

Implementation of Precast Concrete for Rapid Renewal of Pavements

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Abstract

The rapid repair and rehabilitation of roadways with high traffic volumes is a critical need faced by all highway agencies. This need has been the catalyst for development of long-lasting precast concrete pavement (PCP) systems as alternatives to cast-in-place procedures. In the US, PCP has been shown to be a ready-to-use technology, and its effective implementation has served to reduce construction-related congestion, improve work-zone safety, and provide long-lasting pavement performance. Highway agencies in the US have recognized the potential for using PCP to achieve long-life performance for pavement rehabilitation while reducing the overall duration of lane closures on heavily trafficked roadways. PCP typically is used where high volumes of traffic limit work zones to off-peak times such as nighttime periods, and where long-life pavement performance is desired. The uses of PCP include, but are not limited to: replacement of intersections where rutting and shoving of existing asphalt requires frequent maintenance activity; reconstruction of ramps and mainline sections of heavily trafficked roadways; full-depth replacement of deteriorated joints; reconstruction of bridge underpasses where prestressed concrete can provide increased load-carrying capacity without increasing pavement thickness; overlays of existing concrete and asphalt pavements; inlays of existing asphalt pavements; and the replacement of bridge approaches. This paper provides a brief summary of the highway agencies that used PCP during the years 2000 through 2014; a summary of the uses of PCP planned and underway by highway agencies in response to a rollout of PCP technology by the 2nd Strategic Highway Research Program (SHRP2), and key reference documents published by the Federal Highway Administration (FHWA) and others to advance the use of PCP technology.

Introduction

The FHWA has been involved in the development of PCP technology and in the advancement of its use by highway agencies since the early 2000s. FHWA's technical publications concerning PCP technology have addressed the use of prestressed PCP (FHWA 2009), the use of jointed PCP (FHWA 2010), a work-plan for implementation of the products resulting from SHRP2 Project R05 on PCP technology (FHWA 2014), and links to key PCP resources (FHWA 2015).

Early Users of PCP. As shown in Figure 1, during the period 2000-2014, twenty highway agencies constructed PCP demonstration projects. Also during this period, PCP began to be routinely used for pavement repair and rehabilitation by highway agencies in California, New Jersey, New York (state, city and thruway authority), and Utah.

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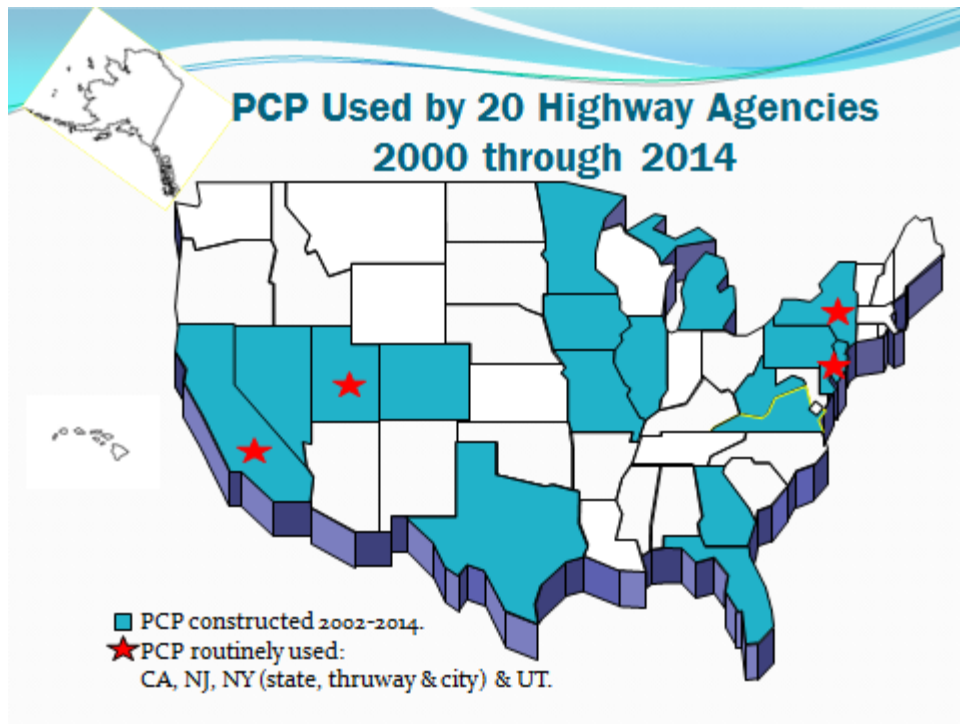


Figure 1. Users of PCP in the US during the period 2000-2014.

2nd Strategic Highway Research Program. In 2013, the Transportation Research Board (TRB) published a report resulting from SHRP2 Project R05 on Precast Concrete Pavement Technology (TRB 2013-A). This report clearly showed that PCP technology was ready for wide implementation and that the PCP systems available in the US could meet the needs of highway agencies for rapid renewal and long-life performance of pavements.

The SHRP2 study reviewed the performance of 15 projects constructed in the US and performed field testing, which indicated 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 – reliable and economical techniques are available to provide effective load transfer at transverse joints in PCP systems; base support – techniques to provide adequate and uniform base support conditions are in use and continue to be improved; performance and efficiency – panels are thinner than standard cast-in-place concrete and last longer because of prestressing and/or reinforcing.

Project R05 also developed model specifications for both jointed and prestressed PCP systems (TRB 2013-B). Links to both the R05 report and the model specifications are available at the following website: <http://www.trb.org/Main/Blurbs/167788.aspx>.

The California Department of Transportation (Caltrans) sponsored the development of a process for the design of PCP (Fugro 2012). Caltrans has allowed this information to be made available to the public.

SHRP2 Implementation Assistance Program. SHRP2 has developed innovative, practical, and proven tools to help transportation professionals quickly rehabilitate aging highways while reducing congestion and improving safety. The four focus areas in SHRP2 are safety, renewal, reliability and capacity. Precast concrete pavement technology is one of the 26 projects included in the renewal focus area. A mechanism within SHRP2 for advancing the use of products from these focus areas is the SHRP2 Implementation Assistance Program (IAP).

The IAP helps State departments of transportation (DOTs), metropolitan planning organizations (MPOs), and other interested organizations deploy SHRP2 products. A total of seven rounds of the IAP were designated to receive applications for three award categories: Proof of Concept Pilot – Funds for piloting products to evaluate readiness for implementation, and contractor support to collect data and evaluate the application; Lead Adopter Incentive – Funds for early adopters to offset implementation cost and mitigate risks, and recipients required to provide specific deliverables designed to further refine the product, and possibly “champion” the product to other States and localities; User Incentive – Funds for implementation support activities after early adopter use, and used to conduct internal assessments, build capacity, implement system process changes, organize peer exchanges, or offset other implementation costs.

Applications for the implementation of PCP technology were received in Round 3 and Round 6 of the IAP with awards announced in March 2014 and August 2015, respectively. The thirteen (13) highway agencies receiving IAP awards are shown in Figure 2.

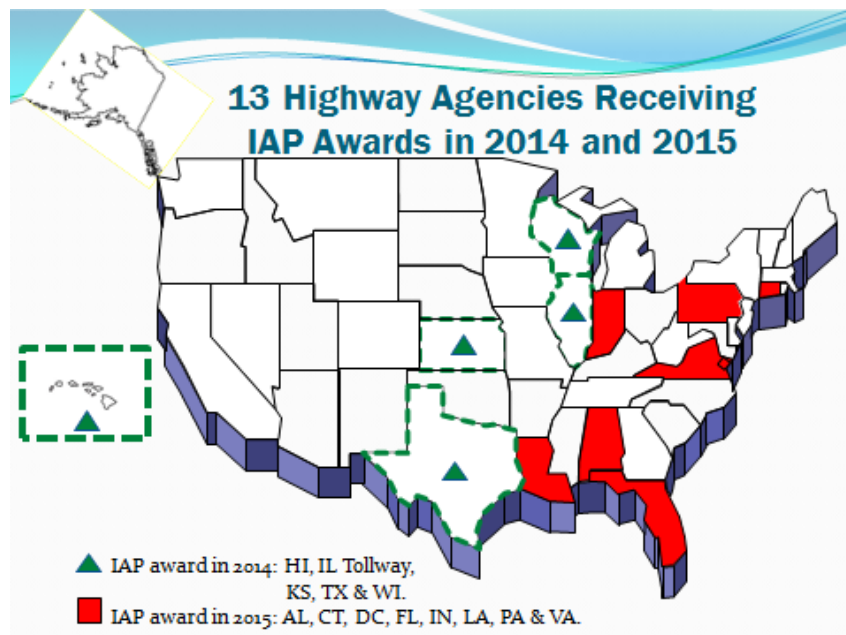


Figure 2. SHRP2 Implementation Assistance Program Awards in 2014 & 2015.

The implementation activities for PCP proposed by each of the highway agencies that received awards in Rounds 3 and 6 of the IAP are briefly described in the following paragraphs. Descriptions of fifteen PCP projects that were constructed during the period 2000-2012 are available in the SHRP2 Project R05 report.

Alabama – The Alabama Department of Transportation (ALDOT) has selected a project to demonstrate the benefits of utilizing PCP in the Mobile area of southwest Alabama on I-165 southbound at Exit 2. This exit carries heavy truck traffic into the Port of Mobile. The left turning movements of trucks onto US 90 have resulted in heavy rutting. A complete shut-down of these ramp lanes for an extended period of time (longer than a work day) is not feasible as this intersection is a corridor for all traffic utilizing the Port of Mobile.

District of Columbia – The District of Columbia Department of Transportation (DDOT) recognizes the potential benefits of PCP to deal with frequent pavement repairs or rehabilitations in an urban environment with a dense roadway network and extremely high volumes of traffic. DDOT intends to implement PCP into an upcoming transportation project to collect and analyze both performance and environmental data that can then be used to develop appropriate design parameters and guidelines for future applications of PCP.

Connecticut – The Connecticut Department of Transportation would like to determine if PCP technology is viable for repairing deteriorated PCC joints which currently are overlaid with bituminous concrete. The joints are exhibiting poor load transfer efficiency, spalling and heaving. CTDOT also would like to consider overlaying existing roads with PCP, before or after milling, if the method is feasible and cost effective. CTDOT intends to gain a department-wide understanding of what the appropriate applications of PCP are, how to go about the design process and what the steps are required for implementing an effective project.

Florida – The Florida Department of Transportation (FDOT) has high interest in utilizing precast concrete for bridge approach and highway pavement slab replacement projects. The intended result would be a more streamlined construction process with less disruption to the traveling public. Additionally, the precast slabs would provide a high strength concrete with reduced potential for cracking.

Hawaii – The Hawaii Department of Transportation (HDOT) used PCP as an inlay of existing section of asphalt pavement on interstate H-1, as shown in Figure 3. This jointed PCP design required the placement of 14 panels per lane for a total of 70 panels across 5 lanes. Work was performed during a series of daily work zones maintained from 12:00 noon until 6:00 am following morning. The project was completed during the spring of 2015. An open house event was held in late March 2015, while the project was under construction.



Figure 3. PCP inlay utilized by HDOT across five lanes of H-1.

Illinois Tollway – The Illinois Tollway proposed the use of PCP for replacement of approach slabs at existing bridges where the embankment behind the abutment has settled and damaged slabs need to be replaced quickly. The PCP approach slabs also will be used with new construction of long-span integral-abutment bridges.

Indiana – The Indiana Department of Transportation (INDOT) interest in developing and delivering an agency-wide program utilizing PCP technology as an alternative to conventional repair and rehabilitation, which utilizes cast-in-place concrete. Maintenance of traffic (MOT) and opening to traffic (OTT) are key parameters along with other interests including material quality and worker safety. INDOT anticipates the statewide deployment of PCP technology, and the use of quick-contact execution for on-demand patching where any pavement contractor will be able to execute a patching contract and meet specified MOT and OTT requirements.

Kansas – The Kansas Department of Transportation (KDOT) proposed the use of PCP for reconstruction of intersections that provide access to Ft. Leavenworth from US 73. Other uses of PCP included in the KDOT project are replacement of sections of US 73/92 and replacement of approach slabs on US 92 at the nearby bridge over the Missouri River. The required plans for MOT with each of these applications of PCP are critical since alternate routes for traffic are not feasible. Construction was scheduled to start in the fall of 2015.

Louisiana – The Louisiana Department of Transportation and Development (LADOTD) will use PCP to reconstruct the entrance ramp in Caddo Parish, near Shreveport, at the interchange where LA 169 northbound enters onto eastbound interstate I-20. The LADOTD District Design Section, in conjunction with Headquarters personnel, will develop plans and the bid package for construction. The District staff will provide construction engineering and inspection services.

Additionally, LADOTD intends to adopt the use of PCP technology for statewide use in applications including detouring interstate traffic in lieu of constructing new lanes or shoulders,

for major freeway repairs, replacement of bridge-approach slabs, and reconstruction of asphalt intersections.

Pennsylvania – The Pennsylvania Department of Transportation (PennDOT) will incorporate PCP into the final design plans for PennDOT Engineering District 6-0's SR 0202 Section 510 Markley Street improvement project in Norristown Municipality, Montgomery County. The PCP will be utilized at the signalized intersection of Markley Street (SR 3020) and Main Street. The PCP will replace the existing reinforced concrete pavement that is over 50 years old and has significant deterioration. Both Markley Street and Main Street are multi-lane principal arterials with average daily traffic (ADT) volumes over 20,000 vehicles per day with heavy peak-hour traffic. The pavement will be rehabilitated using staged construction since there is no suitable detour route for either road.

Additionally, PennDOT intends to adopt the use of PCP technology statewide to minimize traffic impacts during pavement repair and rehabilitation in high-traffic areas in lieu of using accelerated-set and rapid-hardening concrete mixtures, which have experienced issues with curing time, early surface wear, and other durability issues.

Texas – The Texas Department of Transportation (TxDOT) will use jointed PCP to reconstruct the asphalt intersection of SH 97 and SH 72, shown in Figure 4, in the south-Texas energy sector. The ADT through this intersection includes a high percentage of heavily loaded trucks. TxDOT designed this PCP project to include some 235 panels with unique details for doweled load transfer between panels in both the transverse and longitudinal directions. The panel layout for the TxDOT PCP intersection is shown in Figure 5. Construction was scheduled to start in the fall of 2015.



Figure 4. TxDOT PCP project – view west on SH 72 at intersection with SH 97.

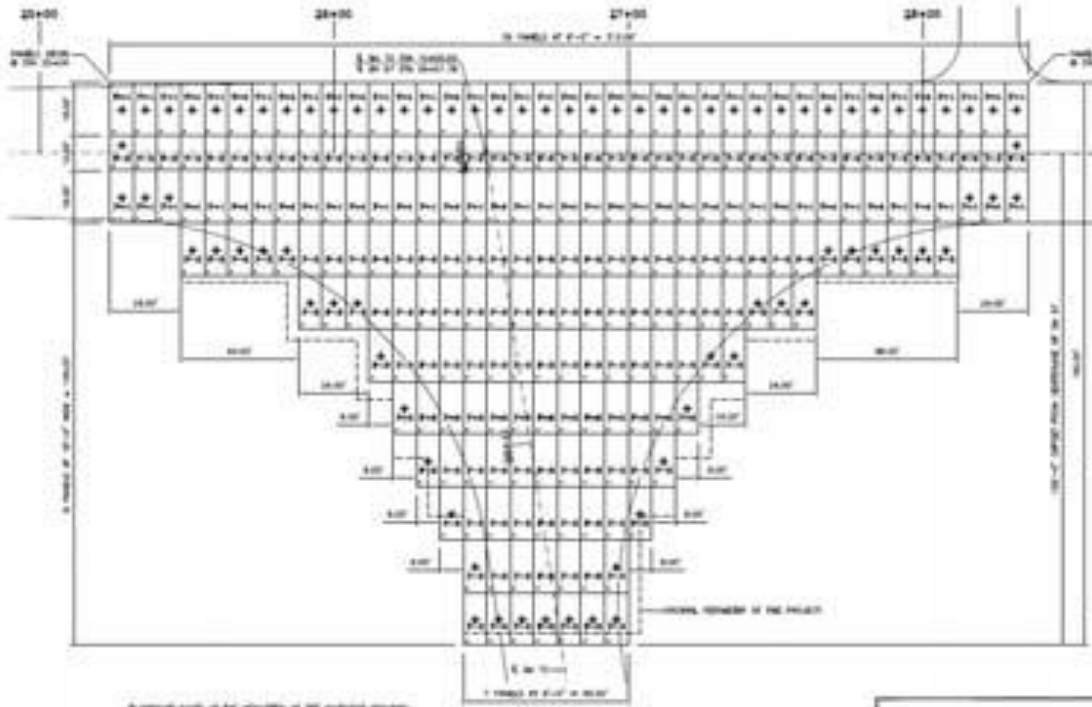


Figure 5. Panel layout for the TxDOT PCP intersection project.

Virginia – The Virginia Department of Transportation (VDOT) intends to adopt PCP technology as an option for concrete pavement repair and rehabilitation activities. VDOT’s goal is to make technical resources available to pavement designers statewide at the District level so this technology can be utilized where applicable, particularly when rapid renewal is needed to minimize disruptions to traffic flow.

Wisconsin – The Department of Transportation (WisDOT) proposed the use of PCP in WisDOT Project 1206-04-62 using jointed precast concrete panels for intermittent full-depth replacement of existing concrete on US 12, the Madison Beltline Highway. The project was completed in January 2015 following the placement of some 600 PCP panels.

Conclusions

This paper provides a summary of the thirteen highway agencies that received funding and technical assistance in Round 3 and Round 6 of the SHRP2 Implementation Assistance Program in 2014 and 2015, respectively. A brief description of the PCP applications proposed by each of these agencies is provided. These projects were at various stages of planning through completion at the time of the writing of this paper.

This paper also provides a summary of the highway agencies that initiated steps to implement the use of PCP for rapid renewal of pavements during the period 2000-2014. Currently, highway agencies in California, New Jersey, New York (state, city and thruway) and Utah routinely use PCP for rapid renewal and long-lasting performance of pavements. Fourteen other highway agencies constructed one or more PCP projects during that period.

The advances in PCP technology made by early users, and the performance of their PCP projects, were documented in the 2013 SHRP2 Project R05 report on PCP technology. The R05 report confirmed that PCP systems can be reliably designed and constructed 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.
- Base support – Techniques to provide adequate and uniform base support conditions are available and continue to be improved.
- Performance and efficiency – Panels are thinner than standard cast-in-place concrete and last longer because of prestressing and/or reinforcing.

Notice

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