PRECAST CONCRETE PAVEMENTS (PCP): US STATE OF PRACTICE

FHWA Precast Concrete Pavement Implementation Team
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The Need – Pavement Rehab Under Heavy Urban Traffic

A very serious issue throughout urban US

- Shorter delays, but shorter service life (rapid setting concrete)
- Longer delays & longer service life (conventional concrete paving)
- Shorter delays & longer service life (PRECAST CONCRETE PAVEMENT)
Preamble

- PCP technology is not a passing fad. It is here to stay
- PCP technology is used routinely by several agencies for rapid repair and rehabilitation of concrete as well as asphalt pavements
- PCP projects have been successfully constructed in numerous States by contractors with no prior experience with PCP & precast panels can be fabricated by most precaster
- Good availability of precast plants throughout the US
PCP Initiatives in the US
(Actively undertaken since mid-1990’s)

- FHWA (since mid-1990’s)
- Highway and airport agencies (since 2001)
- Industry (since 2001)
- AASHTO TIG (mid-2000’s)
- SHRP2 Project R05 (2008 – 2012)
- FHWA/AASHTO - SHRP2 Project R05 products implementation program (2013 - current)
  - Tech Support
  - Financial support
PCP Background

• PCP is a recent technology – in use since 2001
• Used primarily for **RAPID** repair & rehabilitation & longer-lasting treatments
  – Panels fabricated off-site, transported to project site & installed on a prepared foundation
  – Only minimal field curing time required
• Typically, night-time work & short work windows
• Typically, repair/rehab along a single lane
  – Multiple-lane repair/rehab possible based on site constraints
Traffic Considerations

- Traffic volume – is it heavy enough to preclude other pavement alternatives?
  - If fast-track fixed-form or slipform paving techniques are possible, use of precast pavement may not be the best option!

- Alternate routes
  - If traffic can be staged or detoured, use of precast pavement may not be the best option!

But, if there is only 8 hours or less of lane closures to perform the repair/rehab work, precast pavement should be strongly considered
PCP Systems

➢ For intermittent repairs
  • Nominally reinforced panels
  • Prestressed panels

➢ For continuous applications
  • Jointed PCP systems (JPrCP)
    o Nominally reinforced panels
    o Prestressed panels
  • Post-tensioned systems (PPCP) - fewer active joints; longer sections

Generic & Proprietary Systems (Components) Available
PCP Systems

Repair Panels

Conventional Jointed PCP System
### State of Practice (Jointed Systems)

#### Approaches

**Support Condition**
1. Panels placed on grade
2. Panels set above grade using leveling bolts and high strength bedding grout used

**Load transfer using slots**
1. Slots at the surface
2. Slots at the bottom

#### California Systems

![California Systems Image]

- Load transfer using slots
  1. Slots at the surface
  2. Slots at the bottom

#### Fort Miller System

![Fort Miller System Image]

- Load transfer using slots
  1. Slots at the surface
  2. Slots at the bottom
PPCP Systems
(Concept Developed at University of Texas – 2001)

• A number of panels are posttensioned together to result in a posttensioned section length of 200 to 250 ft & induced prestress of 150 to 200 psi
• Tendons are bonded to the concrete thru grouted tendon ducts
Panel Production vs. Installation Rates

• Panel fabrication rate
  – 8 to 10 panels per day (inside plant – jointed)
  – Similar rate for PPCP panels – inside plant or outdoor beds

• Panel installation rate
  – Repair – 15 to 20 repairs/night
  – Jointed continuous – 30 to 40 panels/night (500 to 600 ft)
  – PPCP – two posttensioned sections or up to about 500 ft

• So, several weeks (months) of back-log of panels is necessary before installation can begin

**NEAR FUTURE EXPECTATIONS**

REPAIR APPLICATION – 30 TO 40 REPAIRS PER NIGHT
CONTINUOUS (JOINTED OR PPCP) – 1,000 + FT/NIGHT
Overseas
Russia, Japan, France, the Netherlands, Indonesia
Japan

Joint Load Transfer Devices
Japan - Urban streets
Japan - Airfield pavements
Japan - Tunnel & shipping terminals

Reuse of tunnel panels when surface is worn out, by turning panels upside down
Russia

- Oldest production user of PCP technology – during the Soviet era (at least since 1960’s)
  - Several thousands of miles of PCP in Western Siberia
- Past use on roadways and military airfields; current use for airfields primarily
- Design and fabrication practices standardized – current standards established during the 1990’s.
- Panels are about 7 to 10 ft wide, about 20 ft long, and thin
  - The panels are prestressed using the electro-thermic process
- The panel lifting loops are welded together at the site to provide panel continuity
Russia
Intersections
(Rehab of distressed AC Intersections)

• A very effective option to rehab distressed/rutted AC intersections that carry high volume of traffic, including heavy truck traffic
**Bridge Approach Slabs (BAS)**

- Thousands of distressed approach slabs exist
  
  - Exhibited by classic “bump” at bridge end/approach

- Causes of failure
  
  - Settlement of underlying soils
  
  - Erosion of embankment materials

- Difficult to rehab/replace
  
  - Often repaired with “band-aid” materials

- Precast panels - a good fast and permanent repair
  
  - Full-depth replacement allows opportunity to repair underlying embankment
  
  - Can be installed in over night or over-the-weekend work windows

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Active program underway at the Illinois Tollway to study implementation of precast panels to rehab existing BAS & for new BAS at new integral abutment bridges
Example: Approach Slab on Existing Bridge Abutments

Cross Section at End of Existing Bridge

Placing panel Over Anchor Rods

Placing panels In One Lane

Source: The Fort Miller Co., Inc.
Bus Pad Rehabilitation

Hollywood & Santa Monica Blvd.
North Hollywood, CA, 2012

Grading Bedding Material

Placing Last panel

Placing

Opened Next Morning

Source: The Fort Miller Co., Inc.
Long-Life Expectations for PCP

• Repair applications – 15 to 20 years or to reconstruction of existing pavement

• Continuous applications
  – Original PCC surface service life – 40+ years
  – Pavement will not exhibit premature failures and materials related distress
  – **Pavement failure** => Result of traffic loading
  – Pavement will have reduced potential for cracking, faulting & spalling, and
  – Pavement will maintain desirable ride and surface texture characteristics with minimal intervention activities to correct for ride & texture, for joint resealing, and minor repairs
PCP Technical Considerations

a. General Details
b. Concrete Requirements
c. Jointing and Load Transfer
d. Support Conditions
e. Surface Characteristics (smoothness & texture)

ONCE INSTALLED, PCPs BEHAVE SIMILAR TO CONVENTIONAL CONCRETE PAVEMENTS.

- Only the method of construction is different
- THE CONCRETE & THE PANELS CAN BE VERY DURABLE

However, uniform support condition & good load transfer at joints are critical
# Panel Weight

<table>
<thead>
<tr>
<th>Panel Size (ft)</th>
<th>Panel Thickness (in.)</th>
<th>Panel Weight (lb)</th>
<th>Four-Point Lift Anchor Load (Static) (lb)</th>
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<td>7,000</td>
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<td><strong>21,600</strong></td>
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# Panel Static Lifting Flexural Stresses

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<tr>
<th>Panel Length (ft.)</th>
<th>Panel Width (ft.)</th>
<th>Panel Thickness (in.)</th>
<th>Maximum Concrete Lifting Stress (psi)</th>
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*PCI guidelines (PCI 2004)*

As a panel dimension gets longer, pretensioning becomes necessary.
Panel Handling

- Four point lifting method
  - Lifting anchors are embedded in each panel at four symmetrically offset locations
  - Ensure the least tensile stresses in the panel
- Lifting hardware left in place must have 2.75 in. (70 mm) top cover and 2 in. (50 mm) bottom cover after installation
- PCI provides guidance on lift anchor locations
Panel Fabrication (Current Jointed) – Reasonably Standard & Routine
The Panel Fabrication Process (Current) - Prestressed Panels for Jointed PCP
Panel Support Condition Considerations

• Use of existing base
  – Granular
    • Reworked, compacted & regraded
    • Reworked, compacted, regraded, bedding material applied
  – Stabilized
    • Used as is or trimmed; bedding material applied
  – Bedding material
    • < ¼ in. fine-grained granular material
    • Thicker layer of rapid-setting flowable fill (RSFF) or grout using elevated panel placement techniques
    • High density polyurethane grout

• New base – granular or rapid-setting LCB, with or without bedding material
Virginia I-66 (Sept. 2009)
Continuous Placement – Fort Miller System (Ramp Lane)

Note: If an extra 6 in. width had been trimmed off, most of the longitudinal spalling would have been taken care of.
New York City - Continuous Jointed PCP
Fort Miller System – Rehab of AC Intersections, 2010
Rockaway Boulevard near JFK Airport
Although experience with PCP systems is limited, less than 15 years, performance to-date indicate that well-designed and well-constructed PCP systems can be installed rapidly and can be expected to provide long-term service.

Precast concrete pavement technology is an implementable technology and continues to evolve.

The need for the technology is obvious – rapid construction and longer-lasting solutions.

A viable PAVEMENT PRESERVATION & REHABILITATION TOOL for extending the service life of existing pavements.
Thank You!