West Virginia’s First ABC Deck Replacement Project
Bill Manuel & Johann Aakre  |  10.26.2016  |  HNTB Corporation
Overview of West Virginia Turnpike
West Virginia Turnpike System

Turnpike Facts

- 4 Lane Highway (2 NB & 2 SB)
- I-77 & I-64
- 88 Miles From Princeton - Charleston
- Mountainous Terrain (EL 600 to EL 3400)
- 116 Bridges
- ADT = 39,000
Existing Conditions

- 116 bridge decks that are reinforced concrete slabs
- Average age = 32 years
- Average year built = 1982
- Oldest bridge is 3001 (1977) = 37 years old
- Youngest bridge is 4178 (1996) = 18 years old
- Deck Thicknesses range from 7 ½” – 9”
- 31 bridge decks are fully composite
- 53 bridge decks have lower rebar mat with bare steel not epoxy coated
Bridge Deck History on the WV TPK

Maintenance and Operation History

- TPK started routing and sealing deck cracks in the late 80’s with a two-part epoxy called Equamix
- TPK started overlaying bridge decks with epoxy/aggregate thin overlays in 2006; to date, 36 bridge decks have been overlaid
- TPK began flooding decks with water based sealers in 2010, over 40 decks have been sealed
- Bridge decks from mile 10 to mile 60 receive up to 18,000lbs of salt per bridge per year
GEC Contract

HNTB Provides

- Bridge Inspection
- Design Services
- CE&I Services
Ghent NB Bridge Existing Conditions
Ghent NB - Bridge Facts

- Designed 1972, Constructed 1978
- 3 Spans Supported by Rolled Steel Stringers with a non-composite Deck
- Span Lengths 61.25’- 91.0’ - 61.25’
- Deck Width = 40.5’ – (5.25’ shldr, 2-12’ NB Lanes, 11.25’ shldr)
- 34°-20’-00” Skew
Ghent NB – Existing Deck Conditions

- Deck = 7 ¾” Thick, 8,900 sf
- Bridge deck is 36 years old
- 15% of the bridge deck is compromised
- Deck sufficiency rating of 17% (Bridge Deck Matrix)
- Deck was tested in 2009 (WVDOH Materials division and again in 2013 (Martin Engineering)
- Deck thicknesses measured were 6 ½” – 8” thick
- Compressive strength was measured at 4,900 psi
- Chloride content measured was 15 lbs/cy at 1 ½” deep (note, acceptable levels is < 2 lbs/cy)
- Since the kickoff of the MMS system in July 2011 - 215 sf of deck patched at a cost of $12,000

NOT GOOD, NEEDS REPLACEMENT
# Deck Replacement Considerations

<table>
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<tr>
<th>OPTION</th>
<th>SCOPE</th>
<th>ESTIMATED CONST. COST</th>
<th>DAYS OF LANE CLOSURES (24 HRS/DAY)</th>
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<tr>
<td>1</td>
<td>Non Widening, With ABC</td>
<td>$1,377,000</td>
<td>4</td>
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<td>2</td>
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<td>3</td>
<td>Widening, W/O ABC</td>
<td>$3,190,000</td>
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</table>
Good candidate of ABC deck replacement

• Non-composite: 70% of the TPK’s bridges are W/O shear studs (demolition is easier since time is of the essence)
• Adjacent room at the bridge site for staging
• Utilize existing roadway alignment with only minimal deviation
• Road User Cost > $12,000
• Minimize traffic disruption
ABC Deck Replacement Alternatives
Accelerated Bridge Construction (ABC)
ABC is bridge construction that uses innovative methods to reduce mobility impacts when replacing/rehabilitating existing bridges.

Full Depth Precast Concrete Deck Panels
Discretize bridge deck into precast units so that a majority of concrete and rebar placement is completed in advance off site in a controlled environment.

Advantages:
-Time savings
-More durable
-Safety
Precast Concrete Deck Panels
Emulate Cast-in-place Deck

- Continuous Slab → Panel to Panel Connections
- Composite Slab → Panel to Girder Connections
- Geometric Profile → Overlay or Grinding
Panel to Girder Connection

Setting & Leveling

Composite Connection

Haunch Material
Panel to Panel Connection: Longitudinally Post-Tensioned or Jacked

**Match Cast**
- Polyurethane sealant
- 1/16" Neoprene sheet

**1" Grouted Connections**

- Min 200 psi prestress required across transverse joints from post-tensioning
Panel to Panel Connection: Mild Reinforcement with Closure pours

- **Narrow Width**
  - UHPC

- **Intermediate Width**
  - Rapid Set Concrete

- **Larger Width**
  - Rapid Set Concrete

![Diagram of panel connections](image)
Stage DOT’s with Deck Panel Standards

• Post Tensioned Panels
  • MassDOT
  • PennDOT
  • Utah DOT

• Panels with Closure Pours
  • Oregon DOT
  • Florida DOT
  • New York State DOT
ABC Project Scoping
Conceptual Design

- New or Rehab/Replacement
  - Rehab
    - Bridge Survey
    - Bridge Load Rating

- Precast Deck Technology Selection
  - Overlay Selection
  - Closure Pour Material
  - Expansion Joint Selection
  - Use of PT or Prestressing
  - MOT Staging for ABC
ABC Deck Replacement Scoping

Project Objectives & Site Conditions drive Technology Selection

• Desired Duration:
  • 2 weekend single lane closures
  • 1 week Single lane closure (Sunday 9pm – Saturday 6am) 129 hours

• Site Conditions – Good Crane Access & Storage Areas

• Demolition – Cut & Lift Out

• Deck Construction
  • Panel to Girder ➔ Shear Pockets with Stud Clusters
  • Panel to Panel ➔ Rapid Set Concrete Closure Pours
  • Overlay ➔ Asphalt with waterproofing membrane
Deck Panel - Design Process
Preliminary Design - Staging

Stage 1: ABC - Removals

Stage 2: ABC - Construction
Preliminary Design - Staging
**Preliminary Design: Panel Layout - Constructability**

**Crane Placement**

- Assess site
- Crane Reach vs. Panel Weight

**Panel Layout**

- Set Panel Sizes (repetition, weight, transport)
- Special Panels
Panel Design

Bridge Rating & Analytical Model

Change in State
- Deck Thickness 7 ¾” → 8 ½”
- Non-Composite → Composite

Bridge Rating
- Larsa 4D Steel Bridge Module

Analytical Model Results
- Shear Forces → Stud Design
- Staged Deflections → Haunch Preset
Deck and Deck Panel Design

1. Final Design = Traditional CIP Deck Design
   • Strength, Service & Extreme Event at Overhang

2. Erection and Constructability Considerations
   • Lifting Locations and Erection Stresses
Lifting Locations and Erection Stresses

PCI Design Handbook: $\gamma f_a < f_r/1.5$, where load factor $\gamma$ is typically 1.25
Panel & Closure Pour Reinforcement

- Epoxy Coated Bars within Panel
- Galvanized Bars in Closure Pours
- Rapid Set Concrete Closure Pour
  - 3 hour 3,200 psi
  - 1 day 4,500 psi
  - 28 day 7,000 psi
Plan Details – Unique to ABC

- Panels
  - Panel Layout
  - Panel Details
  - Connection Details
  - Haunch Forming

- Constructability
- ABC Timeframe
- Disincentives
- Pay Items
  - Dismantling Structure – Existing Bridge Deck Rem (LS)
  - Rapid Set Concrete Closure Pour (CY)
  - Spray Applied Waterproofing Membrane (SY)
  - Galvanized Reinforcing Steel Bar (LBS)
  - 8 ½” Precast Concrete Deck Panel (SF)
  - (Class K Concrete) – (CY)
Letting Process
Letting

**Pre-Bid**
Pre-bid meeting conducted to inform contractors about the project.

### 3 Bidders

<table>
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<tr>
<th>Entity</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Engineers Estimate</td>
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<tr>
<td><strong>Orders Construction, Inc</strong></td>
<td><strong>$2.38M</strong></td>
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<td>Braymen Construction, Inc</td>
<td>$2.73M</td>
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<tr>
<td>Triton Construction, Inc</td>
<td>$2.84M</td>
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**General Contractor**
![Orders Construction Company Logo](Orders.png)

**Precaster**
![Foster Supply Logo](FosterSupply.png)
Pre-ABC Construction
Proposed Changes By Contractor

• **Waterproofing Membrane** – Peel-n-stick as opposed to the spray applied at a $50k credit. Rejected by the TPK.

• Steel barrier instead of concrete barrier. Increase Pin spacing from 4’ to 25’ approx. 25’ instead of 4’ o.c.

• All deck panels used threaded inserts for the headed bars instead of being a solid piece.

• Haunch Material - Neoprene compression material vs. EPS foam board.
Deck Panel Casting
ABC Construction
Full Depth Precast Concrete Deck Panel Features
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Time Lapse – May 1 to May 11, 2016
Lessons Learned

- Weather
- Waterproofing Weep Holes
- Asphalt Plug Joint
Future of ABC with WV TPK

- Ghent SB – Scheduled for spring or fall of 2017

- North Beckley Interchange Southbound – Schedule for the spring or fall of 2017

- Plan is to replace 2 – 4 decks per year using ABC until ALL decks have been replaced.
Thank You & Questions