Overview of Continuously Reinforced Concrete Pavement in the United States

Continuously reinforced concrete pavement (CRCP) is widely used by highway agencies in the United States, typically for heavily-trafficked roadways. CRCP has the potential to provide long-term, "zero-maintenance" service life under heavy traffic loadings and challenging environmental conditions, provided that proper design and quality construction practices are utilized. CRCP differs from other concrete pavements as follows:

1. CRCP has no active transverse joints, except at its ends.

2. CRCP provides continuous longitudinal reinforcement, which results in tight cracks in the concrete at about 2 to 6 feet (0.6 to 1.8 meters) spacing. Sufficient reinforcement keeps the cracks tight, < 0.02 inches (< 0.5 mm). In the United States, the longitudinal reinforcement, typically No. 6 bars, is placed over transverse bars to ensure proper placement with respect to depth and transverse spacing.

3. CRCP can extend, joint-free, for many miles with breaks provided only at structures (e.g., bridges). Joints, designed as *expansion joints,* are provided at structures or at a terminus of the CRCP.

CRCP design focuses on managing the cracking that develops so as to reduce the structural distresses that may develop as a result of traffic and environmental loadings. These distresses include punchouts, steel rupture, and crack spalling. CRCP design involves determining the proper combination of slab thickness, concrete mixture constituents and properties, and steel reinforcement content and location; providing for sufficient slab-edge support; strengthening or treating the existing soils; and providing nonerodible bases that also provide friction, which leads to desirable transverse cracking patterns. In addition, CRCP design details must ensure that the large movement that can occur at CRCP terminal ends is managed adequately.

Over the years, many improvements in the best practices in the design of CRCP have been implemented to improve long-term performance. These improvements, which have resulted from experience in the field, provide a better understanding of CRCP behavior, improved structural modeling of CRCP, improved materials, and improved construction processes. The Federal Highway Administration (FHWA) has developed extensive resources for the use of CRCP technology.

Continuously Reinforced Concrete Pavement Resources

Continuously Reinforced Concrete Pavement Manual: Guidelines for Design, Construction, Maintenance, and Rehabilitation, FHWA-HIF-16-026, August 2016 https://www.fhwa.dot.gov/pavement/concrete/pubs/hif16026.pdf

This manual provides comprehensive information for materials selection and quality assurance, and for the mechanistic–empirical design, construction, maintenance, and rehabilitation of CRCP. Case studies are summarized to document the overall long-life performance of CRCP in the United States and in other countries.

Optimized Design Details for Continuously Reinforced Concrete Pavements, Tech Brief, FHWA-HIF-19-066, August 2019 https://www.fhwa.dot.gov/pavement/concrete/pubs/hif19066.pdf

This Tech Brief provides information on optimizing several key design features based on the information included in the publications listed here and recent refinements implemented in the field. The following key design features are discussed:

- Optimizing longitudinal steel content.
- Simplified details for terminal ends.
- Improved transverse construction joint detail.
- Shoulder type.

Continuously Reinforced Concrete Pavement: Extending Service Life of Existing Pavements, FHWA-HIF-13-024, April 2013 http://www.fhwa.dot.gov/pavement/concrete/pubs/hif13024.pdf

This document provides information on best practices in rehabilitation strategies for extending the service life of CRCP. The procedures described consist of defining the problem, identifying potential solutions, and selecting the preferred rehabilitation alternatives. The rehabilitation strategies described comprise two categories: restoration and resurfacing. Restoration activities preserve the existing pavement by repairing isolated or localized areas of distress in the CRCP and to prevent their reoccurrence by stopping or delaying the deterioration process. Restoration activities include preventive maintenance and repair methods. Restoration activities can be utilized either before or in conjunction with pavement resurfacing methods. Resurfacing activities, or overlays, significantly increase the structural or functional capacity of an existing pavement. These treatments are applied over the entire surface of the existing pavement. Overlays are used when restoration techniques are no longer effective or cost effective, but before reconstruction is needed.

Jointed Full-Depth Repair of Continuously Reinforced Concrete Pavements, Tech Brief, FHWA-HIF-12-007, November 2011 http://www.fhwa.dot.gov/pavement/concrete/pubs/hif12007/hif12007.pdf

This Tech Brief describes both conventional methods and an alternative method for making full-depth repairs in CRCP. The alternate method, developed and implemented by the South Carolina Department of Transportation, does not utilize continuous longitudinal reinforcement in the repair area. It is suitable for repairing a single lane (or two of three adjacent lanes), and results in repair areas that have performed well after several years.

Precast Concrete Panels for Rapid Full-Depth Repair of CRC Pavement to Maintain Continuity of Longitudinal Reinforcement, Tech Brief, FHWA-HIF-18-050, July 2018
https://www.fhwa.dot.gov/pavement/concrete/pubs/hif18050.pdf

This Tech Brief describes a recently implemented method for rapid overnight full-depth repairs of CRCP using precast concrete panels. This method, developed by the Illinois Tollway, uses continuous longitudinal reinforcement throughout the repair area to make the method applicable for repairing multiple lanes or large areas, as well as for isolated repairs for long-term performance with minimal impact to traffic. The Illinois Tollway has successfully utilized this method for a high-traffic expressway in the Chicago metropolitan area.

NM 136 Continuously Reinforced Concrete Pavement, Tech Brief, FHWA-HIF-19-015, February 2019 https://www.fhwa.dot.gov/pavement/concrete/pubs/hif19015.pdf

The New Mexico Department of Transportation (NMDOT) rehabilitated about 8.7 miles of New Mexico State Road 136 (NM 136) in Dona Ana County, just northwest of El Paso, TX. This four-lane arterial roadway serves as a connection between the Santa Teresa Port of Entry and Interstate 10 (I-10) near the Texas State Line. The roadway rehabilitation involved the use of long-lasting CRCP to significantly upgrade the existing asphalt concrete (AC) pavement. This was NMDOT's first CRCP project. The CRCP is being constructed over the existing AC pavement and was selected because of its ability to accommodate heavy border-truck traffic (up to 96,000-pound (43,500 kg) vehicle loads), lower life-cycle costs, and less maintenance requirement. This Tech Brief provides details related to the planning, design, and construction of the NM 136 CRCP.

Continuously Reinforced Concrete Pavement Performance and Best Practices, Tech Brief, FHWA-HIF-12-039, September 2012 http://www.fhwa.dot.gov/pavement/concrete/pubs/hif12039/hif12039.pdf

CRCP has a long history of good performance in the United States and other countries when designed and constructed well. Many U.S. highway agencies consider CRCP their pavement of choice for implementing long-life pavement strategies that have lower life cycle costs and require fewer lane closures for routine maintenance and repair/rehabilitation. Today's CRCP design details and quality of construction reduce or eliminate punchout occurrence. This Tech Brief provides an overview of CRCP technology and the major developments in the design details and the construction process that have led to what are referred to as the "best practices" for CRCP design and construction.

Continuously Reinforced Concrete Pavement: Improved Transition Designs, Tech Brief, FHWA-HIF-13-026, May 2013 http://www.fhwa.dot.gov/pavement/concrete/pubs/hif13026.pdf

A transition between CRCP and any other type of pavement or structure needs to accommodate a gradual change in either the configuration or the structural capacity of the pavement cross section to maintain rideability, minimize or facilitate slab end movements, and minimize the potential for drainage-related issues to be a factor in performance. In CRCPs, transitions are design measures to accommodate a uniform or gradual change in slab thickness, width, restraint, or movement (either vertically or horizontally) at a specific location with the intent of preventing early deterioration and minimizing the need for maintenance over the design life. A variety of joint configurations and movements can be included in transitions. The jointing details of key transition types are described in this document.

Continuously Reinforced Concrete Pavement: Design Using the AASHTOWare Pavement ME Design Procedure, FHWA-HIF-13-025, April 2013 http://www.fhwa.dot.gov/pavement/concrete/pubs/hif13025.pdf

With the completion of the *Mechanistic–Empirical Pavement Design Guide* (MEPDG) and the recent designation of the MEPDG software as "AASHTOWare® Pavement ME Design," the standard for CRCP design has undergone significant changes from the 1993 *AASHTO Guide for Design of Pavement Structures.* CRCP performance problems observed in the past, such as material durability, base erosion, steel placement and content, and construction methods have been addressed, and the improved pavement design procedure reflects modern construction practices, pavement layer materials, specifications, and best concrete pavement engineering practices. This report provides the basic mechanistic–empirical design background and criteria utilized in the AASHTOWare Pavement ME Design software for CRCP. Also, this report describes the key CRCP design inputs to assist the pavement engineer through the CRCP design process with the AASHTOWare Pavement ME Design software, including identifying the most sensitive design inputs and features.

Continuously Reinforced Concrete Pavement: Design Using the AASHTO Pavement ME Design Program, Tech Brief, FHWA-HIF-13-027, June 2013 http://www.fhwa.dot.gov/pavement/concrete/pubs/hif13027/hif13027.pdf

This Tech Brief provides a summary of the basic mechanistic–empirical design background and criteria utilized in the new AASHTOWare Pavement ME Design software for CRCP. This document describes the primary CRCP design inputs and identifies the most sensitive design inputs and features. In addition, examples are included in the tech brief to demonstrate the use of the new software for the design of both new CRCP and CRCP overlays.

ADDITIONAL INFORMATION

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DISTRIBUTION AND AVAILABILITY

This Tech Brief can be found at https://www.fhwa.dot.gov/pavement/concrete.

KEY WORDS

Concrete pavements, concrete pavement construction, concrete pavement design, concrete pavement rehabilitation, continuously reinforced pavements, CRCP

NOTICE

QUALITY ASSURANCE STATEMENT

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