National Concrete Pavement Technology Center

Tech Center

Concrete Overlay Performance on Iowa's Roadways

tech transfer summary

Concrete overlays are a successful preservation technique that can provide extended service lives to roadways in need of rehabilitation.

Problem Statement

Concrete overlays are a cost-effective, low-maintenance preservation technique used to extend pavement life. However, there have been few comprehensive studies of long-term performance of concrete overlays.

Project Objective

The objective of this project was to determine the performance of concrete overlays on Iowa's roadways. The long history of concrete overlay construction in Iowa coupled with the availability of performance data presents the opportunity for a comprehensive, long-term performance study of concrete overlays.

Background

Pavement preservation and rehabilitation have been growing in importance nationwide, leading to increased interest in concrete overlays. This study was necessary to evaluate the performance of concrete overlays as well as understand lessons learned and determine reasons for success.

Research Description and Methodology

The National Concrete Pavement Technology (CP Tech) Center partnered with the Iowa Concrete Paving Association (ICPA) and the Iowa Department of Transportation (DOT) on this project.

The Iowa DOT collects pavement condition data including international roughness index (IRI), transverse cracking, longitudinal cracking, D-cracking, spalled joints, and faulting. Data collection on all paved secondary roads began in 2002; since 2013, data collection has occurred on every paved public roadway in Iowa.

Grundy County Highway T-55 with 6-inch overlay in 1978

July 2017

RESEARCH PROJECT TITLE
Concrete Overlay Performance on Iowa's Roadways

SPONSORS
Iowa Highway Research Board
(IHRB Project TR-698)
Iowa Department of Transportation
(InTrans Project 15-559)

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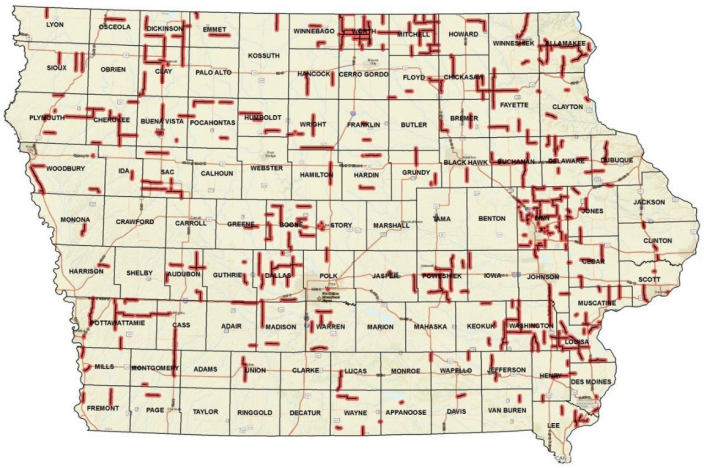
The mission of the National Concrete Pavement Technology Center is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, tech transfer, and technology implementation.

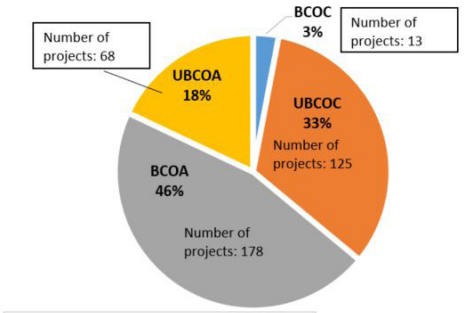
IOWA STATE UNIVERSITY
Institute for Transportation

The Institute for Transportation (InTrans) at Iowa State University manages the pavement condition data as part of the Iowa Pavement Management Program (IPMP). The ICPA has an extensive database of historical information for overlays constructed within Iowa.

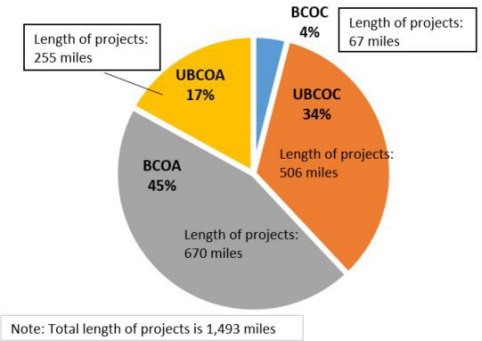


As of 2016, the ICPA historical database had construction information on more than 500 overlay projects, encompassing more than 2,000 centerline miles

Four overlay types were studied: unbonded and bonded concrete overlays on concrete and on asphalt (UBCOC, BCOC, UBCOA, and BCOA, respectively). Concrete overlays on composite pavements were included in the BCOA and UBCOA categories.

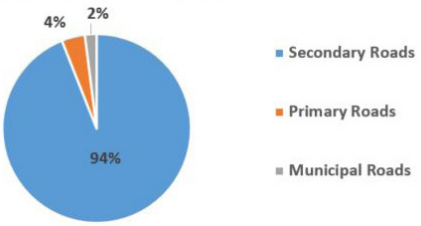


Overlay types based on number of projects

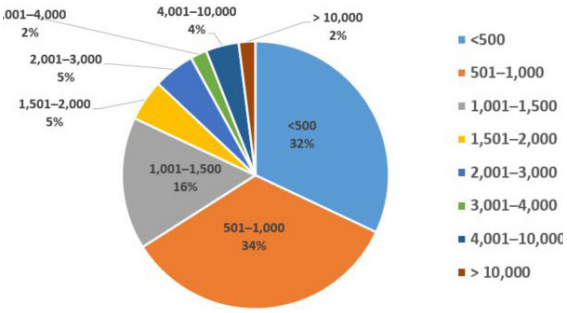


Overlay types based on project length (total centerline miles)

A majority (94%) of Iowa's overlays were constructed on secondary roads. A majority (87%) of these overlays are traveled by 2,000 or fewer vehicles per day.



Concrete overlay road type based on number of projects



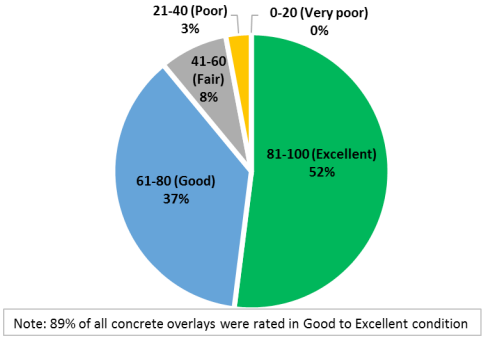
Concrete overlay traffic volume (vehicles per day) based on number of projects

For this study, the researchers analyzed concrete overlay performance using the pavement condition index (PCI) from the IPMP and the IRI. The research included PCI and IRI performance data from 384 concrete overlays on 1,493 miles of roadway and encompassing 14 years of data collection.

Key Findings

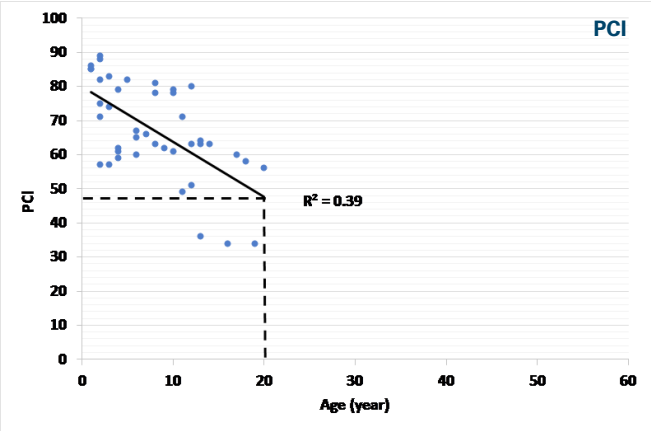
In the early years of development and implementation of concrete overlays, expected service life was approximately 20 years (McGhee 1994). The results of this study developed by a review of the performance data showed that concrete overlays in Iowa exceed this service life. Key findings include the following:

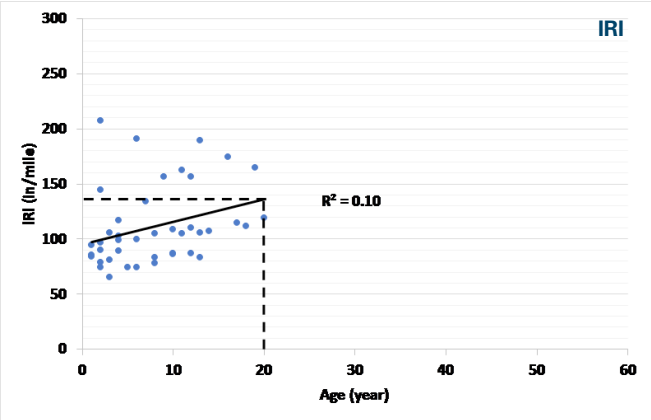
- 89% of all concrete overlays had a PCI of 60+ (good to excellent)



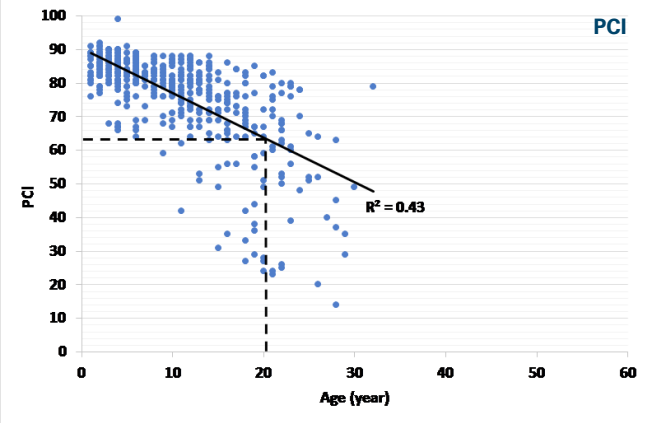
IPMP PCI rating of all concrete overlays

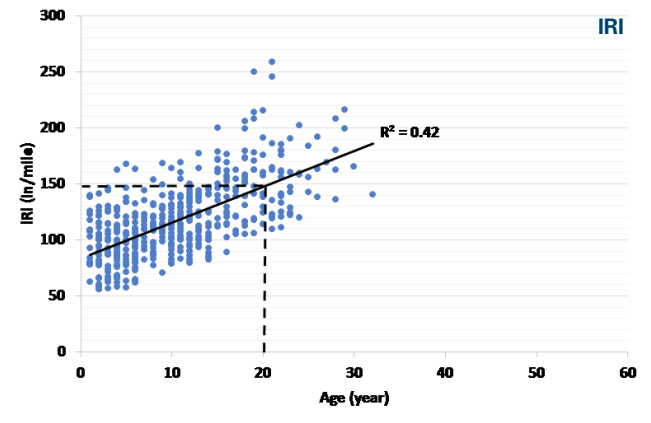
- Overlays on asphalt generally performed better than overlays on concrete



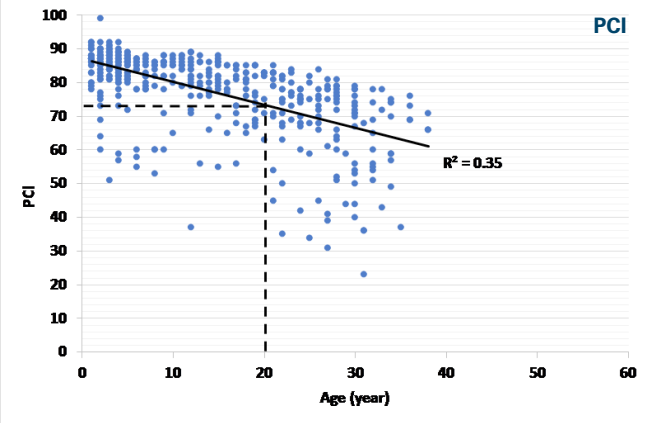


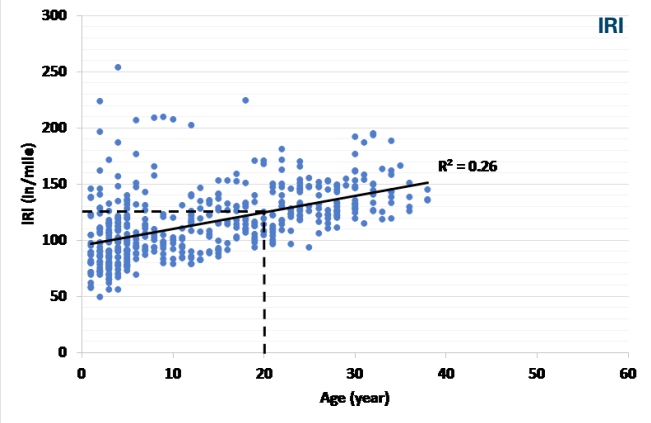
BCOC performance at year 20 with PCI left and IRI right



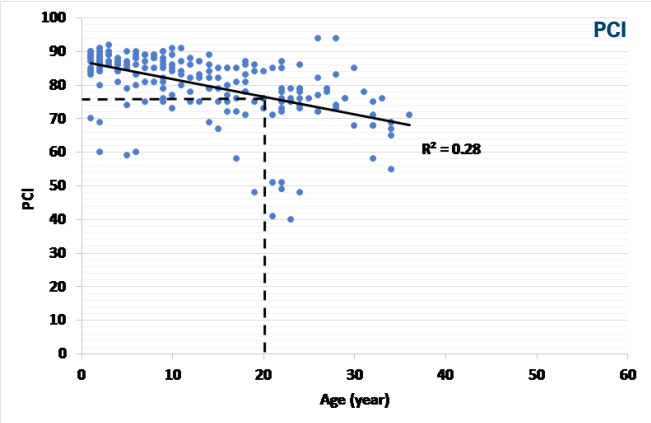


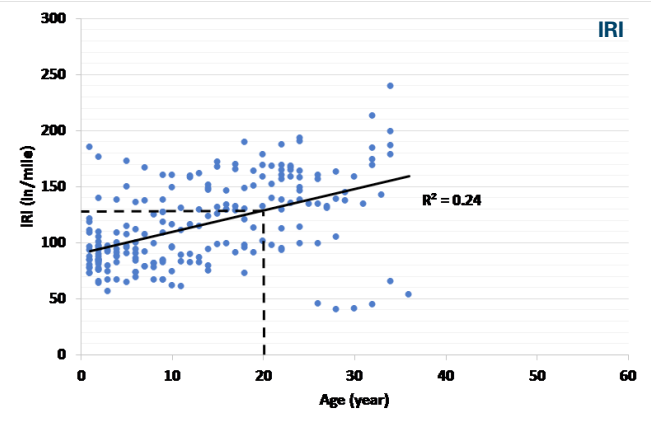
UBCOC performance at year 20 with PCI left and IRI right





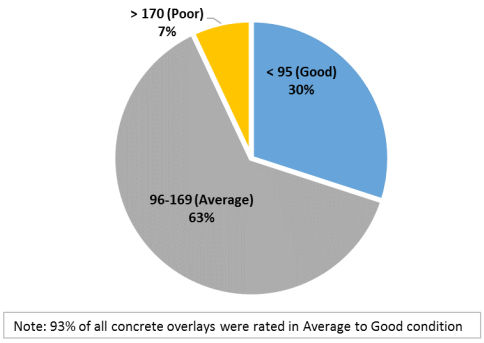
BCOA performance at year 20 with PCI left and IRI right





UBCOA performance at year 20 with PCI left and IRI right

- 93% of all concrete overlays had an IRI of 170 in/mi (the Federal Highway Administration upper threshold limit for acceptable ride quality) and below

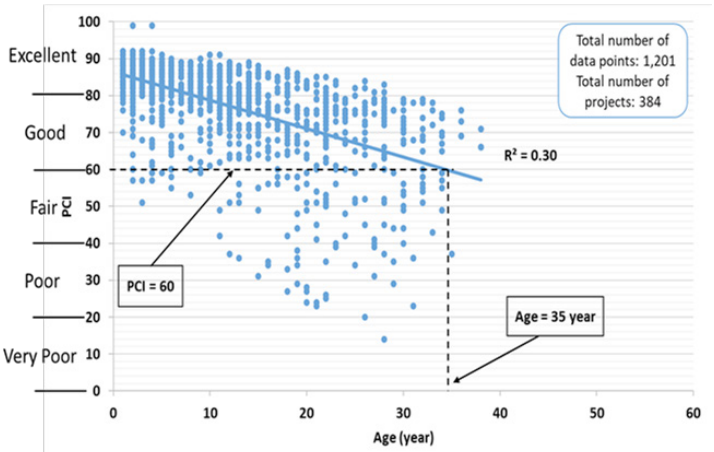


IRI rating of all concrete overlays

- Among overlays on concrete, UBCOCs performed better than BCOCs (90% of UBCOCs were in good to excellent condition while 72% of BCOCs were in good to excellent condition)
- Among overlays on asphalt, UBCOAs performed slightly better than BCOAs (94% of UBCOAs were in good to excellent condition while 88% of BCOAs were in good to excellent condition)
- With respect to PCI values, analysis of the complete concrete overlay data set showed that a majority of projects were on track to achieve good performance (PCI=60) or better during the first 35 years of service life
- With respect to IRI values, analysis of the complete concrete overlay data set showed that most projects were on track to maintain adequate ride quality (IRI=170 in/mi) or better during the first 37 years of service life
- UBCOCs with short joint spacing (i.e., 12- and 15-ft) perform better than those with longer joint spacing (i.e., 20-ft) in terms of IRI
- BCOAs with shorter transverse joint spacing (5.5- and 6-ft) have shown better performance compared to 12-, 15-, and 20-ft joint spacings
- Overlays on asphalt (BCOA and UBCOA) showed PCI trends for 12-ft joint spacing with lower performance than 15- and 20-ft joint spacing
  - Field reviews of a number of Iowa overlays did not find any inherent issue with 12-ft joint spacing that caused those overlays to perform poorer than other joint spacing designs; the reviews discovered the underlying causes of poorer performance to include material-related distresses, deficient thickness, and inadequate system drainage

Implementation Readiness and Benefits

The majority of concrete overlays in Iowa have service life trends exceeding the expectations listed in the National Cooperative Highway Research Program (NCHRP) Synthesis of Highway Practice 204 (McGhee 1994). A majority of projects in the complete overlay data set were on track to achieve a PCI rating of good (PCI=60) or better and a ride quality rating of adequate (IRI=70 in/mi) or better during the first 35 years of service life.



Performance of concrete overlays based on PCI and age for the complete data set (PCI of 60 = lower bound of good)

The results of this study are beneficial to the Iowa DOT and local agencies. The results provide definite evidence on a large scale that concrete overlays are a successful preservation technique that can provide extended service lives to roadways in need of rehabilitation.

Future Research

To provide further benefit to the Iowa DOT and local agencies, concrete overlay jointing for thin (4 to 6 in.) overlays can be studied to determine optimum spacing. This will help to determine the most optimum and efficient joint spacing for varying thicknesses and traffic counts, both with and without macro-synthetic fiber reinforcement.

By optimizing the spacing, concrete overlays will be more cost effective and may lead to increased service life. As part of the Iowa Highway Research Board's IHRB TR-698, Phase 2A and 2B will study optimum joint spacing with emphasis on both analytical investigation and field demonstration.

Reference

McGhee, K. H. 1994. *NCHRP Synthesis of Highway Practice 204: Portland Cement Concrete Resurfacing.* National Cooperative Highway Research Program, Washington, DC.