PRECAST CONCRETE PAVEMENT PRACTICES - GENERIC SYSTEM USE IN MICHIGAN, TEXAS & CALIFORNIA

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Presentation Focus

• Michigan PCP system – not used as developed; refined systems now in use
  – Development funded by FHWA & Michigan DOT
  – System developed by Michigan State researchers

• Texas PCP system – developed in-house by TxDOT
  – Implemented at a heavily loaded energy roads intersection

• Caltrans PCP system – developed by Caltrans engineers
  – Minor variations from project to project
Michigan PCP System
(FHWA/MIDOT funded Non-Proprietary System)

- For intermittent repair of jointed concrete pavements
- As conceived, applicable to repairs at joints (full lane width and about 6 ft long repair areas) and performed by DOT maintenance staff
- Panels to be fabricated at DOT maintenance yards, stored at the yards and used as needed
- Repair work to be performed by DOT maintenance staff between the rush hours during daytime
- Assumed installation rate – 8 to 10 panels/day
Michigan PCP System

- Panel geometry: Standardized as full width by 6 ft long. When repair areas are longer, two panels may be used side by side.
- Panel thickness: The precast panels to be 0.25 in. to 0.5 in. thinner than the existing concrete pavement to account for variable thickness of the existing pavement.
- Load transfer at transverse joints:
  - Dowels embedded in the precast panel and slots provided in the existing pavement.
- Bedding material:
  - A fast-setting cementitious flowable material placed before installation of the precast panel.
  - A fast-setting polymer-based material injected under the panel after installation of the panel.
Michigan PCP System
Panel Fabrication
Michigan PCP System

Existing pavement  Jackhammered and sandblasted dowel slot  Dowel bar  Precast slab

Base  Flowable fill or HDP
Michigan PCP System
Michigan PCP System Performance
April 2010
Texas Energy Sector
Intersection
Application of PCP
Texas Oil and Gas Regions

Texas oil and gas fields

Texas has more than one-fifth of the world’s drilling rigs operating and five major areas of oil and gas production. The Barnett Shale in North Texas was the first field where horizontal drilling and hydraulic fracturing were used to produce oil and gas from dense shale rock. Since then, drilling and production have ramped up in the Eagle Ford in South Texas, the Haynesville/Bossier Shale in East Texas and the Panhandle’s Granite Wash, a tight sandstone. The Permian Basin, a historically prolific area for oil and gas production, has re-emerged as a complex field with drilling in multiple geologic horizons.

Sources: Railroad Commission of Texas, Baker Hughes Rig Count.
The Challenge – Heavily Loaded Traffic

Courtesy of MNT Division
The Challenge: Excessive rutting in AC pavements due to heavy truck traffic
The Intersection Demo Site
(Partially funded by FHWA/SHRP2 R05 IAP)
Texas Intersection PCP Demo
(May 2016)
(Rehab of intersections damaged by energy trucks)

Bid/Cost Data
$425/SY for Intersection Construction = $1,550,000
Estimated cost of precast panel: $200/SY
Preliminary panel cost: $180 to $225 SY
Texas Panel Details

- Base layer: compacted subgrade and 4” HMA layer
- Panels placed directly over HMAC layer
- “Generic” Panel Design
- 12” Thick Panels
- Panels pre-tensioned in the long direction.
- Doweled on all interior sides.
- Grout holes for filling voids beneath panels.
- Exterior panels anchored thru base layers.
Texas April 2016 Installation

Placed directly over a well-graded AC base
## Caltrans PCP Use Evolution

<table>
<thead>
<tr>
<th>Location</th>
<th>System</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-10 El Monte, Los Angeles</td>
<td>PPCP</td>
<td>Completed 2004</td>
</tr>
<tr>
<td>Research Center - APT</td>
<td>Super Slab</td>
<td>2005</td>
</tr>
<tr>
<td>I-15 Ontario, San Bernardino</td>
<td>Super Slab</td>
<td>Completed 2010</td>
</tr>
<tr>
<td>I-5/14 Sylmar, Los Angeles</td>
<td>PPCP</td>
<td>Completed 2010</td>
</tr>
<tr>
<td>I-680 San Ramon</td>
<td>PPCP &amp; ISR</td>
<td>Completed 2012</td>
</tr>
<tr>
<td>I-710 Los Angeles</td>
<td>PPCP</td>
<td>Construction</td>
</tr>
<tr>
<td>I-80 Dixon, Solano</td>
<td>PPCP</td>
<td>Completed 2014</td>
</tr>
<tr>
<td>I-580 Alameda</td>
<td>PPCP &amp; IPSR</td>
<td>Completed 2014</td>
</tr>
<tr>
<td>I-5 Los Angeles</td>
<td>PPCP &amp; IPSR</td>
<td>Completed 2014</td>
</tr>
<tr>
<td>I-405 Los Angeles</td>
<td>PPCP</td>
<td>Construction</td>
</tr>
<tr>
<td>I-210 Los Angeles</td>
<td>PJCP, IPSR</td>
<td>Construction</td>
</tr>
<tr>
<td>101 (Section 1) Los Angeles</td>
<td>PJCP, IPSR</td>
<td>Completed</td>
</tr>
<tr>
<td>101 (Section 2) Los Angeles</td>
<td>PJCP, IPSR</td>
<td>Construction</td>
</tr>
<tr>
<td>I-605 Los Angeles</td>
<td>PJCP, IPSR</td>
<td>Construction</td>
</tr>
<tr>
<td>I-15 Cajon Pass, San Bernardino</td>
<td>PPCP or IPSR</td>
<td>Design</td>
</tr>
<tr>
<td>I-710 (Phase II) Los Angeles</td>
<td>PPCP</td>
<td>Design</td>
</tr>
<tr>
<td>210, 134, 101, 15 Los Angeles,</td>
<td>IPSR</td>
<td>Maintenance Projects</td>
</tr>
<tr>
<td>San Bernardino</td>
<td></td>
<td></td>
</tr>
<tr>
<td>101 Santa Barbara</td>
<td>IPSR</td>
<td>Construction</td>
</tr>
<tr>
<td>I-15/215 San Bernardino</td>
<td>IPSR</td>
<td>Construction</td>
</tr>
<tr>
<td>57 Los Angeles</td>
<td>IPSR</td>
<td>Design</td>
</tr>
</tbody>
</table>
Caltrans PCP Use Evolution

- Prepared draft specifications
- Prepared draft Construction Details
- Developed a report on PCP design methodology
- Developed technical guidance
- Conducted workshops
- Pilot projects
- Production projects
- Requires a JITT – Just in Time Training before start of each new PCP project, by an approved instructor
**SH 101 Case Study**

U.S. Highway 101, is a north–south **U.S. highway** that runs through the states of California, Oregon, and Washington. It is also known as **El Camino Real** (*The Royal Road*).

The southern terminus of U.S. 101 is in **Los Angeles** at the **East Los Angeles Interchange**, the world's busiest freeway interchange.

The Los Angeles portion of SH 101 consists of typically 4 lanes in each direction. The existing jointed concrete pavement was constructed in 1950s.
SH 101 Project Scope

Project Scope: Furnish & install continuous panels and repair panels along sections of SH101, typically along the two outside distressed truck lanes in each direction.

Work to include panel fabrication (including pretensioning), existing pavement & base removal, repair area preparation, installing panels and bedding system, and installing load transfer at transverse joints.

Project owner: Caltrans, District 7
Contractor: OHL USA, Inc.
Precaster: ProCast products Inc., Highland, California
The SH101 Project (Los Angeles Downtown)

Use of precast concrete panels to rehabilitate the outside two lanes in each direction along

Work Items:
1. Remove concrete pavement and base – 15,000 cy
2. Install precast concrete pavement – 10,000 cy (PJCP)
3. Install individual precast panel repairs – 1,350 cy (IPSR)
4. Grind concrete pavement – 306,000 sq yd
Overall Site Views
(typically 4 lanes in each direction; work in outside two lanes; heavy traffic; challenging work areas)

<< At Hollywood Blvd

Near Benton Way >>
Overall Site Views
(typically 4 lanes in each direction; work in outside two lanes; heavy traffic; challenging work areas)

At Northwestern Avenue >>
**SH101 Project General Details**

Panel installation started July 31, 2015

- Existing concrete pavement
  - 0.75 ft (9 in.) concrete slab
  - 0.45 ft (5.4 in.) LCB or CTB

- Work involves
  - Continuous panel installation (~90%)
    - Standard panels: 12 ft wide, 16 ft (nominal) long
  - Individual panel replacement
    - Panel size: Variable width, 16 ft (nominal) long
  - Total no. of panels: ~2,300
  - Work duration: 200 (work) days – allowed to work Friday and Saturday nights only (from about 8 pm to about 5 am)
SH101 Project General Details

• Panels
  – To be prestressed at plant
  – 28-day Concrete strength: 6,000 psi
  – Panels shipped to site after 14 days
  – Panel thickness & base type
    • Repair: 0.7 ft (8.40 in.)
    • Continuous: 0.8 ft (9.60 in.)

• Base type (New)
  – Repair: 0.05 ft (0.60 in.) Rapid Setting LCB
  – Continuous: 0.40 ft (4.80 in.) RSLCB
Panel Types (PJCP – A Series)

- A-PP: Approach panel (at beginning of a section)
- A: Center panel (most)
- A-DD: Departure panel (at end of a section)
- A-DBS: Departure panel (at end of a section) with bottom slots for dowel bars
Panel Types (PJCP – A Series)

- A-PP: Approach panel (at beginning of a section)
- A: Center panel (most)
- A-DD: Departure panel (at end of a section)
- A-DBS: Departure panel (at end of a section) with bottom slots for dowel bars
Panel Types
(PJCP – A Series; Trapezoidal)

- AR2: 2,000 ft radius to the right
- AR4: 3,500 to 4,000 ft radius to the right
- AL2: 2,000 ft radius to the left
- AL4: 3,500 to 4,000 ft radius to the left
Typical Panel Details
(Load transfer details vary between panel types)
Typical Panel Details
Load Transfer Details (At Joints)
(1-1/2 in. diam. dowel bars)
Load Transfer Details (At Joints)
(1-1/2 in. diam., 18 in. long dowel bars)
Polyester Grout for Dowel Bar Slots

As per Section 41-8.03I

<table>
<thead>
<tr>
<th>Time to reach 1250 psi compressive strength (hours:minutes)</th>
<th>Minimum opening age(^a) (hours:minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:10–1:29</td>
<td>2:15</td>
</tr>
<tr>
<td>1:30–1:49</td>
<td>2:30</td>
</tr>
<tr>
<td>1:50–2:09</td>
<td>2:45</td>
</tr>
<tr>
<td>2:10–2:29</td>
<td>3:00</td>
</tr>
<tr>
<td>2:30–2:49</td>
<td>3:15</td>
</tr>
<tr>
<td>2:50–3:09</td>
<td>3:30</td>
</tr>
<tr>
<td>3:10–3:29</td>
<td>3:45</td>
</tr>
<tr>
<td>3:30 or more</td>
<td>4:00</td>
</tr>
</tbody>
</table>

\(^a\)During placing, determine the initial set time for polyester concrete under California Test 551. Add 2 minutes to the minimum opening age for each 1 minute that the initial set time exceeds 30 minutes.
Panel Layout Example
# Panel Dimensional Tolerances

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (longer dimension)</td>
<td>+/- 1/4 inch</td>
</tr>
<tr>
<td>Width (shorter dimension)</td>
<td>+/- 1/8 inch</td>
</tr>
<tr>
<td>Nominal thickness</td>
<td>+/- 1/16 inch</td>
</tr>
<tr>
<td>Edge alignment straightness measured from a horizontal plane</td>
<td>+/- 1/8 inch</td>
</tr>
<tr>
<td>Skew at the ends</td>
<td>+/- 1/8 inch</td>
</tr>
<tr>
<td>Batter</td>
<td>+/- 1/16 inch</td>
</tr>
<tr>
<td>Position of pre-tensioning strands</td>
<td>+/- 1/8 inch, vertical[^a]</td>
</tr>
<tr>
<td></td>
<td>+/- 1/8 inch, horizontal</td>
</tr>
<tr>
<td>Diagonal difference of the corner to corner measurement</td>
<td>+/- 1/8 inch</td>
</tr>
<tr>
<td>Position of lifting anchors</td>
<td>+/- 3 inches</td>
</tr>
</tbody>
</table>

[^a]: Measured from the bottom of the panel
Installing the Panels

- Pre-sawcut the repair areas (few nights before)
- Remove existing pavement
- Prepare base
- Attach foam boards (filler boards) along the transverse and longitudinal joint faces (except at keyway faces)
- Inject bedding grout under the panels
- Apply polyester grout into dowel bar slots
- Fill longitudinal joint gap with bedding grout
- Seal joints
- Grind roadway surface
Gracie Levelling Lift for Setting Panels
### Underslab Grout

Proportion grout for under slab grouting under ASTM C938 or use prepackaged grout complying with ASTM C1107. Fine aggregate, if used, must meet grading 2 in ASTM C637. Proportion the ingredients of the grout to meet the following properties:

<table>
<thead>
<tr>
<th>Quality Characteristic</th>
<th>Test method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength at 1 hr:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@73°F</td>
<td>ASTM C942</td>
<td>2500 PSI Min</td>
</tr>
<tr>
<td>@45°F</td>
<td></td>
<td>2000 PSI Min</td>
</tr>
<tr>
<td>Strength at 7 days</td>
<td>ASTM C942</td>
<td>7600 PSI Min</td>
</tr>
<tr>
<td>@73°F</td>
<td></td>
<td>6000 PSI Min</td>
</tr>
<tr>
<td>@45°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expansion</td>
<td>ASTM C940</td>
<td>0 to 3%</td>
</tr>
<tr>
<td>Bleeding at 30 min</td>
<td>ASTM C940</td>
<td>0.1% Max</td>
</tr>
<tr>
<td>Eflux Time</td>
<td>ASTM C939</td>
<td>15 to 30 seconds</td>
</tr>
<tr>
<td>Grout Bond Strength, bond to dry PCC</td>
<td>CT 551</td>
<td>150 PSI Min in 24 hr</td>
</tr>
</tbody>
</table>

Note: For tests at 45°F condition materials to 45°F for 24 hr before fabrication and store specimens at 45°F until testing.
SH 101 Project – Installation – 2015/16

Rapid setting LCB ➔
Panel Setting Process

- Embedded dowel bars slid into the receiving slot in the previously placed pane
SH 101 Project – Installation – 2015/16
Panel Installation Tolerances

Need to maintain tighter joint width
SH 101 Summary

➢ Work completed during Spring 2016.
➢ Contractor maintained installation at the rate of up to 50 panels per night.
Caltrans Current Projects

- I-210 project in the LA area – thin shims being used with bedding grout; also, modified dowel slot (generic slot design)
- Panels are prestressed in one direction
Caltrans Current Projects

- Several projects starting out later this year (2016) will use the Fort Miller’s bottom slot design with a levelling lift system and bedding grout.
Summary

- PCP 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.
- And, more highways agencies are finding PCP technology to be an important strategy for rehabilitating distressed highway pavements.

Thank You!