PRECAST CONCRETE PAVEMENT PRACTICES
OVERVIEW

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The Need – Pavement Rehab Under Heavy Urban Traffic

A very serious issue throughout urban US

- Shorter closure, but possibly shorter service life (rapid setting concrete)
- Longer service life, but longer closure (conventional concrete paving)
- Shorter closure & longer service life (PRECAST 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)
    - Nominally reinforced panels
    - Prestressed panels
  - Post-tensioned systems (PPCP) - fewer active joints; longer sections

Generic & Proprietary Systems (Components) Available
PCP Systems

Repair Panels

Conventional Jointed PCP System
PCP Used by US Highway Agencies 2001 through 2015

- PCP constructed 2001-2015
- PCP routinely used: CA, IL, NJ, NY (state, thruway & city) & UT
Highway Agencies Receiving SHRP2 PCP Implementation Awards in 2014 and 2015

2014: HI, KS, TX & WI

2015: AL, CT, DC, FL, IN, LA, PA & VA
State of Practice - Jointed Systems

Overall Approaches

**Support Condition**
1. Grade supported - panels are placed directly on grade
   - Cemented bedding layer *should* be used (<1/2 in.)
   - Surface grinding almost *always* required
2. Bedding grout supported - panels are set above grade using leveling bolts (or shims) and high strength bedding grout is used to fill gap under the panel (Typical gap > 1/4 in & < 1 in.)
   - Surface grinding *may not* be necessary

**Load Transfer System**
1. Using slots at the panel surface (several variations)
2. Using slots at the panel bottom (one patented system)
Panel Installation Options
(Grade placed – Repair & Continuous)

Existing Slab

Precast Panel

Existing Slab

Existing Base

Prepared bedding (Granular or flowable concrete)

Or, cemented granular bedding,
Or no bedding if base can be finished/graded well

Always undersealed
Panel Installation Options
(Levelling bolts & thicker bedding
- Repair & continuous)

Generic levelling lift system or proprietary levelling lift systems with plates embedded in the panels (Gracie Lift, etc.)
Repair Panel Installation Options

Roman Stone Method

- Existing Slab
- Precast Panel
- Polyurethane Injection Hole
- Expanded Polyurethane
- Polyurethane Injection Hole

Rapid-setting grout or polyurethane
Adjustable Beam
PCP Load Transfer Alternatives

• All systems require use of dowel bar slots
• Two approaches have been used
  – The Fort Miller Super Slab bottom slots
  – Generic top slots
    • Michigan partial DBR approach – no longer used
    • Full DBR approach – Eg., Roman Road system (New York)
    • SHRP2 R05 narrow-mouth top slots (one sided or two-sided)
    • Illinois Tollway version of narrow-mouth top slots (one-sided)
    • California Barra Glide system – one-sided partial length narrow-mouth slots
    • Caltrans version of narrow-mouth top slots (one sided)
PCP Load Transfer – Bottom Slots

• Developed and patented by the Fort Miller Company (FMC)
PCP Load Transfer – Top Slots

• Alternate method for installing dowel bars at transverse joints developed under the SHRP2 R05 project
  – Using narrow dowel bar slots at the surface for transverse joint load transfer – allows opening to traffic before the dowel bar slots are patched
PCP Load Transfer Refinement (USA)

- Adopted by the Illinois Tollway
  - Use of a narrow-mouth dowel bar slots at the surface
    - Slots in panel for intermittent repairs
    - Slots in every panel for continuous placement
California Rapid Roadway Pavement System

Barra Glide Load Transfer System & Gracie Lift Device
Developed in 2013

Barra Glide System with a receiving dowel hole in the opposite panel
California Rapid Roadway Pavement System

Barra Glide Load Transfer System & Gracie Lift Device
Caltrans Load Transfer Refinement

Generic Caltrans Tear Drop Slot System used with Gracie Levelling Lift System (or Shims)

SH 101 design (2015)

I-210 design (2016)
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

Original - Central panel surface pocket posttensioning

Refined - End panel surface pocket posttensioning

Current - End panel joint face posttensioning and gap panel use
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
Where to Use Precast Pavement? (Open to Traffic the Next Morning!!)

- Primary Applications (90%+ use)
  - Heavily-traveled main line interstate/primary system & urban roadways - A critical need on US’s aging system
  - Interstate/primary system & urban ramps - Often no alternative routes and heavy traffic

- Special Applications
  - Intersections - Where traffic needs to be maintained
  - Bridge approach slabs - A large no. of approach slabs across country need to be rehabilitated under traffic
  - Underpasses - Where height restrictions may limit rehab options
  - Bus pads - Where alternative bus stop locations are not acceptable, bus pads can be replaced overnight
  - Airfield Applications - A developing market
  - Utility “bridges” - Over failed drainage pipes & culverts
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)

DIFFERENT SYSTEMS SHARE MANY COMMON FEATURES AND REQUIREMENTS

BUT, THIS IS WHERE THEY DIFFER

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 Static Lifting Flexural Stresses

As a panel dimension gets longer, pretensioning becomes necessary.

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PCI guidelines (PCI 2004)
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 (levelling bolts/shims)
    • High density polyurethane grout

• New base – granular or rapid-setting LCB, with or without bedding material
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.

There were some early teething problems, but we are well beyond those issues.

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

Several generic and proprietary PCP systems are available.

And, importantly, contractors with no prior PCP construction experience are successfully installing precast panels.
Thank You!