Texas Department of Transportation
TEXAS TECH UNIVERSITY
Multidisciplinary Research in Transportation
PROJECT SUMMARY REPORT

5-6910-01: Implementation of Concrete Overlay Evaluation and Design

Background

As of the fiscal year 2023, the Texas Department of Transportation (TxDOT) has 3,225 lane miles of plain jointed concrete pavement (JCP or CPCD) in service. As for the rehabilitation options for CPCD, asphalt concrete (AC) overlay has been utilized most extensively. However, reflection cracking in AC overlays on CPCD degrades the ride quality and often requires the removal and replacement of the AC layer within a few years. An effective rehabilitation method for old CPCD that will provide a better long-term performance for a reasonable cost is needed. Findings from the AASHO Road Test and TxDOT research project 0-6274, Project Level Performance Database for Rigid Pavements in Texas, Phase II indicate superior performance of rigid pavement or CRCP when the subbase support condition is adequate. Old deteriorated CPCD could provide excellent support for CRCP. Thus, CRCP bonded overlay on CPCD could be a rehabilitation method for deteriorated CPCD that will provide long-term good performance with a reasonable cost. In 2010, a 7-in bonded CRCP overlay was placed on 10-in CPCD in US 75 in Sherman in the Paris District and results provided convincing evidence that CRCP bonded overlay on deteriorated CPCD could be a good option for the rehabilitation of CPCD that needs strengthening or other form of rehabilitation. Encouraged by the satisfactory performance of this 7-in CRCP bonded overlay on CPCD under heavy truck traffic, the Paris District identified a section of Loop 286 in Paris between US 82 and US 271 as a potential candidate for CRCP bonded overlay on CPCD. The primary objectives of this project were to (1) develop pavement design, materials, and construction specifications, (2) develop pavement design details, (3) develop early-age monitoring plan for CRCP bonded overlay behavior, and (4) conduct early-age performance evaluations.

What the Researchers Did

Researchers evaluated the existing pavement conditions of the candidate section. A visual survey was conducted to identify existing distresses that are prevalent on the CPCD. An FWD testing was conducted to measure the structural capacity of the CPCD by obtaining slab deflections and calculating the load transfer efficiency (LTE). The CRCP overlay design was calculated using the TxBCO-ME program that was developed in Project 0-6910. Using the structural information obtained during the field investigation and estimated the design traffic, the researchers proposed 4-inch and 5-inch CRCP overlays. It was later decided that the 5-inch CRCP overlay will be implemented. Subsequently, the reinforcement details were developed and submitted to the district. Prior to concrete overlay placement, sensors were installed accordingly such as steel strain gages (SSG), 2- and 6-inch vibrating wires strain gages (VWSG), and thermocouples at the transition section and at the regular section. Early- age strain analysis relative to environmental conditions was conducted along with the investigation of the overlay cracking behaviors. Researchers also conducted a post- overlay structural evaluation by performing FWD on the CRCP overlay in order to compare the deflections obtained before and after the overlay. Lastly, the researchers also performed a pull-off testing on the overlay to investigate its bonding condition.

What They Found

The findings from the evaluation of existing CPCD, field instrumentation, post-construction pavement

Research Performed by:
Texas Tech Center for Multidisciplinary Research in Transportation

Research Supervisor:
Dr. Moon Won, TechMRT

Researchers:
Niwesh Koirala
Chuljin Hwang
Heejun Lee
Jeonghee Nam
Christopher Jabonero

Project Completed:
08-31-2023

evaluation and data analysis are summarized as follows:

- The typical pavement condition of Loop 286 is generally good with no identified severe distress.
- The structural evaluation, conducted using Falling Weight Deflectometer (FWD) testing, revealed that the average deflection at the mid-slab of the 9- inch CPCD section was about 5 mils. Post-CRCP BCO construction structural evaluation has shown that there was a reduction of deflection with values between 2 to 4 mils, indicating the strengthening of the structural capacity of the pavement by CRCP overlay.
- Using the structural information obtained and estimating 30-year design traffic, the CRCP overlay design thicknesses that were proposed are 4 inches and 5 inches. Eventually, it was decided that a 5-inch overlay will be implemented. The steel percentage of the 5-inch overlay was recommended to be 1.02%.
- Slab temperature profile has shown that the CRCP overlay provided an insulating effect on the existing CPCD that significantly reduced the range of daily temperature variation at the surface of the CPCD after concrete overlay placement.
- Bond test results have indicated insufficient bond at the interface, which might compromise the long-term performance of this overlay. Anecdotal evidence shows concrete with quite a high slump was responsible for poor bonding.
- Longitudinal cracks were observed where concrete slump was rather large, and most of them were settlement cracks. Also, debonding was observed near longitudinal cracks, supporting the hypothesis that poor bonding was partly due to the use of high slump concrete.
- Transverse crack surveys showed that cracks propagated above the location of the CPCD joint, indicating that reflection cracking is a dominant mechanism in CRCP bonded overlay on CPCD.
- Finally, it appears that some transverse contraction joints in the existing CPCD were locked. It is possible that these locked joints are not limited to this project. It could be that locked joints may be a statewide issue.

What This Means

The CRCP bonded overlay on CPCD could be a rehabilitation method for deteriorated CPCD that will provide long-term good performance with a reasonable cost. The structural evaluation before and after the CRCP overlay construction has shown that there is a significant reduction in measured deflections after the overlay. The huge benefit is at the sections with higher deflections prior to construction of the overlay. This indicates that it can strengthen the structural capacity of the composite pavement structure which is the goal of pavement rehabilitation.

The insulating effect of the CRCP overlay significantly reduces the active joint movement in the CPCD. This means that, while reflection cracking is observed to be dominant in the crack propagation on the CRCP overlay, the movement of the CPCD joints are minimal to cause excessive stress at the transverse crack on the CRCP overlay layer.

Lastly, the proper construction of the overlay with established quality control measures in material quality, surface preparation, surface saturation condition prior to placement and curing application can ensure development of sufficient at the CRCP and CPCD interface.

Further evaluations, including forensic evaluations of longitudinal cracks and debonding, should be conducted in order to document additional findings.

For More Information

Project Manager:
Tom Schwerdt, RTI Tom.Schwerdt@txdot.gov

Research Supervisor:
Moon Won, TechMRT moon.won@ttu.edu

Project Monitoring Committee Members:
Andy Naranjo, Pan Gil Choi, Rachel Cano, Ryan Phillips

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research

Technical reports when published are available at
https://library.ctr.utexas.edu.