PA Report on Innovative Bridge Designs for Rapid Renewal

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Overview

- Rapid Renewal/ABC background in Pennsylvania
- ABC highlights (types, standards, detour, RULD's, prefab elements, connections)
- Summary of ABC Bridges done recently and in the near future
- Three projects (built in 30 days or less)
Rapid / ABC History in PA

- Incentives/Disincentives/RULD's (Road User Liquidated Damages)
- 1980’s – P/C decks
- 1990’s - Inverset (steel I-beams with P/C Concrete deck)
- 2000’s P/C abutment systems, P/S beams, pier caps, District 6 (Phila) RR truss launch over I-76
- 2012 – 2014 full pre fab/ precast elements built in thirty days or less
- P3 (Public-Private Partnership Project)
Rapid / ABC History in PA

- Pennsylvania has no ABC policy
- We started out using incentives/ disincentives/ RULD's
- Bridges getting done fast but we paid extra dollars and contractors weren’t always getting done early (asking for and getting extensions). We still use A + Bx bidding, lane rental with incentives/ disincentives with limited delay penalties and overall project penalty.
Recent ABC Development

• Geosynthetic Reinforced Soil (GRS) Abutments
  – PennDOT guidelines issued July 2014
  – Ok for low volume road
• Precast/prefab - all elements
  – P/C substructure standards developed by CABA (Central Atlantic Bridge Alliance) approved by PennDOT March 2013
  – P/C Deck standards created & approved by PennDOT Nov 2014
GRS Abutments

Built in 2 months by contractor

Built in 2 months by Department forces
GRS Abutments

- **Beam Seat**
  (Supported Directly on Bearing Bed)

- **Jointless**
  (Continuous Pavement)

- **Integrated Approach**
  (Geotextile Wrapped Layers at Beams to Form Smooth Transition)

- **Facing Elements**
  (Frictionally Connected — Top Three Courses Pinned and Grouted)

- **Bearing Bed Reinforcement**
  (Load Shedding Layers Spaced at ≤ 6 in.)

- **Scour Protection (Rip Rap)**
  (If Crossing a Water Way)

- **GRS Abutment**
  (Reinforcement Spacing ≤ 12 in.)

- **Reinforced Soil Foundation**
  (Encapsulated with Geotextile)
GRS Abutments

Backfilling Geotextile

Finished Abutment
Precast Elements – Early Concept

- Precast footing, abutments, moment slabs, prestress beams, conventional deck, 21 days non-comp., 6 weeks to do a traditional deck or a day to do an asphalt overlay
- Match-cast, post-tensioned, precast concrete footing and wall panel components
- No moment connection between wall and footing pieces (footings sized to resist vertical loads only)
- Avoided MSE wall or proprietary items
- Multi-level interconnected grid of galvanized steel chains for abutment unit self-stabilization
- GRS backfill to eliminate lateral load on wall panels
- Scour cutoff wall panel for stream environment
Precast Components

- 8.5’ Max – Shipping Panel Width
- Minimize Weight
- Repetitive Panel Sizes
- Match Casting
- Mostly Table Formwork
Precast – All Elements

- TEKLA 3-D Model – Fabricator (Newcrete)
- Complete Bridge with Moment Slabs
- 3D very helpful in how all pieces fit together resolves interferences
Precast Substructure

- Instrumentation
- Geodetect Strip – check movement of GRS fabric
- Earth Pressure Cell – to see if Geogrid was reducing load on wall panels

Preformed Cellular Polystyrene to Absorb Lateral Deformation of Backfill
Precast Superstructure

- Plank beam (non-voided)
- Deepened shear key
- Epoxy mortar shear key grout (11-12 ksi)
- Add’tl transverse PT

- Two layers of waterproofing on long. jts and FJ overlay with membrane curb to curb
- Drain tubes in membrane to curb
- P/C barrier on fascia cast in shop
Completed in 21 Days
Total Precast Bridge - VE

116 ft. Span  31’-4” Width
Total Precast Bridge - VE

- Match-cast P/C P/T footing and wall panel components
- Grouted coupler splice connections for footing-to-stem vertical reinforcement bar continuity. 11 ksi @ 28 days strength
- Deck panels one-half width of bridge -- 12’ +/- in length.
- Ultra High Performance Concrete (UHPC) used in transverse and longitudinal closure pours.
- Following completion of transverse closure pours, panels post-tensioned in longitudinal direction to achieve 250 psi compression.
- Leveling bolts used for grade adjustment and load distribution.
- Epoxy grout used to fill beam haunches and shear pockets.
Total Precast Bridge - VE

- 1 Wall Panel per Wing Wall
- Corner Transition
- Splice Sleeves for Vert Reinf Continuity
- 2 Wall Panels per Abut Breast Wall 15' High
- 3 Segments per Abut Footing
- Transverse Post-Tensioning Duct

30.4 T, 18.9 T, 22.2 T, 29.2 T, 21.9 T, 24.8 T, 36.0 T, 39.4 T, 33.0 T, 31.5 T, 34.9 T, 36.0 T, 39.4 T, 33.0 T, 34.9 T, 18.5 T
Total Precast Bridge - VE

- Barriers Integral w/ Deck Panel
- Shear Pockets (Typ over Bms)
- UHPC Longitudinal Closure Pour
- P/T Ducts

Left Deck Panel
Right Deck Panel
Total Precast Bridge - VE

ABUTMENT FOOTING INSTALLATION
Total Precast Bridge - VE

ABUTMENT WALL INSTALLATION
Total Precast Bridge - VE

PRECAST DECK PANELS

- Post-tensioning duct
- Horizontal Shear Reinf Projecting from P/S Bulb-T Beams
Total Precast Bridge - VE

PRECAST DECK PANELS
UHPC Closure Pours

Leveling bolt

Transverse Joint Profile

Transverse Closure Pour

Haunch Formwork
PRECAST DECK PANELS
Epoxy Grout in Beam Haunches & Shear Pockets
Total Precast Bridge - VE

Completed Project
54 Calendar Days
contract commitment
could have opened sooner
Integral Abutment ABC Bridge

- SR 288, single lane condition. 78’ span, 35’-3” width
- A + Bx Bidding Used
- $36,000/day Incentive/Disincentive
- Pre-Cast Fabrication of Pile Caps, Three (3) Two-Beam Deck Modules, Wing Walls & Approach Slabs
- Pick weights <118K using LW concrete and steel I beams
- Ultra High Performance Concrete closures
- Integral Abutments.
- Goal was to construct in 17 days. Contractor bid 9 days. Actually finished in 7 days.

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Integral Abutment ABC Bridge

Pennsylvania Department of Transportation
Integral Abutment ABC Bridge

- Pre-Cast Backwall
- Grouted Splice Couplers
- Grout
- Shear Studs
- Corrugated Metal Pipe
- Steel H-Pile
- Pre-Cast Pile Cap
- HP 12x74
- Steel Angle
Integral Abutment ABC Bridge
Integral Abutment ABC Bridge

- Deck Module with Attached Barrier
- Deck Module
- Deck Module with Attached Barrier

- Field Cast Ultra High Performance Concrete Connection

- Architectural Surface Treatment

- W36 x 170 Steel Rolled Beam
Beam-Deck Modules were Set in 3 Hours
Integral Abutment ABC Bridge

Ultra High Performance Concrete

11”

8”

#5

#5

pennsylvania DEPARTMENT OF TRANSPORTATION
Integral Abutment ABC Bridge

Approach Slabs
Integral Abutment ABC Bridge

UHPC Pour

Fiber Board
Integral Abutment ABC Bridge

Segregation Check

7-10” Desirable – actual 9.4” average
Integral Abutment ABC Bridge

- Pre-closure - Most piles placed (centerline shift)
- Day 1 - Demo
- Day 2 - Placement of remaining integral abutment piles
- Day 3 - Placement of abutment cap, cheekwalls and wings
- Day 4 - Place 2 beam deck modules
- Day 5 - Placement of sleeper slabs, approach slabs and leveling approach slabs
- Day 6 - Pour UHPC Joints
- Day 7 - Attach guiderail and pave approaches
- Days 8 & 9 (30 days later) - Place epoxy overlay and finish staining barrier
Integral Abutment ABC Bridge
Upcoming Projects

- 6 Bridge Replacements over I-78 (Incent/Disincent)
  - 2 higher ADT I/C bridges with 30 day max
  - 4 others with 60 day max
  - Currently advertised for bidding (bid open 9/17)

- 1-span Integral Abut replacement with full closure from Fri PM to Mon AM
  - Piles driven beforehand under flagging
  - Using P/S NEXT beam sections
Corridor with substandard underclearance over Interstate
I-78 Underclearance

Using P/S beams with P/C Deck panels
Include longitudinal UHPC closure for wider decks
I-78 Underclearance

• All precast elements must be dry-fit prior to leaving yard to ensure fit-up in field
• Allowed single-lane conditions and 15-min interval shutdown of Interstate off-peak to place overhead elements
• Currently advertised for 3rd time (bid open 9/17)
  – Bids high in 1st attempt (quick 2015 construction)
  – Bids high & temp runarounds in 2nd attempt – no go
  – Contractors may be unfamiliar/reluctant
  – Fabricator availability (& effort?)
  – Higher risk
Future Use of ABC

- Where traffic restrictions are problematic
- Where RR flagging is extensive
- Where costs for ABC have smaller premium
- Foresee using the beam-deck module approach, as well as the precast deck with shear pockets
- P3 project just starting construction – will see what approaches they use
Thank you!