11th University Transportation Centers Spotlight Conference
Rebuilding and Retrofitting the Transportation Infrastructure

Track 3: Rapid Repair & Keeping Things Moving

RAPID/OVERNIGHT RENEWAL OF AMERICA'S HIGH VOLUME ROADWAYS USING THE INNOVATIVE PRECAST CONCRETE PAVEMENT TECHNOLOGY

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Precast Concrete Pavement – A recently developed technology that continues to be refined

This is a ripe area for innovations to improve productivity, efficiencies in design, and reduce cost – well suited for academia & UTC involvement

First, the Problem

- Thousands of miles of concrete pavements were constructed during the Interstate construction during 1960's and 1970's and many thousands before that and after that
- Many of these concrete pavements and also asphalt pavements are in need of repair/rehabilitation or reconstruction
- In high traffic urban areas, we cannot afford to close lanes to perform the repairs/rehab – these have to be done during short night-time work windows
- In addition, a Resilient transportation system requires that any recovery from major disruptions can be handled effectively and rapidly without significant lane closures

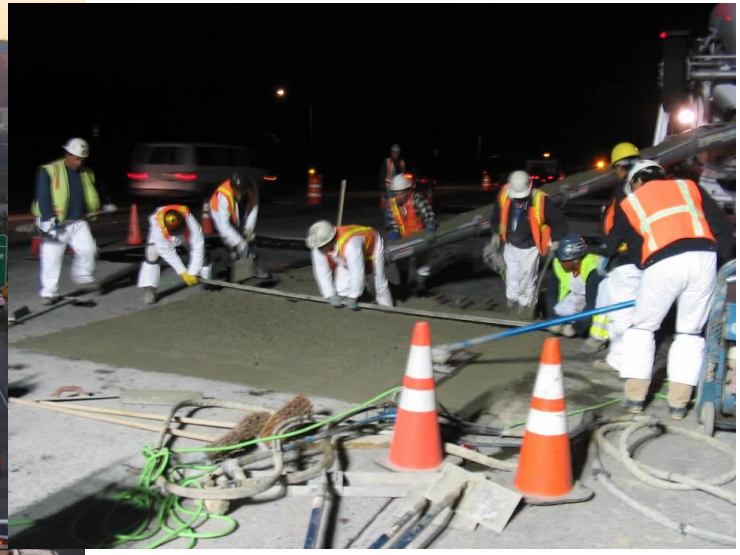
Pavement Rehab Under Heavy Traffic

A very serious issue throughout urban US

Congestion problem relates to capacity, but we as pavement engineers and technologists should not compound the problem by designing and constructing poorly performing pavements and repair/rehabilitation.

Serious Need – Rapid & Longer Lasting Rehab Under Heavy Urban Traffic

A very challenging issue throughout urban US



Shorter closures may possibly lead to <u>shorter</u> service life

Longer service life techniques, but typically require longer closures

Serious Need – Rapid & Longer Lasting Rehab Under Heavy Traffic

The challenge: shorter lane closure & longer service life

The use of precast concrete pavement addresses this challenge

For pavement repair & rehabilitation, shorter life cannot be accepted as the price of rapid renewal

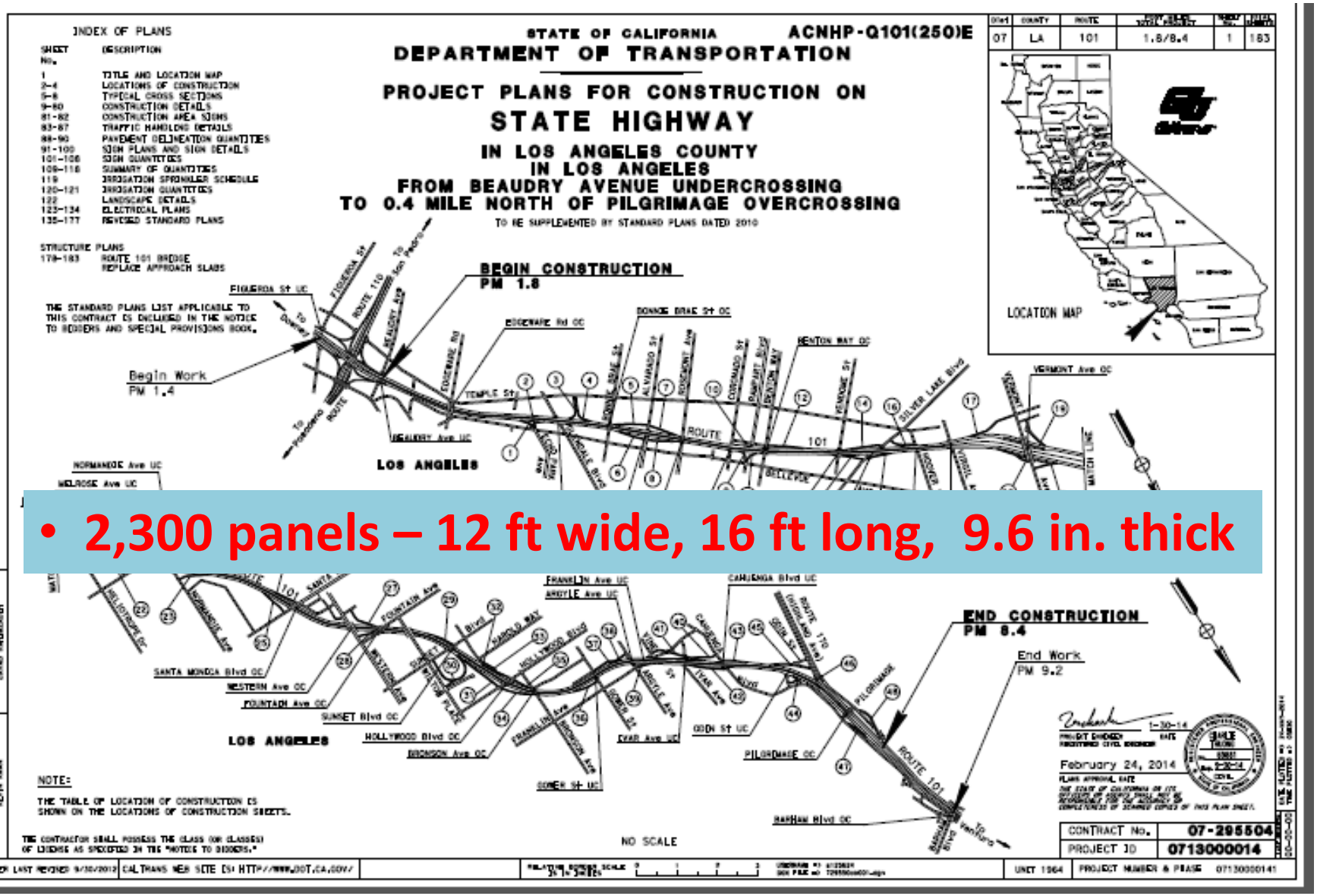
A Real Repair Installation

NJ I-295

FIRST NIGHT

SAME OR NEXT NIGHT ➔

A Real Continuous Installation
The SH101 Project (Los Angeles Downtown)

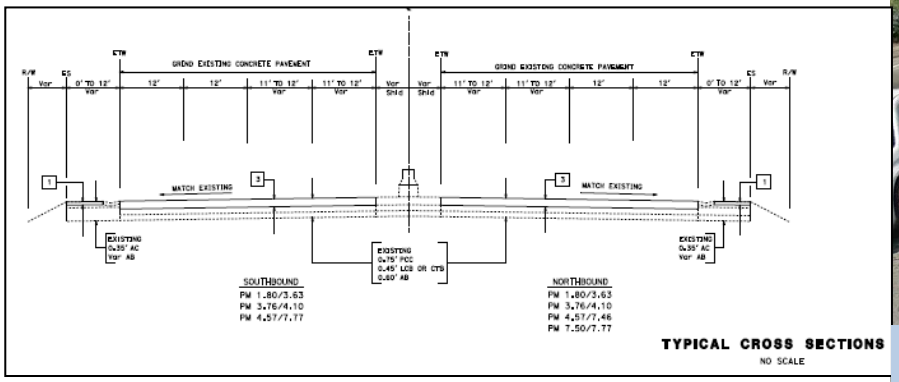


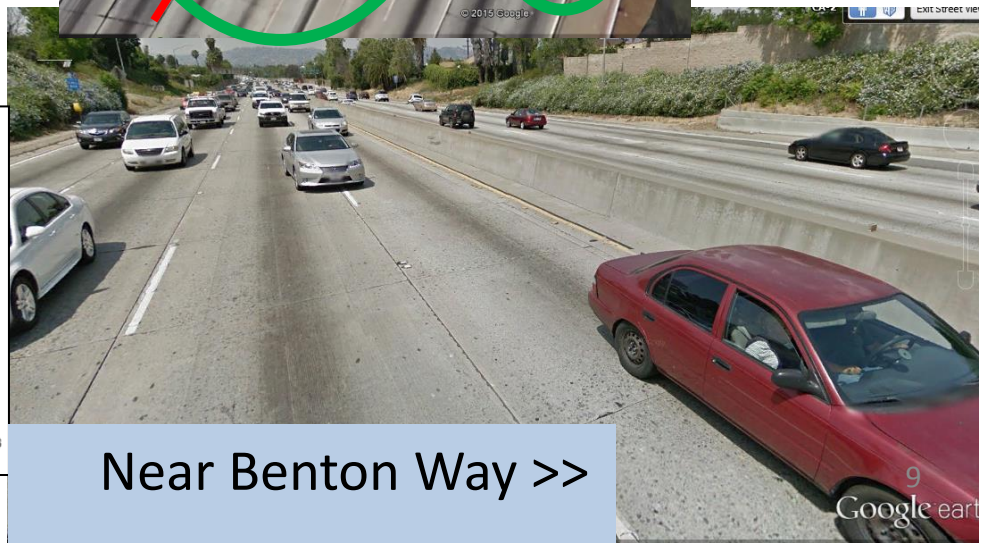
- **2,300 panels – 12 ft wide, 16 ft long, 9.6 in. thick**

Overall Site Views

(typically 4 lanes in each direction; work in outside two lanes; heavy traffic; challenging work areas)

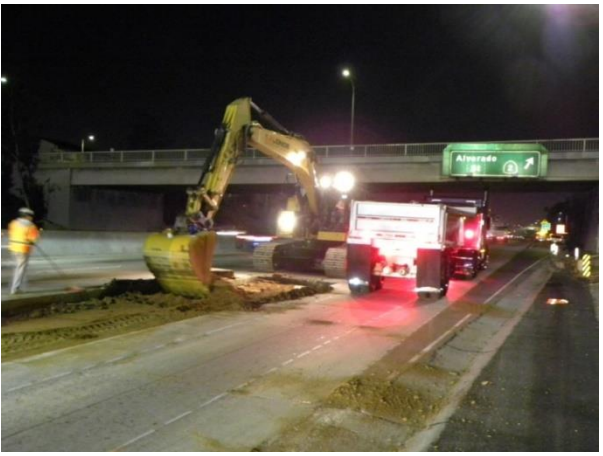
<< At Hollywood Blvd

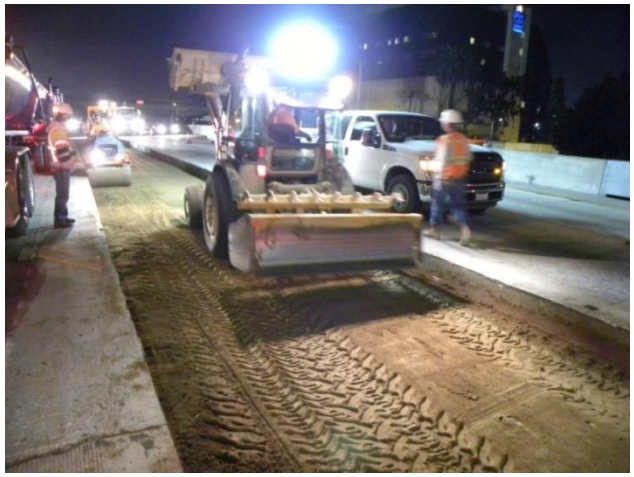


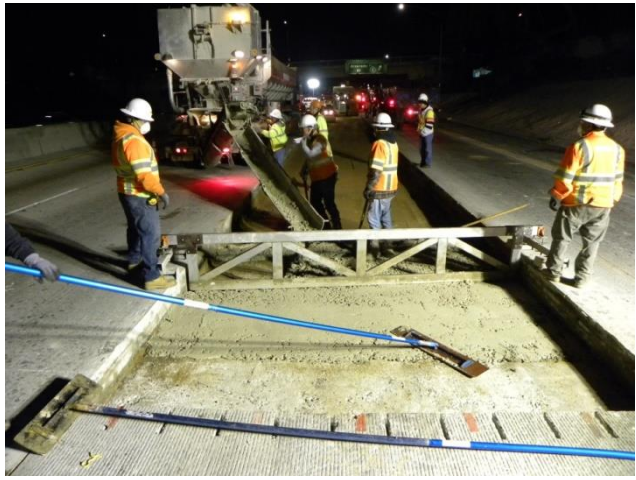


Near Benton Way >>

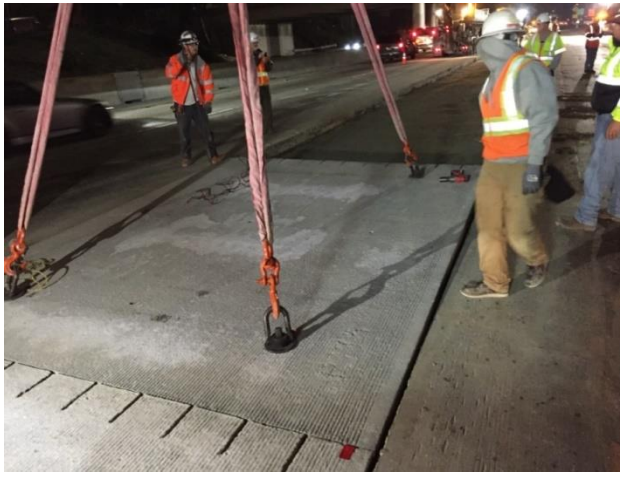
California SH 101 Panel Installation

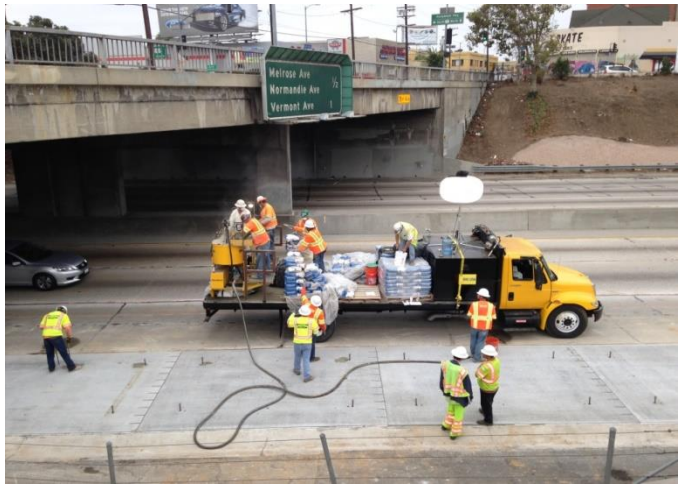


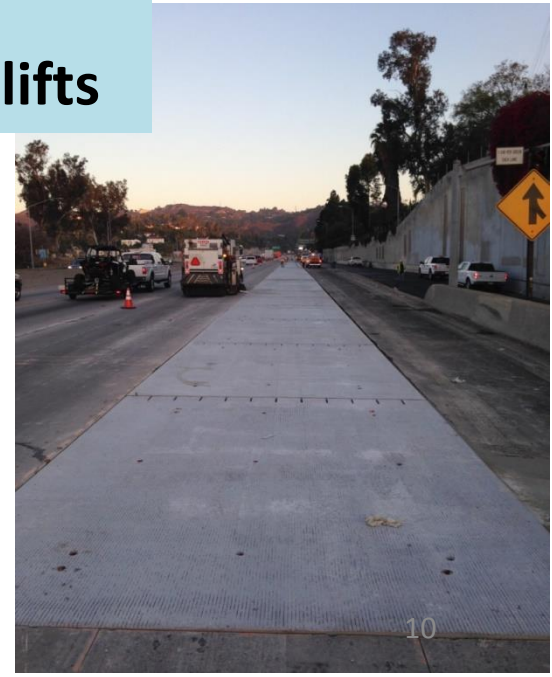




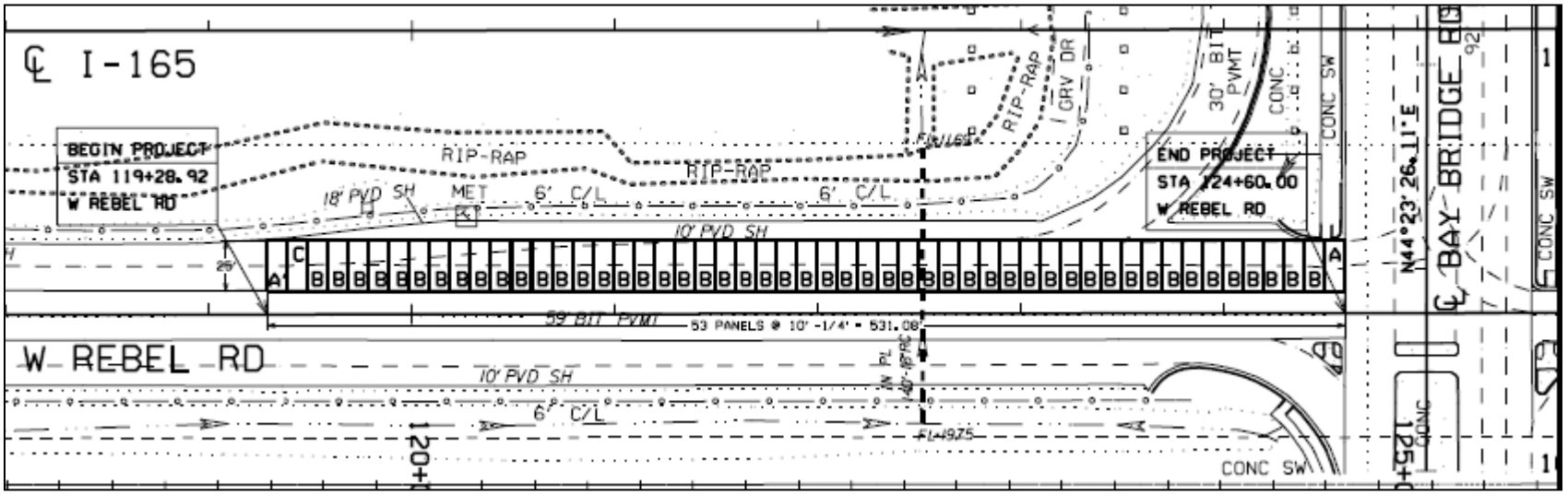
- Weekend nights only; up to 50 panels/night
- New rapid setting Lean Concrete Base; leveling lifts



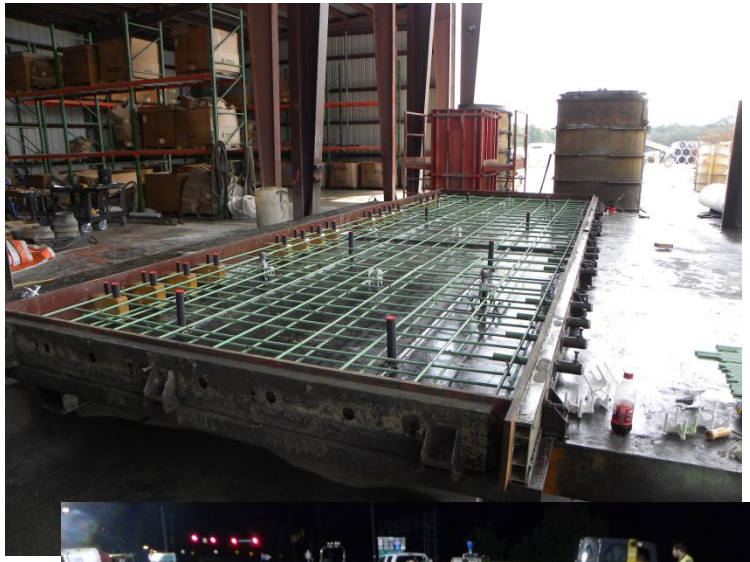


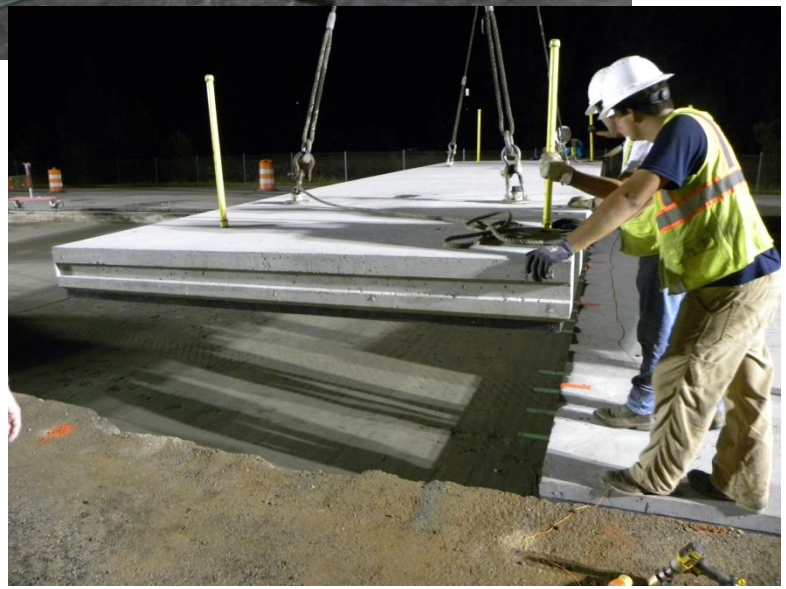


Rehab of a Heavily Trucked Rutted AC Ramp - (Dual left turn lane to a port facility) September 2017



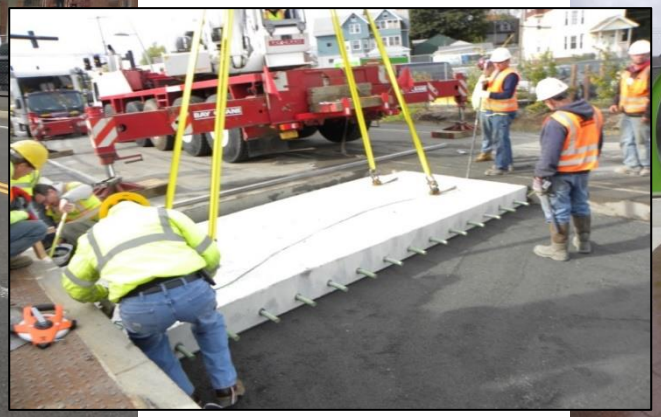
Rehab of a Heavily Trucked Rutted AC Ramp - (Dual left turn lane to a port facility) Under Construction – September 2017



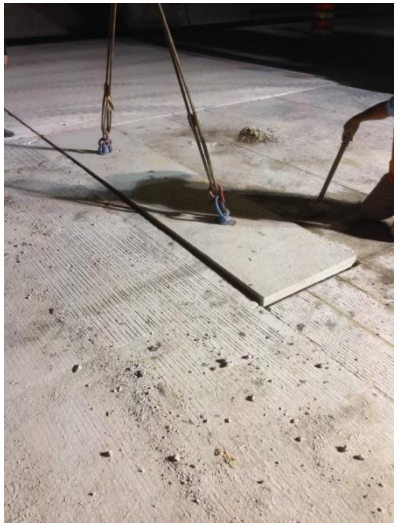


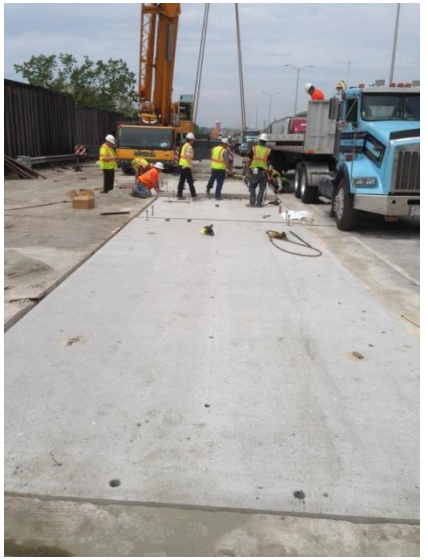
Bus Pads – Connecticut (2016)

- Rehabilitation of two recently constructed rutted AC bus pads along the CTfastrack busway in New Britain
- Custom designed system with bottom slot panels and leveling lifts, 24 panels
- Panels – 15 ft wide, 9 ft long. 10 in. thick
- Both bus pads replaced over a weekend



Illinois Tollway Bridge Approach Slab Rehab



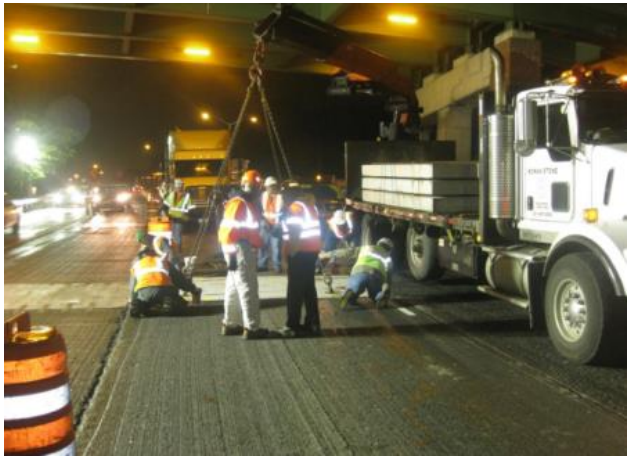


PCP Initiatives in the US
(Actively undertaken since mid-1990's)

- **FHWA (since mid-1990's)**
- **Highway and airport agencies (since 2001)**
- **Industry (since 2001)**
- **AASHTO TIG (mid-2000's)**
- **SHRP2 Project R05 (2008 – 2012)**
  - **Guidelines for PCP developed**
- **FHWA/AASHTO - SHRP2 Project R05 products implementation program (2013 - current)**
  - **Active technical support for wider implementation of PCP**
  - **Financial support to a few highway agencies for demo projects and for implementation 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

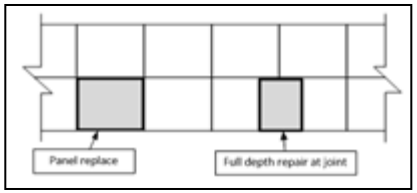


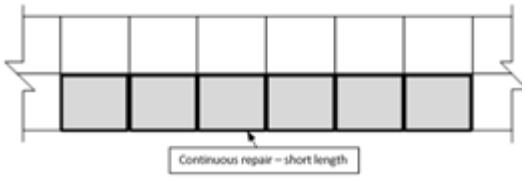
Where to Use Precast Pavement?
(Open to Traffic the Next Morning!!!)

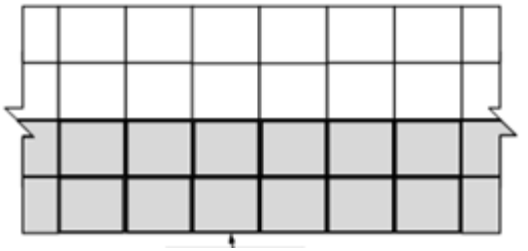
- Primary Applications (90%+ use)
  - Heavily-traveled main line interstate/primary system & urban roadways - A critical need on US's aging system
  - Interstate/primary system & urban ramps - Often no alternative routes and heavy traffic
- Special Applications
  - Intersections - Where traffic needs to be maintained
  - Bridge approach slabs - A large no. of approach slabs across country need to be rehabilitated under traffic
  - Bus pads/bus lanes - Where alternative bus stop locations or re-routing are not acceptable, bus pads/bus lanes can be replaced overnight
  - Underpasses - Where height restrictions may limit rehab options
  - Utility "bridges" - Over failed drainage pipes & culverts
  - Airfield Applications - A developing market?

PCP Applications

- Intermittent repairs
  - Nominally reinforced panels (common)
  - Prestressed panels (typically longer/wider panels)
- Continuous Applications
  - Jointed PCP systems (JPrCP)
    - Nominally reinforced panels
    - Prestressed panels (typically longer/wider panels)
  - Post-tensioned systems (PPCP) - fewer active joints; longer sections
    - Nominally reinforced panels
    - Prestressed panels (typically longer/wider panels)

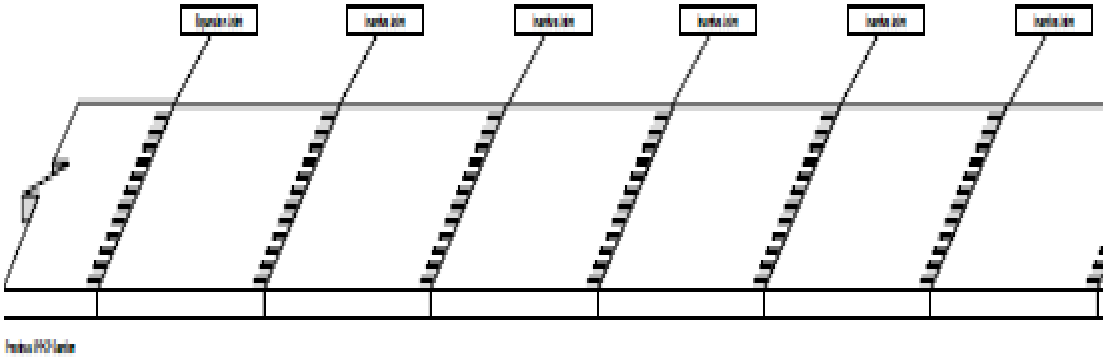






PCP Applications

Repair Panels – A current concept



Conventional Jointed PCP System – top or bottom dowel slots

State of Practice - Jointed Systems

Overall Approaches for PCP Systems

Support Condition

1. **Grade supported** - panels are placed directly on grade
   - Cemented bedding layer may be used (<1/2 in.)
   - Surface grinding almost always required
2. **Bedding grout supported** - panels are set above base grade using leveling bolts (or shims) and high strength bedding grout is used to fill gap under the panel (Gap > ¼ in. & typically < 1 in.)
   - Surface grinding may not be necessary

State of Practice - Jointed Systems

Overall Approaches for PCP Systems

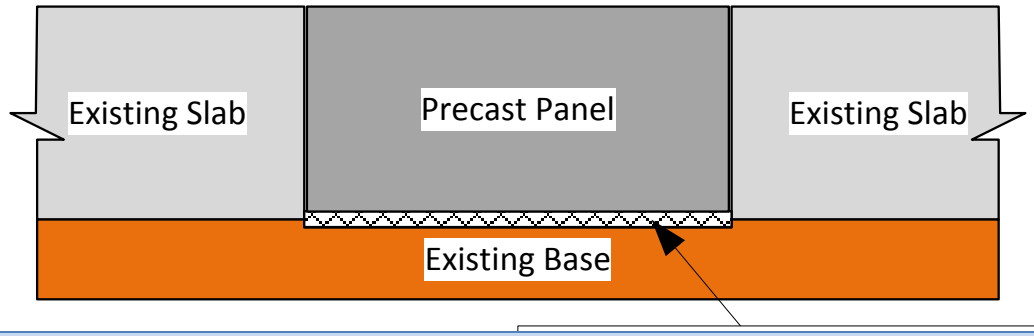
Load Transfer System

1. **Using slots at the panel surface (several generic variations)**
2. **Using slots at the panel bottom (one patented system)**
3. **Using ducts (generic & patented systems)**

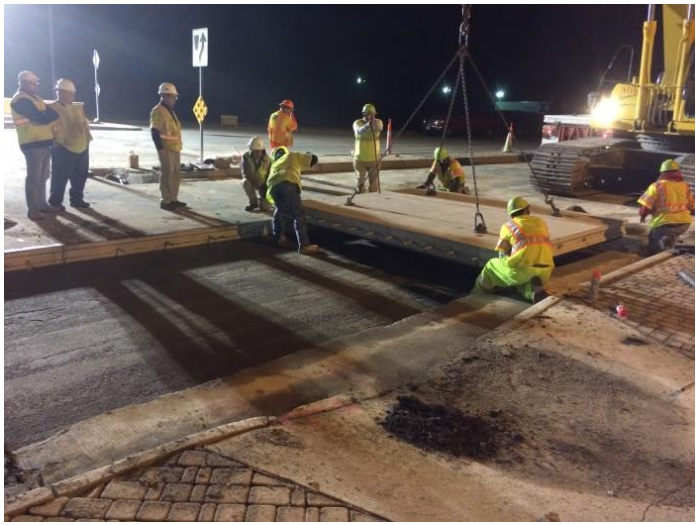
Panel Installation Options

(Grade Supported – Repair & Continuous)

Use of thin granular bedding over finished base

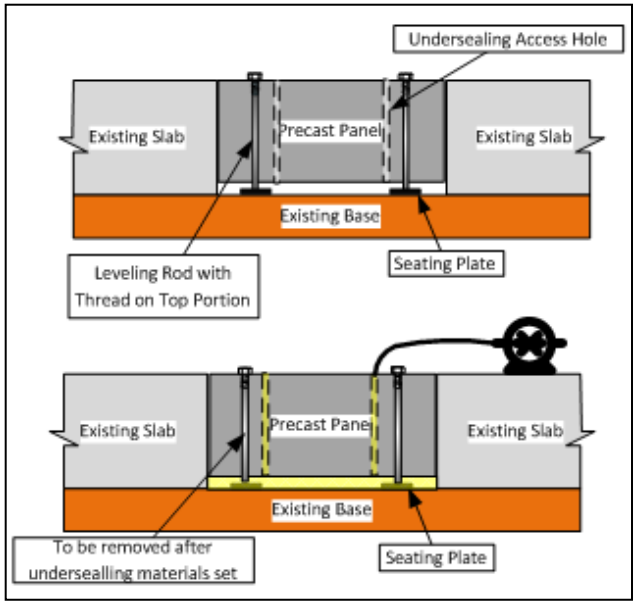


Recommend use of cemented sand bedding layer



Panel Installation Options

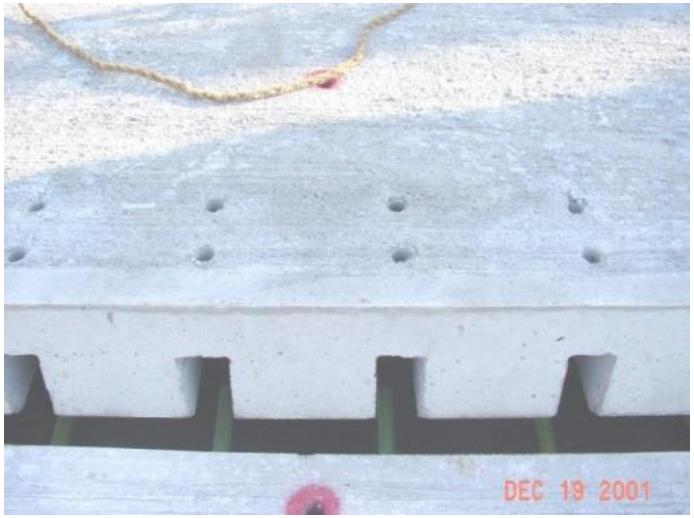
(Bedding Grout Supported – Repair & Continuous) Using Levelling Bolts & Thicker Bedding (1/4 to ½ in)

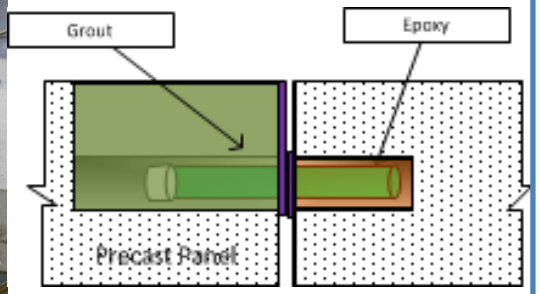


La Guardia Airport – 16 in., 12.5 by 25 ft panels
- Generic levelling bolt/plate system & cementitious grout

California current -)
–- proprietary levelling bolt/plate system & high strength rapid setting cementitious bedding

PCP Load Transfer – Top/Bottom Slots





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 Fabrication (Current Jointed) –
Reasonably Standard & Routine
6 to 8 panels/day

Forms stripped at ~ 16 hours

The Panel Fabrication Process (Current)

- Prestressed Panels for Jointed PCP

- 15+ panels/day (300+ ft long prestressing beds)

Typically, steam cured – precaster option

Panel Production vs. Installation Rates

- Panel fabrication rate
  - 8 to 10 panels per day (inside plant – jointed)
- Panel installation rate
  - Repair – 15 to 20 repairs/night
  - Jointed continuous – 40 to 50 panels/night (600 to 800 ft)
- So, several weeks (months) of back-log of panels is necessary before installation can begin

NEAR FUTURE EXPECTATIONS

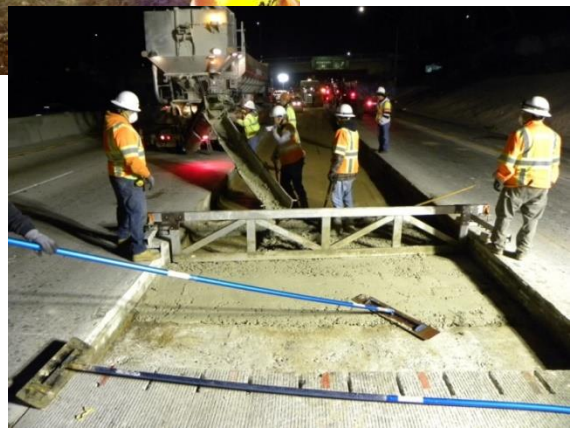
REPAIR APPLICATION – 30 TO 40 REPAIRS PER NIGHT

CONTINUOUS (JOINTED OR PPCP) – 1,000 + FT/NIGHT

Construction Considerations

Base preparation

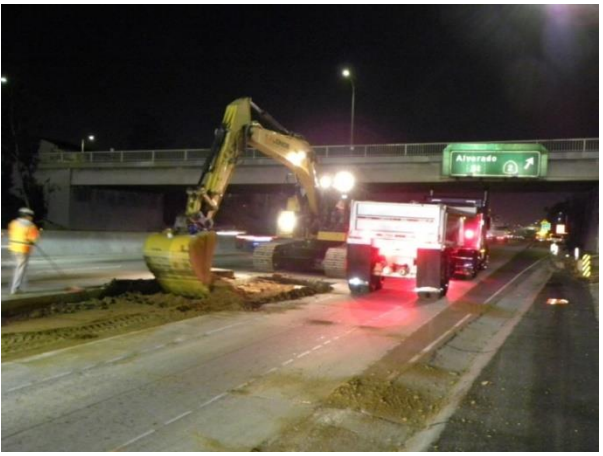
- **Existing bases**
  - **Granular**
  - **ATB**
  - **CTB/LCB**
- **New base**
  - **Granular**
  - **Rapid setting LCB (Mobile Mixture)**

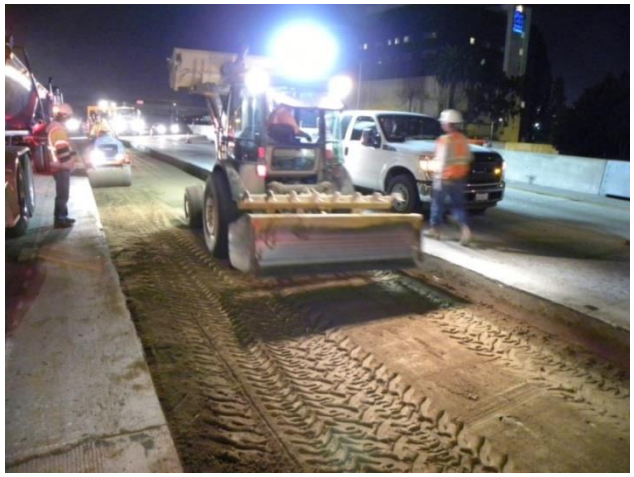


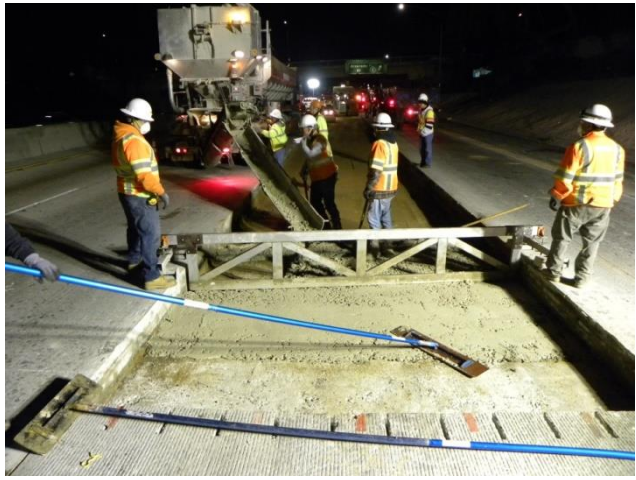
<u>The final base surface should be graded to a smooth finish</u>

- **Panels will be grade-placed over a thin cemented bedding layer, or**
- **Placed over higher strength thicker bedding grout using leveling lifts**

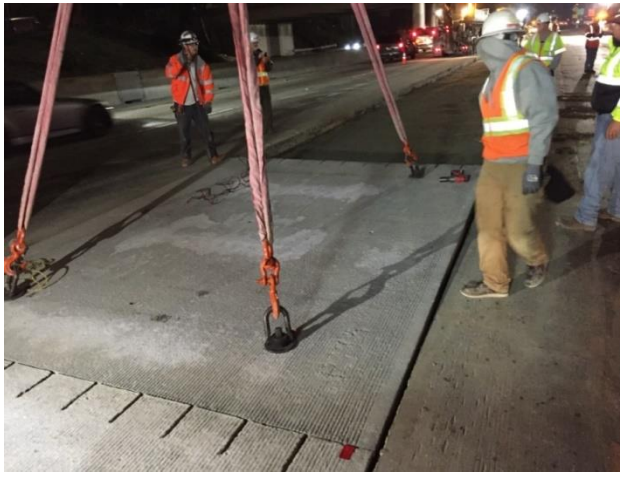
California SH 101 Panel Installation

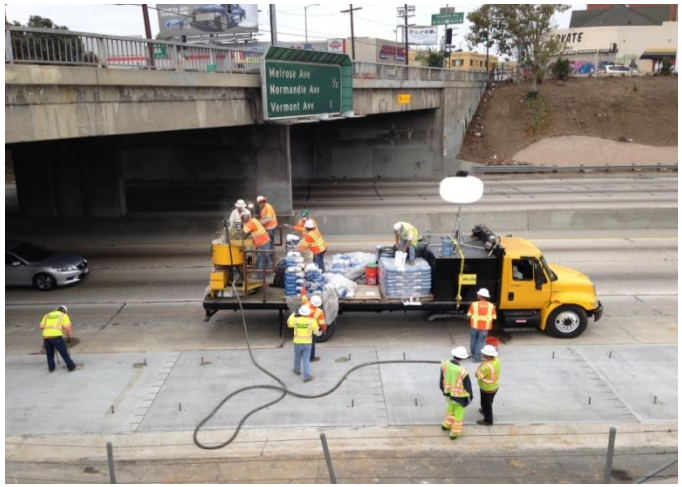


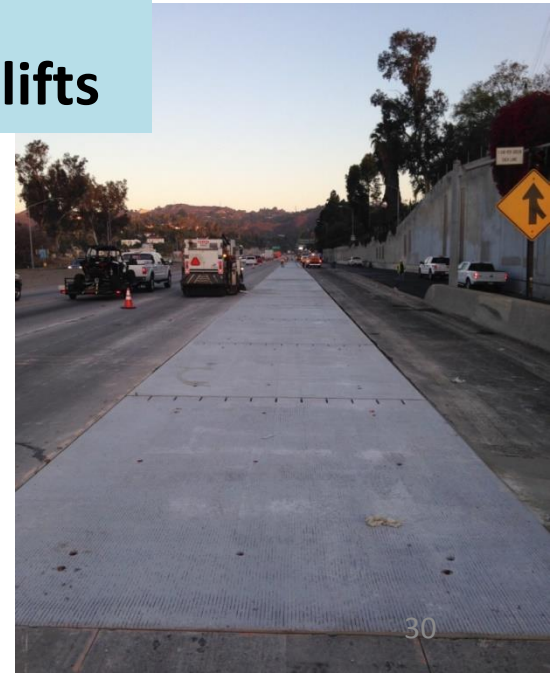




- Weekend nights only; up to 50 panels/night
- New rapid setting Lean Concrete Base; leveling lifts







PCP Performance

- Some early installations exhibited some panel cracking early on but the reinforcement keeps the cracks tight and so no impact on performance
- **No structural performance issues at projects constructed in the last 5 to 10 years with refined PCP systems and installed well**
  - **Good deflection response at joints (low deflections indicating good load transfer across transverse joints)**
  - **Good load transfer = Very low risk of joint faulting**
  - **Grinding and use of grout supported systems result in smooth surface**

PCP Cost

- Cost of implementing/using PCP is NOT high
- In 2001, about $900/sy
- Today (2017), costs range from $350 to $450/sy depending on project size and other logistics
  - So, a 12 ft by 15 ft long panel (20 sy) may cost $7,000 to $9,000 installed
  - For 50 panel installations/night, the price would be $350,000 to $450,000
- More and more, new projects involve hundreds to thousands of panels
- And, with continued innovations and refinements to existing systems, costs are expected to decrease

Summary

- PCP Technology is ready for production implementation and is being implemented on a production basis by many agencies
- Alt… …d, les… constructed PCP systems can be installed rapidly and can be expected to provide long-term service
- This is a ripe area for innovations to improve productivity, efficiencies in design, and reduce cost – well suited for academia & UTC involvement

Thank You!