Evaluation of Concrete Pavement Repair Using Precast Technology in Virginia

Shabbir Hossain
Research Scientist

Celik Ozyildirim
Principal Research Scientist

A partnership of the Virginia Department of Transportation and the University of Virginia since 1948
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 preinstalled dowel

3 slabs with dowel bar retrofit
US 60 Project - Installation

- Removal of old pavement and loose soil cement

Approximately 2” of flowable fill

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
Two weeks after construction

• **Visual condition survey**
  – Problems with leveling – as much as 1/4\textsuperscript{th} 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 polymer 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!