APRIL 2019 FHWA-HIF-19-012

Tech Brief

PRECAST CONCRETE PAVEMENT TECHNOLOGY RESOURCES

INTRODUCTION

Precast concrete pavement (PCP) technology is gaining wider acceptance in the US for rapid repair and rehabilitation of concrete pavements as well as for reconstruction of heavily trafficked asphalt concrete intersections. While widespread use of PCP technology in the US is of recent origin, with most projects in service less than about 17 years, tens of projects have been constructed and many advances have been made and continue to be made in all aspects of the technology including panel design, fabrication, and installation. In the US, PCP technology is being used for intermittent repairs (both full-depth repairs and full panel replacement) and for continuous applications (longer-length/wider-area rehabilitation) with service life expectations of at least 20 years for repairs and at least 40 years for continuous applications, without significant future corrective treatment. Available PCP systems include jointed PCP with reinforced or pretensioned panels installed singly or in a continuous series; and, posttensioned PCP that typically incorporates thinner panels installed and posttensioned in a continuous series resulting in fewer joints.

The use of PCP technology can significantly reduce traffic impacts of roadway repair and reconstruction projects, particularly on heavily traveled routes. The technology is applicable to both small segments, enabling flexibility in construction phasing, as well as for use in corridor-wide pavement rehabilitation/reconstruction. The review of projects constructed in the US and field testing of selected projects indicate that sufficient advances have been made to reliably design and construct PCP systems to achieve five key attributes of successful pavements, as follows:

- Constructability – Techniques and equipment are available to ensure acceptable production rates for the installation of PCP systems.
- Concrete durability – Plant fabrication of precast panels results in excellent concrete strength and durability.
- Load transfer at joints – Reliable and economical techniques are available to provide effective load transfer at transverse joints in both jointed and posttensioned PCP systems.
- Panel support – Techniques to provide adequate and uniform base support conditions are available and continue to be improved.
- Efficiency – Panels are thinner than standard cast-in-place concrete and last longer because of prestressing and/or reinforcing elements in the PCP systems.

U.S. Department of Transportation
Federal Highway Administration

The use of both jointed and posttensioned PCP systems has advanced during the last decade due to a combination of work sponsored by the Federal Highway Administration (FHWA), projects constructed by highway agencies, and innovations by the construction industry. PCP has been adopted for routine use in California, New Jersey, New York, and Utah. Also, Illinois Tollway uses PCP for intermittent repairs and for ramp rehabilitation. Since the late 1990s, FHWA has been working with highway agencies to implement the use of PCP for pavement repair and rehabilitation. Since 2015, twelve highway agencies have received funding awards under Round 3 and Round 6 of the Strategic Highway Research Program 2 (SHRP2) Implementation Assistance Program (IAP) (http://www.fhwa.dot.gov/goshrp2/ImplementationAssistance). Under IAP, the Lead Adopter awards supplemented the cost of a PCP project constructed by each recipient; and, the User Incentive awards assisted recipients with making PCP technology available for use on an agency-wide basis.

This TechBrief provides a summary of the technical resources available to engineers and planners seeking an understanding of PCP technology. Weblinks are provided for access to recent documents covering a range of PCP topics.

RESOURCES

A brief description of selected technical resources concerning PCP is presented in each of the following sections.

SHRP2 Project R05 Documents

The SHRP2 R05 report on Precast Concrete Pavement Technology was published in 2012. The report includes the following:

- Guidelines for PCP design, fabrication and installation
- Guidelines for project selection
- Guidelines for PCP system acceptance
- Findings based on field testing of 15 PCP projects in the US
- Model specifications for both jointed and posttensioned PCP systems.

Link: Final R05 Report and model specifications: http://www.trb.org/main/blurbs/167788.aspx

Several documents related to the implementation of SHRP2 Project R05 products are available online, as follows:

- Tools for using precast concrete pavement (PCP) systems to reduce the duration of construction closures on critical roadways and to provide long-life performance – provides a summary of findings from the SHRP2 Project R05 study. https://www.fhwa.dot.gov/goshrp2/Solutions/All/R05/Precast_Concrete_Pavement
- PCP Implementation Plan (2014) – presents the details and results of the SHRP2 implementation assistance program's Round 3 funding related to PCP implementation. https://www.fhwa.dot.gov/pavement/concrete/pubs/hif14007.pdf
- FHWA's PCP Marketing plan - This marketing plan, published during early 2014, provides an overall framework for carrying out activities that will support delivery and implementation of promising PCP technology products. https://www.fhwa.dot.gov/pavement/concrete/pubs/hif14005.pdf

FHWA Highways for LIFE Program Reports

The Highways for LIFE (HfL) program, FHWA's initiative to accelerate innovation in the highway community, provided incentive funding prior to 2014 for demonstration construction projects. Through these projects, the HfL program promoted and documented improvements in safety, construction-related congestion, and quality that could be achieved by setting performance goals and adopting innovations. The HfL support of the PCP technology is documented by information that can be accessed using the following weblinks.

- HfL PCP Overview – presents an overview of the HfL program related to PCP implementation. https://www.fhwa.dot.gov/hfl/
- California PCP Project – A jointed PCP system was used to rehabilitate a section of I-15 in Ontario, California during 2010. https://www.fhwa.dot.gov/hfl/projects/ca_pcps_i15_ontario.pdf
- Florida PPCP Project – A posttensioned PCP system was used during January 2012 as an unbonded overlay to rehabilitate a section of US 92 between DeLand and Daytona Beach, Florida. https://www.fhwa.dot.gov/hfl/projects/fl_pcps_us92.pdf
- Utah PCP Project – A jointed PCP system was used to rehabilitate a section of southbound I-215 during mid-2011. https://www.fhwa.dot.gov/hfl/projects/ut_pcps_i215.pdf

- Virginia Posttensioned and Jointed PCP Projects – A posttensioned PCP system was used to replace a section of mainline I-66; and a jointed PCP system was used to replace a ramp exiting I-66; both in Fairfax County, Virginia during 2009. https://www.fhwa.dot.gov/hfl/projects/va_pcps_i66.pdf
- Georgia PCP Project – A jointed PCP system was used to rehabilitate a street corridor in downtown Winder, Georgia during 2013.
- https://www.fhwa.dot.gov/hfl/projects/ga_pcps_sr11_broadstreet.pdf
- Delaware Posttensioned PCP Project – A posttensioned PCP system was used during 2009 to rehabilitate a left-turn lane and the outside lane and shoulder along a section of northbound Route 896. http://www.precastconcretepavement.com/projects/PPCP59%2028-061-11%20-%20PCI%20PCPS%20-%20Project%20Overview.pdf

FHWA Tech Briefs

- Precast Prestressed Concrete Pavement for Reconstruction and Rehabilitation of Existing Pavements, 2009. This Tech Brief discusses the application of precast posttensioned concrete pavement for new construction and for rehabilitation of existing asphalt and concrete pavements. The background of the development of precast posttensioned pavement technology is briefly summarized. The details of several field trials of this innovative technology are presented and recommendations for ensuring successful precast posttensioned concrete pavement installation are provided.
- Precast Concrete Panels for Repair and Rehabilitation of Jointed Concrete Pavements, 2008. This Tech Brief discusses the application of precast concrete pavements for repair for distressed concrete pavements. The background of the development of precast repair technology is briefly summarized. The results of recent field trials of precast concrete pavement repairs are presented and recommendations for ensuring successful precast repair installation are proviced.
- https://www.fhwa.dot.gov/pavement/concrete/pubs/hif16008.pdf. Load Transfer Systems for Jointed Precast Concrete Pavements, 2015. Transverse joint faulting negatively affects the ride quality of jointed concrete pavements. A pavement design feature that has been found to have a significant impact on joint faulting is the use of load transfer devices, typically round dowel bars, at transverse joints. The load transfer features currently used at transverse joints in PCP are described in this Tech Brief.
- https://www.fhwa.dot.gov/pavement/concrete/pubs/hif16009.pdf. Precast Concrete Pavement Bedding Support Systems, 2015. For new construction, as well as for repair applications, pavement support is critical to the long-term performance of PCP systems. The proper seating of the panels on the base is a critical design and construction element. All PCP applications require an “interlayer” of material between the base and the bottom of the precast panels since these two surfaces will not match each other perfectly. To compensate for this, a bedding layer (interlayer) must be used to serve as grade control and as void filler to ensure the panels are fully supported. This Tech Brief describes the technical considerations for bedding support and current bedding support practices for PCP.
- https://www.fhwa.dot.gov/pavement/concrete/pubs/hif19011.pdf. Precast Concrete Pavement Implementation by U.S. Highway Agencies, 2019. This Tech Brief describes the actions taken by 29 highway agencies in the US to implement the use of PCP for repair and rehabilitation of asphalt and concrete pavements. Individual agencies are at various stages of PCP implementation, with some just beginning to develop specifications and to identify projects where PCP can most effectively be used, and others monitoring the performance of one or more in-service PCP projects and planning for additional applications of PCP.

- https://www.fhwa.dot.gov/pavement/pubs/hif19016.pdf. Jointed Precast Concrete Pavement Panel Fabrication and Installation Checklists, 2019. This Tech Brief includes the following PCP panel fabrication and installation related checklists:
    - A. Fabricated Panel Pre-Shipping Checklist.
    - B. Panel Post-Shipping (At-Site) Checklist.
    - C. On-Site Equipment Checklist.
    - D. On-Site Materials Checklist.
    - E. Work Area Preparation Checklist.
    - F. Panel Placement Checklist.
    - G. Dowel Bar and Tie Bar Slot Grouting Checklist.
    - H. Dowel Bar Slot Patching Checklist (if grout not used).
    - I. Clean-up Operation and Opening to Traffic Checklist.

  This guide set of checklists for the construction of PCP is intended for highway agency construction personnel. However, the checklists should be of use for the contractor personnel too. The checklists presented here follow the flow of typical PCP project construction activities. The checklists are not intended to replace the agency's QA and the contractor's QC activities, but rather to supplement and reinforce these activities to ensure a quality product is constructed. Agency and contractor personnel using the checklists should be knowledgeable in PCP construction and PCP technology. Depending on the type of PCP being used for a specific project and the project plans and specifications, not all the items in the checklists may be applicable. The user will need to determine which items are pertinent to their specific project.
- https://www.fhwa.dot.gov/pavement/concrete/pubs/hif19017.pdf. Guide Specification for Jointed Precast Concrete Pavement, 2019. This guide specification presents considerations for the use of JPrCP based on the best practices observed from experiences of numerous highway agencies. This document provides best practices for the use of JPrCP. It does not create any Federal requirements other than those stipulated in statute or regulation.

FHWA/SHRP2 IAP Case Study Reports

In 2013, the SHRP2 IAP was created to help State highway agencies, metropolitan planning organizations, and other interested organizations deploy SHRP2-developed products to deliver more efficient, cost-effective solutions to meet the complex challenges facing transportation agencies. During 2015 and 2016, the Federal Highway Administration—in partnership with the American Association of State Highway and Transportation Officials—selected several highway agencies to receive implementation and technical assistance awards as part of Rounds 3 and 6 of the SHRP2 IAP funding. The agencies receiving implementation assistance funding up to $300,000 constructed precast concrete pavement demonstration projects. Details of the demonstration projects are described in the following case study reports:

- Alabama Case Study - Mobile Ramp Precast Concrete Pavement Demonstration Project. https://www.fhwa.dot.gov/pavement/concrete/pubs/hif18003.pdf. The Alabama Department of Transportation, received an award of $300,000 to help offset the cost of constructing a PCP project. This case study report provides details of the 2017 PCP use for rehabilitation of a distressed asphalt concrete ramp at Exit 2 of I-165, intersecting with Alt US 90 (New Bay Bridge Road), in Mobile, Alabama.
- Connecticut Case Study - New Britain Bus Pads Precast Concrete Pavement Demonstration Project. https://www.fhwa.dot.gov/pavement/concrete/pubs/hif17015.pdf. The Connecticut Department of Transportation received an award of $150,000 to help offset the cost of constructing a PCP project. This case study report provides details of the 2016 PCP use for rehabilitation of two distressed asphalt concrete bus pads along a section of the busway of CTfastrak, a bus rapid transit system, in New Britain, Connecticut.
- Florida Case Study – Florida I-10 Precast Concrete Bridge Approach Slab Demonstration Project https://www.fhwa.dot.gov/pavement/concrete/pubs/hif18057.pdf. The Florida Department of Transportation received an award of $300,000 to help offset the cost of

constructing a PC project. This case study report provides details of the 2018 project that used PC panels for rehabilitation of the east-side bridge approach slab along westbound I-10 near Quincy, Florida.

- Hawaii Case Study - Honolulu Interstate H1 Precast Concrete Pavement Demonstration Project. https://www.fhwa.dot.gov/pavement/concrete/pubs/hif17001.pdf. Hawaii Department of Transportation received an award of $300,000 to help offset the cost of the implementation of PCP technology in the State. This case study report provides details of the 2015 PCP implementation on a concrete pavement rehabilitation project along a section of Interstate H1 in the Honolulu area.
- Kansas Case Study – Leavenworth Precast Concrete Pavement Demonstration Project https://www.fhwa.dot.gov/pavement/concrete/pubs/hif17005.pdf. Kansas Department of Transportation received an award of $300,000 to help offset the cost of the implementation of PCP technology in the State. This case study report provides details of the 2015 PCP use for rehabilitation of two distressed concrete pavement intersections and a bridge approach section along US 73 in Leavenworth, Kansas.
- Louisiana Case Study – Louisiana I-20 Ramp Rehabilitation Using Precast Concrete Pavement https://www.fhwa.dot.gov/pavement/concrete/pubs/hif18053.pdf. The Louisiana Department of Transportation and Development (LADOTD) received an award of $300,000 to help offset the cost of constructing a PCP project. The LADOTD also received a User Incentive Award of $75,000 to help support PCP implementation. This case study report provides details of the 2018 PCP use for rehabilitation of the distressed eastbound concrete pavement ramp onto I-20 at LA 169, in Greenwood, Louisiana.
- Texas Case Study - Texas Precast Concrete Pavement Intersection Demonstration Project. https://www.fhwa.dot.gov/pavement/concrete/pubs/hif17017.pdf. The Texas Department of Transportation received an award of $300,000 to help offset the cost of constructing a PCP project. This case study report provides details of the 2016 PCP use for rehabilitation of a distressed asphalt concrete pavement at the intersection of Route 97 and Route 72 in McMullen/LaSalle County, Texas.
- Washington State DOT Case Study - Interstate 90 Rehabilitation with Precast Concrete Pavement, FHWA-HIF-19-026, March 2019. (Web link to be added.) Washington State Department of Transportation (WSDOT) received a grant in the amount of $1,000,000 from FHWA's Center for Accelerating Innovation for a concrete replacement demonstration project using precast concrete panels on eastbound I-90. This PCP project was under construction during April 2019.
- Wisconsin Case Study - Madison Beltline Precast Concrete Pavement Demonstration Project. https://www.fhwa.dot.gov/pavement/concrete/pubs/hif17003.pdf. Wisconsin Department of Transportation received an award of $300,000 to help offset the cost of the implementation of PCP technology in the State. This case study report provides details of the 2014 PCP use for repair of distressed concrete pavement along sections of the Madison Beltline Highway (US 12).

Precast Concrete Pavement Technology Implementation - Final Report

This report summarizes the current state of PCP technology and also provides details of the technical assistance provided under the FHWA technical support contract DTFH61-13-C-00028, from October 2013 through April 2019. The overall scope of the contract involved timely and cost-effective deployment, delivery, and implementation of products developed under the SHRP2 Project R05 study. The principal recipient and end-user organizations for these products included State and toll highway agencies and others government entities, industry organizations, consultants, contractors, research organizations, and academia.

FHWA Research and Technology Evaluation Report

https://www.fhwa.dot.gov/publications/research/randt/evaluations/18063/18063.pdf.

During 2018, the Volpe National Transportation Systems Center reported the findings of a study conducted to assess the outcomes of FHWA's investment in precast concrete pavement.

As part of the assessment, the study team conducted interviews with routine users of PCP and with IAP Rounds Three and Six awardees. The evaluation team determined the benefits and costs of PCP projects individually and, where possible, extrapolated overall themes related to the technology into findings. Additionally, the evaluation team determined the outcomes and impact of FHWA research, demonstrations, workshops, and related activities and developed recommendations to facilitate the continued adoption of the technology. FHWA's efforts were found to be largely successful and contributory to the development and adoption of PCP. FHWA has overseen initial research and prototypes and has helped to advance the technology to routine use in some States. The study indicated that PCP is an effective and efficient way to conduct roadway maintenance, repairs, and reconstruction. Benefits of using PCP significantly exceed costs in high volume areas or unique roadway sections that would lead to significant detours if closed for long periods of time. PCP also allows for innovative maintenance practices and cost-savings, such as the reuse of concrete panels for temporary repairs.

Industry Resources

PCI

The Precast/Prestressed Concrete Institute (PCI) published several documents to summarize the various technical aspects of using precast posttensioned concrete pavements. The reports were developed through a cooperative agreement between PCI and FHWA. *The State-of-the-Art Report on Precast Concrete Pavements, 2012*, PCI Publication PP-05-12, is the combination of these documents and constitutes a state-of-the-art report on this topic. The report provides guidance on the design and construction of precast posttensioned concrete pavements, including guidance on fabricating precast panels. The report also includes brief descriptions of several completed precast posttensioned concrete pavement projects.

National Precast Concrete Association (NPCA)

- *The Manual for Jointed Precast Concrete Pavement*, released in November 2018, is available from NPCA. The manual is a comprehensive, photo-rich document that presents the best practices related to jointed concrete pavement technology. The manual consists of the following:
  - Chapter 1 – Introduction
  - Chapter 2 – Criteria and Considerations for Using Precast Pavement Systems
  - Chapter 3 – Applications for Jointed Precast Pavement Systems
  - Chapter 4 – Design of Jointed Precast Concrete Pavement Systems
  - Chapter 5 – Developing Plans, Specifications and Cost Estimates
  - Chapter 6 – Shop Drawings and Other Submittals
  - Chapter 7 – Fabrication of Precast Pavement Panels
  - Chapter 8 – Pre-Installation Procedures Common to All Systems
  - Chapter 9 – System-Specific Installation Procedures
  - Chapter 10 – Organizing and Managing a Project for a Quality Installation
  - Chapter 11 – After Panel Installation – The Finishing Touches
  - Chapter 12 – Precast Concrete Pavement Maintenance Requirements
  - Chapter 13 – Future Applications for Jointed Precast Concrete Pavement
  - References

SUMMARY

PCP technology is gaining wider acceptance in the US, and advances have been made to reliably design and construct PCP systems to achieve five key attributes of successful pavements, as follows:

- Constructability – Techniques and equipment are available to ensure acceptable production rates for the installation of PCP systems.
- Concrete durability – Plant fabrication of precast panels results in excellent concrete strength and durability.
- Load transfer at joints – Reliable and economical techniques are available to provide

effective load transfer at transverse joints in both jointed and posttensioned PCP systems.
- Panel support – Techniques to provide adequate and uniform base support conditions are available and continue to be improved.
- Efficiency – Panels are thinner than standard cast-in-place concrete and last longer because of prestressing and/or reinforcing.

This TechBrief provides a summary of the technical resources readily available to engineers and planners seeking to implement the use of PCP. Weblinks are provided for access to the resources.

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