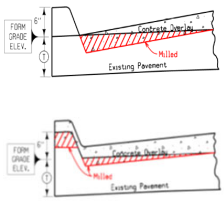
Manholes, Inlets and Other In-Pavement Structures

- Telescoping rings
- Boxout for slip form paving



Treatment of Existing Curb

- Leave the existing curb in place
- Remove the curb
- Remove the curb and gutter
- Overlay the curb



Concrete Overlay Details

Mill and Fill Transitions for Bonded Concrete Overlays

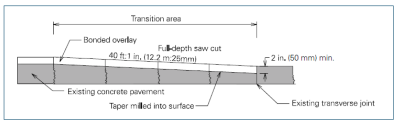


Figure 72. Mill and fill transition for concrete overlay of concrete pavement (adapted from ACPA 1998)

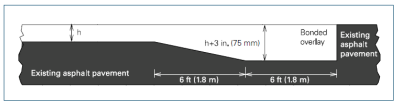


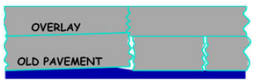
Figure 73. Mill and fill transition for concrete overlay of asphalt or composite pavement (adapted from ACPA 1998)

Pre-overlay Repair & Surface Preparation

- Full-depth repair of deteriorated joints
- Partial-depth repair of severely spalled areas
- Load transfer restoration or full-depth repair of working cracks
- Surface preparation
  - Mechanical preparation
  - Clean the surface

Separation Layer

- Isolate overlay from existing pavement
- Provide level surface for construction
- Provide a cushion



Options for a Separation Layer

- 1” asphalt
  - A stress relief layer
  - Can help prevent keying of the overlay in faulted concrete pavements
  - Stripping of the asphalt binder can occur due to poor drainage and heavy truck traffic.

Options for a Separation Layer

- Geotextile
  - Easy to place at lower cost
  - Improved drainage, but must have outlet
  - Faulting should be minimal to prevent keying of the overlay
  - Movement?

The Mixture

- Conventional requirements:
  - w/cm
  - Air
  - SCM dose
  - Combined aggregate gradation
  - Paste content

Joints

- Panel sizes depend on type and thickness of overlay
- Bonded:
  - Smaller panels
  - Bonded on concrete: match existing
  - Cut full depth
- Unbonded:
  - Thinner overlay = smaller panels
  - Saw depth: T/3

A Default? 6x6x6

Dowel Basket Anchorage

- If dowels are needed then fasteners are required to prevent tipping

Constructing Overlays Under Traffic

- Safety
- Traffic Flow
- Work Zone Space
- Impact to shoulder

Two Lane Paving With Detour

- Faster
- Safer
- Traffic control is simpler

- More effort needed on public relations

Stringless Paving

- GPS and Total station
- Increases clearances
- Improved smoothness

Curing

- Not Optional

Research: A Joint-Free Test Section

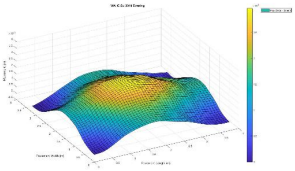
- Unbonded concrete overlay in Worth County, IA
- Typical Section:
  - 6 in with 12 x 12 ft panels
  - Geotextile interlayer
  - 4 lb/cy structural synthetic fibers
- 600 ft test section:
  - 7.5 lb/cy structural synthetic fibers
  - Increased cementitious content from 570 lbs to 640 lbs for workability
  - No transverse sawed joints – pavement allowed to crack on its own

Joint-Free Test Section

- Initial crack pattern:
  - 7 transverse cracks in 600 ft after 11 days (6 after 72 hours)

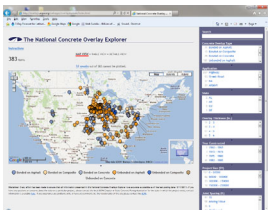
Internal Curing and Warping

- Two overlays built in 2018 in IA
- Both with ¼ mile IC test sections
- Both showing reduced movements with changing weather

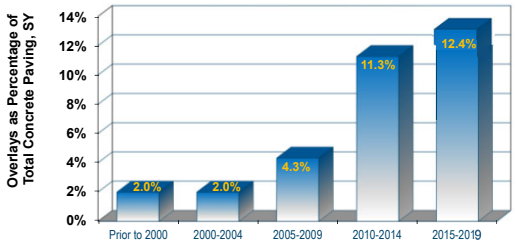


Do they work?

- ACPA.org
  - Resources: Project Explorers: Concrete Overlays

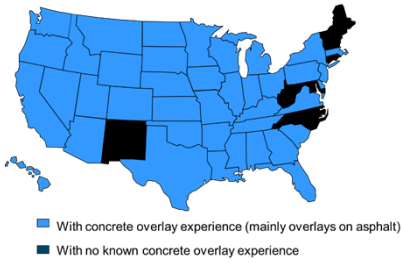


Nationwide Concrete Overlay Usage



Data submitted by ACPA Chapters/State paving associations and other sources, including Bid Express, Oman Systems and DOT websites

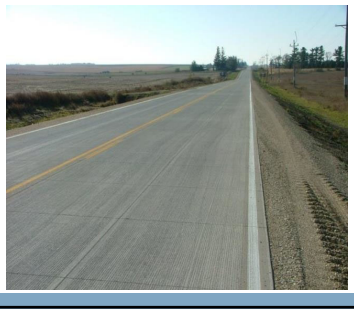
Concrete Overlay Experience Around the Country



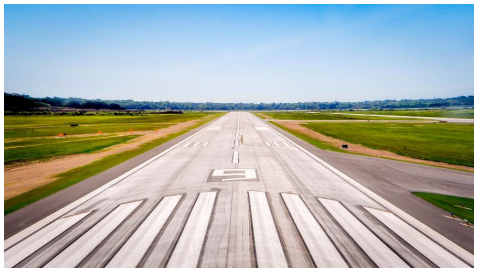
Municipal Street in Lombard, Illinois (2003)

Interstate 70 near Grand Junction, Colorado

A Rural Road In Mitchell County, Iowa

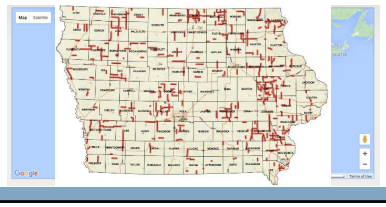


Executive Airport in Charleston, S.C.



Iowa's History of Concrete Overlays

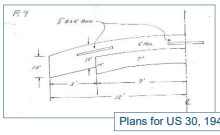
- Over 2,000 centerline miles of concrete overlays have been constructed in Iowa since the late 1970s.
  - Over half constructed since 2006
  - Primarily on the rural county highway system



Iowa's History of Concrete Overlays

- Early experimentation
  - Bonded concrete overlays of concrete
  - Many BCOC projects were constructed over the years, but have fallen out of favor since the 1980s and 1990s

Experimental Concrete Overlay, 1970s



Plans for US 30, 1949

Iowa's History of Concrete Overlays

- "Whitetopping" projects emerge in the 1970s
  - Concrete over asphalt
- By late 1970s and 1980s, they begin to be constructed regularly on county highways

Storm Lake Airport, 1971

Iowa's History of Concrete Overlays

- Prevailing early whitetopping designs: 6 inch PCC over HMA
  - The two layers will tend to bond together, but the bond was not considered in design or construction

Washington County, IA, Constructed 1977

Iowa's History of Concrete Overlays

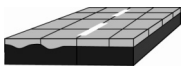
- 1980s: Unbonded concrete overlays of concrete (UBCOC)
  - Again, predominantly on county highways
  - HMA interlayer became the standard
  - 2000s: geotextile interlayer is introduced

Madison County, IA, 1980s

Warren County, IA, 2013

Iowa's History of Concrete Overlays

- 1990s: Experiments begin with "ultra-thin whitetopping"
  - Thin PCC overlay (3-6 inches)
  - Designed to bond to underlying HMA for structural support (bond is critical to the design)
  - Shorter joint spacings help reduce stresses, slab curling



IA 21 Test Section, 1994

Iowa's History of Concrete Overlays

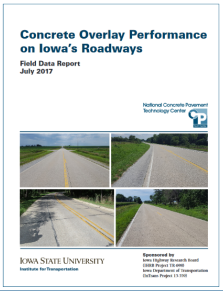
- Construction today:
  - Many Iowa counties continue to build UBCOC projects and 6+ inch PCC overlays of asphalt (BCOA/UBCOA) with conventional joint spacing
  - In some Iowa cities and counties (and with Iowa DOT), thinner BCOA designs have become popular

Buchanan County, IA, Constructed 2013

Le Mars, IA, Constructed 2013

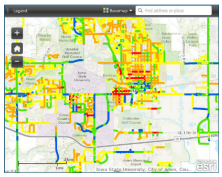
Performance History of Iowa's Concrete Overlays

- Concrete overlays have been used successfully in Iowa for decades
- Despite this history, unanswered questions:
  - What kind of service life can we expect from a new PCC overlay?
  - From our existing overlays?
- 2017 CP Tech Center performance review:



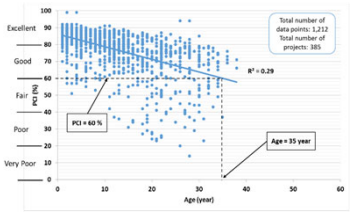
Performance History of Iowa's Concrete Overlays

- Performance data obtained through the Iowa Pavement Management Program (IPMP)
  - Automated pavement condition data collected for local agencies
  - Performance characterized by PCI (Pavement Condition Index)
    - IRI (smoothness)
    - Transverse Cracking
    - Joint Spalling
    - D-Cracking
    - (Faulting considered separately)



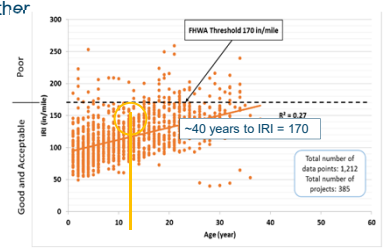
Performance History of Iowa's Concrete Overlays

- Results (PCI):
  - All overlay types together



Performance History of Iowa's Concrete Overlays

- Results (IRI):
  - All overlay types together



Performance History of Iowa's Concrete Overlays

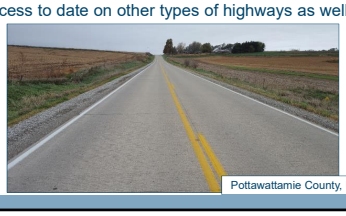
- Key findings and trends:
  - Overall performance of Iowa's overlays has been excellent
  - Good performance from each of BCOA, UBCOA & UBCOC
    - Overlays of asphalt performed slightly better than UBCOC
    - BCOC: less successful overall, but performed well in context of design life expectations

Performance History of Iowa's Concrete Overlays

- Key findings and trends:
  - Thickness
    - In general, thicker overlays have performed better for all overlay types (e.g. for BCOA, 6 in. > 5 in. > 4 in.)
  - Transverse joint spacing
    - Good early performance from BCOA short slab designs
    - Older designs with conventional joint spacing performed well over longer periods of time
  - Traffic – inconclusive
    - Most of these projects are low volume, <1,000 vpd

Performance History of Iowa's Concrete Overlays

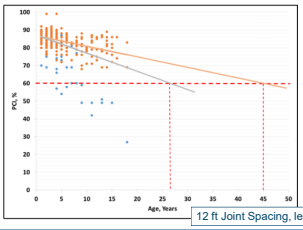
- Lessons learned from Iowa performance history:
  - Based on performance history to date, we can design concrete overlays to last 30+ years
  - Concrete overlays are very well-suited to county highways
  - Good success to date on other types of highways as well



Pottawattamie County, IA, Constructed 1993

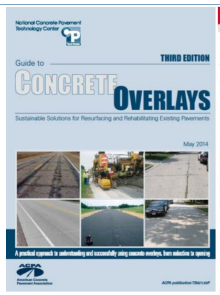
Performance History of Iowa's Concrete Overlays

- With proper materials, construction and design, there is still plenty of room to improve performance!



12 ft Joint Spacing, less than 20 years old

Resources



https://cptechcenter.org/concrete-overlays/

QUESTIONS?