IOWA’S HISTORY OF CONCRETE OVERLAY PERFORMANCE

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ICPA
IOWA CONCRETE PAVING ASSOCIATION
ConcreteState
OUTLINE

- Concrete Overlays in Iowa
- Project Background & Objectives
- Data Collection & Compilation
- Results and Analysis
- Field Reviews
ACKNOWLEDGMENTS

- Full Report: Performance of Concrete Overlays in Iowa
  - Phase I of Iowa Highway Research Board TR-689

- Project Team:
  - CP Tech Center: Jerod Gross, Dale Harrington, Dr. Peter Taylor
  - Iowa State University: Yu-An Chen, Dr. Halil Ceylan, Inya Nnelanya, Dr. Omar Smadi
Concrete overlays: increasing use and acceptance nationwide over past few decades

CP Tech Center Guide:
Iowa: over **2,000** centerline miles of concrete overlays have been constructed since the late ‘70s

- Over half constructed since 2005
- Mostly on county highway system
CONCRETE OVERLAYS IN IOWA

- National perspective
  + ACPA overlay project explorer:
How well have Iowa’s overlays performed? (How long do they last?)

- Approximately 470/506 overlay projects are still in service today
- Includes 68/96 constructed before 1990
- Compare to older sources that indicate expected service life for a concrete overlay is only about 20 years
However, as of 2015, there had been no attempt to characterize performance of overlays to determine expected service life & what made projects successful.
PROJECT OBJECTIVES

- Define performance of Iowa’s concrete overlays
  - Create performance curves
  - Analyze specific design choices and characteristics and link to performance
    - Thickness
    - Joint spacing
    - Traffic
    - Overlay type (thin bonded, unbonded)

- Incorporate lessons learned to improve overlay design and performance
DATA COMPILATION & COLLECTION

- Automated pavement condition data: Iowa Pavement Management Program (IPMP)
  - Opt-in program for local agencies
  - Data collection began in early 2000s (opt-in)
  - Since 2013, all streets & roads are covered every other year
- This data then combined with ICPA overlay project records to produce the complete data set
OVERLAY TYPES

- Bonded Concrete Overlay of Concrete (BCOC)
- Bonded Concrete Overlay of Asphalt (BCOA)
  + Defined as thickness $\leq$ 6 inches
- Unbonded Concrete Overlay of Concrete (UBCOC)
- Unbonded Concrete Overlay of Asphalt (UBCOA)
  + Defined as thickness $>$ 6 inches
DATA DISTRIBUTION

- Typical designs in Iowa
  - Early on: 6 inches on asphalt ("whitetopping") or 6+ inches unbonded on concrete
    - Performance data for projects up to 40 years old

Washington County, IA, Constructed 1977
DATA DISTRIBUTION

- Typical designs in Iowa
  - ‘00s: more types of projects, including thinner overlays
    - Advent of new design procedures, shorter slabs, fiber-reinforcement
    - About 10 years worth of data, with some exceptions

Boone, IA, Constructed 2005
Full data set contains all overlay types/designs:

- BCOA: 18% (Number of projects: 178)
- BCOC: 32% (Number of projects: 13)
- UBCOA: 3% (Number of projects: 69)

Note: Total number of projects is 385
### DATA DISTRIBUTION

- **Distribution based on slab thickness:**

<table>
<thead>
<tr>
<th>PCC slab thickness (in.)</th>
<th>Total number of projects</th>
<th>Percent of data based on number of projects (%)</th>
<th>Project length (mile)</th>
<th>Percent of data based on length of projects (%)</th>
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<tbody>
<tr>
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<tr>
<td><strong>Total</strong></td>
<td><strong>387</strong></td>
<td><strong>100</strong></td>
<td><strong>1,499</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Performance metrics are characterized by PCI (Pavement Condition Index) & IRI.

The IPMP PCI equation incorporates:
- IRI (accounts for 40% of PCI)
- Transverse Cracking
- Joint Spalling
- D-cracking (no faulting)

Le Mars, IA, Constructed 2010
PERFORMANCE METRICS

× Performance charts:

× PCI scale:
  + Excellent: 81-100
  + Good: 61-80
  + Fair: 41-60
  + Poor: 21-40
  + Very Poor: 0-20

Image: Pavement Interactive
RESULTS AND ANALYSIS

Data set as a whole:

- Total number of data points: 1,212
- Total number of projects: 385

PCI = 60%
Age = 35 year

Figures: Chen and Ceylan
RESULTS AND ANALYSIS

Data set as a whole:

- FHWA Threshold 170 in/mile
- $R^2 = 0.27$
- Total number of data points: 1,212
- Total number of projects: 385
- ~40 years to IRI = 170

Figures: Chen and Ceylan
RESULTS AND ANALYSIS

- BCOA only (organized by thickness):

![Graph showing PCC slab thickness vs. Age](image)
RESULTS AND ANALYSIS

× BCOA only (organized by joint spacing):

- Figures: Chen and Ceylan

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![Diagram](image)

- Short slab designs
- PCI = 60%
- Total number of data points: 428
- Total number of projects: 162

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Figures: Chen and Ceylan
RESULTS AND ANALYSIS

× UBCOA only (organized by thickness):

![Graph showing PCC slab thickness (PCI vs. Age)](image)

- PCI = 60%
- Total number of data points: 172
- Total number of projects: 61

Figures: Chen and Ceylan
RESULTS AND ANALYSIS

- UBCOC only (organized by thickness):

![Graph showing PCC slab thickness (PCI vs. Age) with data points for different thicknesses and PCI categories. The graph includes trend lines and notes on data points.]

Total number of data points: 451
Total number of projects: 117

Figures: Chen and Ceylan
RESULTS AND ANALYSIS

Key findings and trends:

+ Overall performance of Iowa’s concrete overlays has been excellent
  - As a whole: about 35 years to PCI = 60
  - About 40 years to IRI = 170 in/mi
+ Good performance from each of BCOA, UBCOA & UBCOC
  - Overlays of asphalt slightly better than UBCOC
  - BCOC: less successful overall, but performed well in context of design life expectations
RESULTS AND ANALYSIS

Key findings and trends:

- **Thickness**
  - In general: thicker overlays have performed better for all overlay types (e.g. for BCOA, 6” > 5” > 4”)

- **Transverse joint spacing**
  - Good early performance from short slab designs (6”) on BCOA/thin overlays
  - Older designs with 15-20 foot slabs performed well long-term
  - 12 foot slabs—inconclusive

- **Traffic—inconclusive**
  - Most of these projects are low-volume, <1,000 vpd
  - Not enough truck traffic data available from local agencies
RESULTS AND ANALYSIS

- 12 foot transverse joint spacing
  - Across multiple splits, apparent decline in performance of overlays with 12 foot joint spacing (even compared to longer spacings)
  - UBCOA (organized by joint spacing):

Figures: Chen and Ceylan
To supplement data analysis, field reviews were performed.

- Verify findings and investigate trends, outliers.
FIELD REVIEWS

× Observed distresses:

+ Materials-related
FIELD REVIEWS

× Observed distresses:

  + Rough ride—construction or curling/warping
  + Occasionally faulting

Buchanan County, IA, Constructed 1996
FIELD REVIEWS

- Observed distresses:
  + Load-related, possibly mis-designed or under-designed
FIELD REVIEWS

Key takeaways:

- Observed performance generally matches data
- Poor performing outliers & early failure causes:
  - Materials-related
  - Load-related/under-design
  - Rough ride
- In short... mostly the same issues that we run into with conventional PCC pavements
  - Be aware of increased potential for curling/warping
  - Beyond above explanations, no direct observations to indicate that there’s a specific problem with 12 ft joint spacing design
CONCLUSIONS

- Overall performance of Iowa’s concrete overlays has been excellent
  + Upwards of 30-40+ year performance life
  + Overlays are very well-suited to county highways
  + Good success to date on interstate, state highways, and city streets as well
NEXT STEPS

- Move from performance history → survivability, performance models
- Continue compiling data, keeping the database updated
Thank you!