What is a Precast Concrete Pavement System?

• Definition:
  – An engineered system of precast concrete pavement slabs
    • Fabricated under controlled conditions (usually at a remote location)
    • Interlock or connect with surrounding pavement slabs (both existing pavement and new precast panels)
      – Load transfer
      – Edge support
    • Structurally designed
      – Reinforcement
      – Thickness Design
  – Transported to and installed at the project site
Heavy Traffic = Short Work Windows

180,000 ADT
I-66, Fairfax, VA

145,000 ADT
I-287, Tarrytown, NY

200,000 ADT
I-15, Ontario, CA

Source: The Fort Miller Co., Inc.
What is Needed At These Locations

**Very Rapid Repairs**

Work windows are limited
Minimize construction-related congestion

**Very Durable Repairs**

Needed most in high traffic areas
Think in terms of 40- to 50-year pavement life

**Premium Pavement – Overnight!**
Lane Miles of Jointed Precast Slab Installations (June 2013) (All Systems, U.S. & Canada)
General Categories of Precast Pavement Systems

*Prestressed Precast Concrete Pavement (PPCP)*

Jointed Precast Concrete Pavement (JPrCP)
Jointed Precast Concrete Pavement (JPrCP) Systems – Typical Characteristics

- Slab sizes customized for specific applications (e.g., joint repair, lane reconstruction, etc.)
  - Full lane-width
  - Similar thickness
  - Lengths up to 16 ft
- Generally reinforced for transportation and handling
  - 0.2 – 0.4% steel and/or fiber reinforcing
- Prestressing and/or structural fiber reinforcing options
- Joints treated like cast-in-place construction joints (i.e., doweled, tied or butt)
- Standard steel dowel load transfer systems
- Useful for intermittent, continuous and areal applications
- Useful in complex geometric situations

NCPA
Precast ... The Concrete Solution
Differences in JPCP Systems

• Leveling
  – Precision grading, shims, lift systems, grout or urethane injection

• Methods of achieving support
  – Grade-supported, grout-supported, urethane-supported

• Load transfer systems
  – Top slots (various), bottom slots; various dowels and connectors

• Achieving surface geometry
  – Nonplanar slabs, plane slabs, diamond grinding
Precast Concrete Pavements Should Emulate Cast-in-Place Concrete Pavements

- Load Transfer Dowels
- Uniform Slab Support
- Slab Surface Geometry

Source: The Fort Miller Co., Inc.
Joint Load Transfer Considerations

- Dowel bar based load transfer system
  - 4 dowel bars per wheel path is generally adequate
  - LTE > 75% at installation
  - Relative defl. < 2 mils for load transfer system approval
- Typically achieved using dowel bar slots at panel bottom or at panel surface
  - Full DBR – both sides of joint have surface slots
  - Partial DBR – only one side of joint has slots - at panel bottom or at panel surface

Source: Shiraz Tayabji, Fugro Consultants, Inc.
Top-Slot Jointed Systems (Generic) (e.g., Roman Road, Utah DOT and Michigan systems)

Typical Placement Sequence:

• Place slab
• Bring to grade using embedded jacks, support system, or urethane injection (not necessary if placed on precisely-graded base)
• Saw and prepare slots
• Place and grout dowels
Load Transfer - Top Slot Systems

Sand-Blast Cleaning - Vital!

Failed Top Slot (Utah)

Failed Slots

Grout must typically cure 2-3 hours before opening to traffic

Load Transfer Typically Through Bond Only

TOP SLOT LOAD TRANSFER
Durability of Top-Slot Dowel Installations

Source: Shiraz Tayabji, Fugro Consultants, Inc.

New York/LI Rt 27

Michigan Same Project
Super-Slab® Bottom Slot System

- Dowels engage slots in adjacent slab
- Pump dowel group into ports
  - Grout reaches 2500 psi in about 2 hours
- Fill slots and joint between slabs
- Dove-tail slot resists bar pop out
- “Clean” pavement surface

Source: The Fort Miller Co., Inc.

Dove tail-shaped slot
Support (Bedding) Considerations

Good, uniform support is key to precast concrete pavement performance.

- Without good support, a PCP system (repair or continuous) cannot be expected to provide expected long-term performance
Grade-Supported Systems:
Placing, Compacting & Grading Bedding Material

Placement of Bedding Material

Wetting & Compacting

First Grading Pass

Final Grading Pass

Source: The Fort Miller Co., Inc.
Repair Panel Installation Options

(Roman Stone Company method: Bring to Grade using Urethane Injection)

Source: Shiraz Tayabji, Fugro Consultants, Inc.
Grade Control with Shims - Grout Supported Panels

• Set shims to grade prior to placing panels
• Use surrounding pavement as a reference when appropriate
• A surveyor and grades may be necessary for complex or large installations
Repair Panel Installation Options
(Levelling Bolt Systems)

Gracie Lift System (California)

Generic

Paterson Bolt
Matching Pavement Surface Geometry

_Slab shape depends on geometry of pavement surface_

**Single Plane**
Slopes of opposite sides are equal

**Warped Plane**
Slopes of opposite sides are unequal

Source: The Fort Miller Co., Inc.
Hard-to-Recognize Non-Planar Surfaces

1.5” Deltas on Straight Road

2” Deltas on 12’ x 18 Panels at Intersecting Ramps

• Often imperceptible by eye
• Perform “x”, “y”, “z” survey if non-planar suspected
Two Ways to Create Non-Planar Pavement Surfaces

• Diamond grind flat (single-plane panels)
  – May require extra (sacrificial) thickness
  – Will likely require extra bedding grout

• Make custom shaped non-planar panels
  – Requires correct “x”, “y”, “z” data to make and place panels
  – May still require slight diamond grinding to meet smoothness requirements
Views of JPrCP Projects

Tappan Zee Bridge Toll Plaza

Minnesota

Virginia I-66 Ramp

Source: Shiraz Tayabji, Fugro Consultants, Inc.
Overall Findings

• The performance of projects constructed in the US indicate that sufficient advances have been made to reliably achieve the following four key attributes of PCPs:
  – Constructability
  – Concrete durability
  – Load transfer at joints
  – Panel support condition

• However, a few JPrCP projects have exhibited some early-age cracking – design details & construction practices are under investigation by the highway agencies

Source: Shiraz Tayabji, Fugro Consultants, Inc.
Places to Use Precast Pavement

- Heavily-traveled main line pavement (e.g., Interstate Hwy)
  - Huge need on aging highways built 40 – 50 years ago
  - The very best place to use premium repair material
- Controlled-access (Interstate and other) ramps
  - Often no alternative routes and heavy traffic
- Intersections
  - Need for rapid, durable replacements in short work windows
- Bridge approach panels
  - Countless approach panels across U.S. need to be replaced
- Bus pads
  - Alternative bus stop locations are often not acceptable
- Utility “bridges”
  - Over failed drainage pipes and other excavations
- Airfield Pavements
  - Runways (esp. intersections), taxiways, aprons
Interruption Repair (Patching)

- Joint repairs – most common
  - Typically involves replacement of failed load transfer devices
  - 6’ – 8’ long, width from longitudinal joint to longitudinal joint
- Mid-slab (existing slab) cracking repair - also common
  - Similar to joint repair slabs in length
Intermittent Repair Locations

Middle Lane Repairs

- Frequently not enough room to detour traffic around during peak traffic hours
- Often difficult to access
- Excellent place to use precast pavement
SHRP-2 Project R05 Final Report

- Overall findings
- Findings based on field testing
- Guidelines for PCP design
- Guidelines for PCP fabrication
- Guidelines for PCP installation
- Guidelines for PCP project selection
- Guidelines for PCP system acceptance
- Model specification
- Implementation plan
Other JPrCP Resources

SHRP 2 Project R05 Report: http://www.trb.org/Main/Blurbs/167788.aspx

AASHTO TIG Website:
http://tig.transportation.org/Pages/PrecastConcretePavingSlabs.aspx
  - Project Listings
  - Example Specifications
    - Generic
    - Single Product
    - Design and Construction Guidelines
    - Manufacturer Information

Manufacturer Websites and Literature (Examples)
  - Fort Miller Company: www.fmgroup.com
  - Kwik-Slab: http://kwikslab.com/index.htm
  - … and more …
Industry Guidance

- Industry organizations initiatives – to support use of quality precast concrete by providing members with the technical support, educational opportunities, plant and other certification programs and technical resources

- NPCA
  - [http://precast.org/pavement/](http://precast.org/pavement/)
  - Videos and technical documentation
  - PCP project database
  - Best Practices Manual – under development

- PCI
  - [http://www.precastconcretepavement.org/](http://www.precastconcretepavement.org/)
  - Videos and technical documentation