

PRECAST CONCRETE PAVEMENT IMPLEMENTATION BY U.S. HIGHWAY AGENCIES

INTRODUCTION

Precast concrete pavement (PCP) technology is gaining wider acceptance in the U.S. for rapid repair and rehabilitation of concrete pavements as well as for reconstruction of heavily trafficked asphalt concrete intersections. Widespread use in the U.S. is fairly recent, with most projects in service less than about 14 years. Nonetheless, dozens of projects have been constructed, and advances continue to be made in all aspects of the technology, including panel design, fabrication, and installation. 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 prestressed panels installed singly or in a continuous series, as well as prestressed 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 small segments, enabling flexibility in construction phasing, as well as for use in corridor-wide pavement rehabilitation/reconstruction. A review of projects constructed in the U.S. 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 prestressed PCP systems.
- Panel support – Techniques to provide adequate and uniform base support conditions are available and continue to be improved.
- Performance/efficiency – Panels can be thinner than standard cast-in-place concrete and last longer because of prestressing and/or reinforcing elements in the PCP systems.



The use of both jointed and prestressed 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 by several highway agencies, as detailed in this Tech Brief. Currently, FHWA is working with 15 highway agencies to implement the use of PCP for pavement repair and rehabilitation. These 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>). The Lead Adopter awards supplement the cost of a PCP project constructed by each recipient, and the User Incentive awards will help recipients to make PCP technology available for use on an agency-wide basis.

This Tech Brief summarizes PCP technology implementation by U.S. highway agencies.

PCP BACKGROUND

The application of PCP technology can be classified as follows:

- Intermittent repair applications – Under this approach, isolated pavement repairs are made using precast concrete panels. Two types of repairs are possible:
 - Full-depth repairs, to repair deteriorated joints, corner cracking, or cracking adjacent to the joint.
 - Full-panel replacement, to replace cracked or shattered slabs.

The process is similar for full-depth repairs and full-panel replacement, and both repairs are typically a full lane wide.

- Continuous applications – Under this approach, full-scale project-level rehabilitation (resurfacing) or reconstruction is performed using precast concrete panels. For both prestressed precast concrete pavement and jointed precast concrete pavement, generic and proprietary systems are available. In this Tech Brief, reference is made to the following PCP systems:
 - Jointed PCP systems:
 - The Fort Miller Company, Inc. Super-Slab® system.

- Illinois Tollway's generic PCP system.
- Roman Stone Construction Company's Roman Road System®
- California Rapid Roadway System.
- Caltrans generic PCP system.
- Prestressed PCP systems:
 - FHWA generic prestressed PCP system, developed at the University of Texas, Austin.
 - Prestressed PCP systems that include modifications or incorporate proprietary components and features.

Traffic Considerations

The decision to use PCP for any repair or rehabilitation project is greatly influenced by the traffic volume along the project and availability of alternate routes to detour traffic without impacting traffic flow along the project and adjacent roadways. The questions to consider include:

- Is traffic heavy enough to preclude other pavement repair/rehabilitation alternatives? If fast-track fixed-form or slipform paving techniques are possible, use of precast pavement may not be the best option.
- Can traffic be staged or detoured? If yes, then the use of precast pavement may not be the best option.

But, if work zones are limited to only 8 hours or less to perform the repair/rehabilitation work during nighttime lane closures, then the use of precast pavement should be strongly considered

PCP Application Types

To date, the widest application types for PCP have been as follows:

- Heavily-traveled mainline interstate/primary system and urban roadways – a critical need on the aging highway system in the U.S.
- Interstate/primary system and urban ramps – where often no alternative routes are available and the ramps carry heavy traffic.

Other important applications of PCP include:

- Intersections – Especially where rutting and shoving of asphalt is a recurring problem and traffic needs to be maintained.
- Bridge approach slabs – A large number of approach slabs across country need to be rehabilitated with minimum interruption to traffic.

- Underpasses – Where overhead clearance restrictions may limit rehabilitation options.
- Bus pads – Where alternative bus stop locations are not an option, and rutted bus pads can be replaced overnight.
- Airfield applications – A developing market.
- Utility “bridges” – Over failed drainage pipes and culverts.

PCP IMPLEMENTATION

This section describes the actions taken by various States 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.

Alabama

During 2015, the Alabama Department of Transportation (DOT) began the planning process to use PCP to rehabilitate a section of the Exit 2 ramp from southbound I-165. The project is expected to be constructed during 2016. This PCP implementation is being supported by a Lead Adopter Award, under Round 6 of the SHRP2 IAP.

California

The use of PCP is gaining wider acceptance in California. Caltrans constructed the first demonstration project using the generic prestressed PCP system along a section of I-10, near El Monte, during April 2004. During 2005, Caltrans tested the Fort Miller system using an accelerated load testing facility. Since then, several PCP projects using both jointed and prestressed PCP systems have been constructed in various Caltrans districts. These projects include both intermittent repair and continuous applications.

Caltrans has developed standard plans and specifications for intermittent repairs, jointed PCP, and prestressed PCP. The systems in use in California include the Fort Miller jointed system, prestressed PCP with proprietary components, the California Rapid Roadway system, and the Caltrans generic PCP system. Some of the recent PCP projects include several hundred to several thousand precast panels. A notable PCP project, constructed in District 4 in 2009, utilized a series of 36-ft long prestressed panels that were placed on a rapid-set lean concrete base and posttensioned to

replace long sections of I-680. Another notable PCP project, involving the installation of over 2,300 panels, currently is under construction along SH-101 in District 7 through downtown Los Angeles.

For major PCP projects, Caltrans requires just-in-time training before the start of a project to review project-specific plans and specifications and to review the contractor’s approach to precast panel installation.

Colorado

Colorado DOT constructed a PCP project during 2002 along a section of I-25, north of Denver. This was an unbonded overlay application and used the proprietary URETEK Stitch-in-Time repair system. This system is no longer marketed. Colorado DOT has not constructed additional PCP projects.

Connecticut

During 2015, Connecticut DOT started planning for implementation of PCP technology to repair and rehabilitate sections of older concrete pavements on high-traffic interstate highways in urban areas.

Delaware

Delaware DOT used FHWA’s generic prestressed PCP system during 2009 to rehabilitate a section of Route 896 northbound at Route 40 (left-turn lane and outside lane and shoulder). During 2015, Delaware DOT started the planning process to use a PCP system to rehabilitate a section of a high-volume highway (Elkton Road in Bear near the Maryland state line).

District of Columbia

During 2015, the District of Columbia DOT was awarded a User Incentive Award, under Round 6 of the SHRP2 IAP, to support activities leading to implementation of PCP technology.

Florida

The Florida DOT constructed an unbonded overlay using FHWA’s generic prestressed PCP system during 2009 along a section of US 92 westbound. This project was funded by FHWA’s Highways for LIFE program. During 2015, Florida DOT was awarded a Lead Adopter Award, under Round 6 of the SHRP2 IAP, to support construction of a PCP project.

Georgia

Georgia DOT used the Fort Miller system to rehabilitate a 0.72-mile section on

SR11/SR53/SR211/Broad Street in downtown Winder during 2013. The roadway carries a large volume of heavy truck traffic. This project was funded by FHWA's Highways for LIFE program.

Hawaii

During December 2006, a locally developed PCP system (the Kwik Slab system) was installed at a bus stop in Leoku Street, in Waipahu. Ten precast panels were installed after removal of the existing asphalt pavement to create a new concrete bus pad. The Kwik Slab system is not currently being marketed in the U.S. During mid-2015, Hawaii DOT used the California Rapid Roadway system to rehabilitate a section of interstate H-1. This section of H-1 is a concrete pavement that had exhibited settlement and had been overlaid with progressively thicker layers of asphalt. The PCP implementation was supported by a Lead Adopter Award, under Round 3 of the SHRP2 IAP.

Also, during 2015, Hawaii DOT used the California Rapid Roadway system and a prestressed PCP system with proprietary components to rehabilitate a section of Middle Street near Honolulu International Airport. This project was funded by FHWA's Highways for LIFE program.

Illinois

The Illinois Tollway operates and manages several hundred lane-miles of toll highways in the Chicago area. The Tollway first tried the Fort Miller system for repairs along a section of I-294 in December 2007 to perform emergency repairs. The Tollway subsequently developed generic plans and specifications during 2009 for its own system for repair applications. Since then, the Tollway has used the Fort Miller PCP system typically for ramp rehabilitation and its own generic PCP system typically for repair applications.

During 2015, the Tollway developed a precast panel system for rehabilitation of bridge approach slabs using 30-ft-long and 12-ft-wide (nominally) structurally reinforced panels. This system was used for the rehabilitation of the approach slabs to the Midlothian Turnpike Bridge along I-294 in June 2015. The Tollway plans to use the precast panel approach-slab system together with PCP transition panels for rehabilitation of existing bridge approaches as well as for new bridge approaches.

Illinois DOT also has used PCP to rehabilitate concrete pavements. Illinois DOT's first PCP project in the Chicago area was a repair application constructed along a section of Route 62.

Indiana

During 2003-2004, Indiana DOT sponsored a study at Purdue University to assess the feasibility of PCP implementation. During 2015, Indiana DOT initiated the planning for a field testing program to evaluate several PCP systems used for repair and continuous applications. Indiana DOT was awarded a User Incentive Award, under Round 6 of the SHRP2 IAP, to advance this implementation activity.

Iowa

Iowa DOT has adopted the use of PCP technology for bridge approaches. During August-September 2006, Iowa DOT installed FHWA's generic prestressed PCP system at the approaches of a newly constructed bridge along SR-60 near Shelton. Subsequently, Iowa DOT developed a jointed PCP system that was used in 2008 to rehabilitate the approaches at a bridge along US-63 at the interchange with Bremer County Road C-50, near the city of Denver.

Kansas

In the fall of 2015, Kansas DOT used the Fort Miller PCP system to rehabilitate several intersections along a section of US 73 that serve through-traffic as well as traffic entering and leaving Fort Leavenworth. This project includes subgrade remediation work and new base placement. The PCP implementation was supported by a Lead Adopter Award, under Round 3 of the SHRP2 IAP.

Louisiana

During 2015, the Louisiana Department of Transportation and Development (DOTD) began the planning process to use PCP to rehabilitate a ramp from northbound LA 169 to eastbound I-20. The project is expected to be constructed during 2016. The PCP implementation is being supported by a Lead Adopter Award, under Round 6 of the SHRP2 IAP. The DOTD also received a User Incentive Award under Round 6 to advance the statewide implementation of PCP technology.

Michigan

During 2003, Michigan DOT evaluated the feasibility of using PCP as a full-depth repair alternative by installing a PCP system developed by researchers at Michigan State University at several locations along I-675 and M-21. During the fall of 2013, Michigan DOT used the Fort Miller system to rehabilitate several bridge underpasses along I-94.

Minnesota

The Minnesota DOT evaluated the feasibility of precast concrete panels as a rapid renewal pavement alternative during 2006 along a section of TH-62 between I-35W and TH-55 in the southeast metropolitan Minneapolis area. The Fort Miller PCP system was used for this project. Minnesota DOT has not constructed additional PCP projects.

Missouri

The Missouri DOT evaluated the feasibility of using PCP by using FHWA's generic prestressed PCP system to reconstruct a section of northbound I-57 near Sikeston during 2006. Missouri DOT has not constructed additional PCP projects.

Nevada

The Nevada DOT installed the Fort Miller PCP system along a section of US 395 in Washoe County during 2010. Nevada DOT has not constructed additional PCP projects.

New Jersey

During 2007-2008, the New Jersey DOT used the Fort Miller system for concrete repairs along a section of I-295 in Burlington County. This project was originally bid as a cast-in-place full-depth patching project. It was converted to a precast panel replacement project because of concerns with construction traffic management. Since then, New Jersey DOT has used the Fort Miller system for several repair projects and as a pre-overlay treatment to correct severely distressed joints and cracks in existing concrete pavements.

New York

The production use of PCP was started in the State of New York by the New York State Thruway Authority (NYSTA). The first project was installed in 2001 at the Tappan Zee Toll Plaza along I-95 using the newly developed Fort Miller system. Since then, the NYSTA, New York State DOT, and New York City DOT have constructed several projects using both Fort Miller's system and the Roman Road System for repair and rehabilitation of both jointed concrete pavements and asphalt pavements.

The New York State DOT and NYSTA continue to actively use PCP throughout the state and have awarded several projects to be constructed during the 2016 construction season. During 2015-2016, a New York City metro area project will be

maximizing the use of intermittent repair panels by using newly developed dowel bars for the Fort Miller system that make it easy to attach new precast panels to previously placed panels.

Pennsylvania

The Pennsylvania DOT used the Fort Miller system to rehabilitate a section of I-676 in downtown Philadelphia during 2009. During 2015, the DOT began the planning process to use PCP to rehabilitate an urban intersection in Norristown. The project is expected to be constructed during 2016. This implementation is being supported by a Lead Adopter Award, under Round 6 of the SHRP2 IAP. Pennsylvania DOT also received a User Incentive Award under Round 6 to advance the statewide implementation of PCP technology. In addition, Pennsylvania DOT will be installing intermittent full-depth repairs along a section of I-80 in Mooresburg in Montour County.

Texas

The Texas DOT's first project using FHWA's generic prestressed PCP system was constructed along a section of I-35 frontage road near Georgetown in 2001. In 2015, the DOT developed its own jointed PCP system to rehabilitate an intersection at SH 97 and SH 72, which carries a high volume of heavily loaded trucks in Texas's "energy district," 90 miles south of San Antonio. The PCP implementation at this project was supported by a Lead Adopter Award, under Round 3 of the SHRP2 IAP. Also in 2015, the Texas DOT started the planning process for use of FHWA's generic prestressed PCP system to rehabilitate a section of I-35 southbound through Austin.

Utah

During 2009, the Utah DOT commissioned a scan tour of several PCP projects in conjunction with attending a meeting and project showcase jointly sponsored by FHWA's Precast Pavement Task Force and FHWA's Highways for LIFE. The scan tour included 28 Utah DOT representatives, consultants, and contractors who traveled to New Jersey and Delaware during May 19-22, 2009. The PCP projects that were visited included New Jersey DOT's Fort Miller system project on Route I-280 and the Delaware DOT prestressed PCP project on Route 896 at Route 40. Since 2009, Utah DOT has constructed several repair and rehabilitation projects using the Fort Miller system. Also, during June 2011, Utah installed a PCP system developed

by the Utah DOT on a ramp along a section of southbound I-215. Utah no longer uses this system.

Vermont

During 2011, the Vermont Agency of Transportation installed a bridge approach slab using PCP panels at a bridge in Chester.

Virginia

The Virginia DOT is one of the few agencies that had investigated, prior to 2000, the use of precast panels for repair of jointed concrete pavements. During the mid-1970s, PCP was investigated as an emergency treatment for full-depth repair of concrete pavements due to blowups. During 2004, Virginia DOT evaluated the use of PCP for repairing jointed concrete pavement along a section of US 60. During 2009, Virginia DOT used the Fort Miller PCP system to rehabilitate an exit ramp from I-66 westbound to US 50WB and used a modified version of FHWA's prestressed PCP system to rehabilitate a 4-lane section of I-66 westbound.

West Virginia

During 2014, the West Virginia Department of Highways used the Fort Miller PCP system for a demonstration project constructed on the I-64/I-77, Exit 97 ramp.

Wisconsin

The Wisconsin DOT constructed a test section using the Fort Miller system along a section of I-94

in St. Croix County during mid-2013. During mid-2014, Wisconsin used the Fort Miller system to rehabilitate a section of Beltline Highway (US 12), a primary east-west route carrying a high volume of traffic around Madison. The PCP project on the Beltline Highway was supported by a Lead Adopter Award, under Round 3 of the SHRP2 IAP. During 2015, the Wisconsin DOT installed approximately 200 full-depth repair panels at the I-90/I-94 interchange in Madison.

SUMMARY

PCP technology is gaining wider acceptance in the U.S., and advances have been made to reliably design and construct PCP systems to achieve acceptable levels of constructability, concrete durability, load transfer at joints, panel support, and performance.

PCP TECHNICAL RESOURCES

For additional information on PCP systems, applications, guidelines, and usage, refer to FHWA publication, Tech Brief FHWA-HIF-15-022 (<http://www.fhwa.dot.gov/pavement/concrete/pubs/hif15022.pdf>). This publication summarizes the technical resources available to engineers and planners seeking an understanding of PCP technology. The Tech Brief includes weblinks that provide easy access to recent documents covering a range of PCP topics. These documents can be read online and downloaded at no cost.

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