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Evaluation of Concrete Pavement Repair Using Precast Technology in Virginia

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Purpose and Scope

Repair of Distressed Concrete Pavement

- US Route 60 in Virginia near Jamestown
- Precast Slab without Prestressing
- Difficulties Encountered
- Lessons Learned

New Demonstration Project

- Interstate I-66 in Virginia near Washington, D.C.
- Compare Three Options:
  - Cast-in-place
  - Precast Slab without Prestressing (PCP)
  - Precast Prestressed/ Post-tensioned Slab (PPCP)
- FHWA *Highways for LIFE* demonstration

US 60 Project

US 60 Eastbound - Constructed in 1948

- 9-inch-thick JRCP
- 30-ft joint spacing
- Supported on 6-inch of soil cement

US 60 Project

Fabrication: Off-site

- Six PCP slabs: 12’ x 6’
- 8.5-inch plain concrete (less than old 9-inch)
- Class A3 concrete
  - Air entrained
  - 3000 psi compressive strength (28 days)

3 slabs with dowel bar retrofit

3 slabs with preinstalled dowel

US 60 Project - Installation

- Removal of old pavement and loose soil cement

Precast slab was lifted and placed with an excavator

US 60 Project - Jointing

Pre-installed dowels – 3 slabs

- Three in each wheel path
- Receiving end in existing slab was slotted before placement
- Dowels aligned in the slot –difficulty encountered
- Slots filled with high-strength general purpose Grout
  - 7-day bond strength 1000psi & compressive strength 4000psi

US 60 Project - Jointing

- **Dowel bar retrofit – 3 slabs**
  - Dowel bars were installed in the wheel path after slab placement
  - Old and new slab slotted together
  - Dowel bars were placed and grouted
- **Joints were sealed with silicone over the backer rod**

US 60 Project - Evaluation

Performance evaluation – 2 weeks and 1.5 years

- Visual condition survey
  - Cracks and spalls in the slab and grouted area
- Load transfer efficiency (LTE) – FWD
- Ride quality, IRI – High speed profiler
- Two weeks after construction
- Again at 1.5 years

Concrete Strength

- Compressive strength from two cylinders
  - 27 days: 4,720 psi and 4,706 psi

US 60 Project - Performance

Two weeks after construction

- **Visual condition survey**
  - **Problems with leveling – as much as 1/4th inch**
- **Ride quality – high speed profiler**
  - **Average of 15 to 20 ft surrounding the precast slab**
  - **Average 130 to 270 in/mile for all six slabs**
    - VDOT spec max allowable 110 in/mile for non-interstate roadway
- **Load Transfer Efficiency (LTE) – FWD**
  - **12 to 70 percent**
  - **Five slabs has less than 50% LTE**
- **Dowel bars are not secured properly**
  - **Improper construction practice**
  - **Grout problem**

US 60 Project - Performance

Visual condition survey @ 1.5 years

- Cracks and spalls in grouted area (12 dowels/ slab)
  - Retrofit – 3 slabs
    - Slab 1: 9 of 12 cracked and 6 of 12 spalled
    - Slab 2: 12 of 12 cracked and 0 of 12 spalled
    - Slab 3: 12 of 12 cracked and 9 of 12 spalled
  - Preinstalled – 3 slabs
    - Slab 4: 3 of 12 cracked and 2 of 12 spalled
    - Slab 5: 2 of 12 cracked and 1 of 12 spalled
    - Slab 6: 7 of 12 cracked and 1 of 12 spalled
  - Preinstalled was relatively better than retrofit
- Lack of proper joint between old and new slabs

US 60 Project - Performance

Visual condition survey @ 1.5 years

- **Slab condition (6 slabs)**
  - **Retrofit – 3 slabs**
    - No major slab distress
    - Only one slab has minor edge break
  - **Preinstalled – 3 slabs**
    - Cracks propagated from dowel
    - Mid slab crack in 2 slabs
  - **Dowel misalignment and poor load transfer**

US 60 Project - Performance

Visual condition survey @ 1.5 years

- **Lack of proper joint between old and new slabs**
  - **Silicon joint materials were missing in grouted area**
  - **Sealer surface was depressed up to 1 inch**
  - **Poor load transfer**

Demo on I-66

Three repair options Near Washington D.C.

- **Precast prestressed concrete panel (PPCP)**
  - Four lane 1000 ft section on I-66W near Jermantown Rd
- **Precast concrete panel (PCP)**
  - 2000 ft on right lane of RAMP from I-66W to US 50W
- **Conventional cast-in-place repair**
  - Rest of the ramp (both right and left lanes)

Demo on I-66

I-66: JRCP Constructed in 1960s

- Mid slab cracks, spalls and joint problems

- Thickness
  - On the Ramp: 9-inch-thick
  - On mainline: 9 to 11-inch
- 6-inch of aggregate subbase
- Supported on 6-inch of soil cement

Demo on I-66

FHWA highways for LIFE program

- Received $1 million funding from FHWA
- FHWA technology support

I-66

- $5 million rehab work
- Awarded to be build during this year's construction
- VDOT's NOVA district supervision
- Special provision/ spec
  - Recommendations of AASHTO TIG Lead State Team
- No proprietary system was specified but allowed
- Pre-approval and trial installation required for PCP

Demo on I-66

PPCP

- FHWA technology support
- Prestressed at the plant and post-tension on the job
  - 160 ft post-tensioned with expansion joint
- Two lane at a time to maintain traffic
- Connection with old pavement
  - Dowel bar retrofit with #5 x 30” tie bars @ 16” C/C
  - LTE with FWD > 80%
- Connection between lanes
  - #5 x 30” tie bar with grout-filled mechanical coupler
- Post-tensioning tendon grout
  - Post-Tensioning Institute Spec (Class C grout)
- Diamond grinding
- #10 coarse aggregate – thickness difference

Demo on I-66

Proper connection for PCP

- LTE using FWD > 80%
  - Between old and new slab
  - Between new slabs and lanes
- Fill grout for dowel bar – according to manufacturer's written instruction
- Completeness of fill
  - Inspection of core through dowel bar – at least two

Reinforced precast slab (PCP)

- Max reinforcement 18-inch C/C
- 2-inch minimum cover
- Steel to concrete ratio is 0.0014

Demo on I-66

Allowable dimensional tolerance for PCP

- 1/8 to ¼ th inch

Slab support for PCP

- Precisely graded bedding material
- Cementitious support grout or urethane ploymer grout
- Underslab grouting to fill any isolated small voids
  - Preapproved prepackaged non-shrink grout
  - Follow manufacturer's recommendation
  - Minimum compressive strength 200 psi in 24 hours

Diamond grinding required

Demo on I-66

Evaluation

- Annually
- Visual (or video logging) condition/ distress survey
- LTE with FWD
- Ride quality/ smoothness
- Possible instrumentation
  - Temperature gage
  - Moisture gage
- Traffic control
  - Night time closure only
    - Two lanes on I-66 at a time
    - One lane at a time on the RAMP

Conclusions

- Precast technology another rehab option
  - Workable in limited lane closures
  - Construction problems need to be resolved
- Problems encountered in this limited study
  - Aligning the dowels
  - Consolidating grout around the dowels
  - Poor load transfer
  - Need durable, strong, and non-shrink grout to provide longevity
- Poor ride quality
  - Mainly because of poor joint areas
  - Base leveling issues/ thickness tolerance
- The new demonstration project will document and present information on placement and performance and enable comparison of cast-in-place, precast (PCP), and precast prestressed patches (PPCP)

Thank you!

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