Agenda

Project Overview
HAM-50-1903R Overview
Design & Construction Challenges
  - Superstructure
  - Utilities
  - Substructure
Conclusion + Q&A
Two projects proposed adjacent to each other on U.S. 50

- ODOT sponsored HAM-50-19.03
  - Bridge rehab project, several US 50 structures involved

- City of Cincinnati sponsored HAM-50-18.79
  - Waldvogel Viaduct Replacement
  - Major rehab with new roadway alignment, multiple major structures, many curved girders.

Projects were combined into a single project to reduce possibility of conflicts between adjacent contractors, primarily a MOT issue.
HAM-50-1903R (Existing Conditions)

- 10 Variable Spans (74’ – 150’)
- Variable Skews (>45°)
- Compound Curves
HAM-50-1903R (Existing Conditions)

- RR Coordination
- Mill Creek

HAM-50-19.03 and HAM-50-18.79 Bridge Design and Construction Challenges
HAM-50-1903R (Existing Conditions)

- Utilities - 24” Water Main
- 72” Concrete Liner
Purpose:

- Roadway Continuity
- Widening for Additional Inside Lane/Shoulder
Purpose:
- Widening for Additional Inside Lane/Shoulder
Purpose:
- Composite Construction
Proposed Horizontal Alignment

- Reverse Curvature
- Tangent
HAM-50-1903R : Design Challenges

Proposed Horizontal Alignment
- Superelevation Transitions
HAM-50-1903R : Design Challenges

Proposed Horizontal Alignment
- Excessive & Variable Haunch Thickness
HAM-50-1903R : Design Challenges

Proposed Framing - Example

Deck Edge
HAM-50-1903R : Design Challenges

Deck Edge

Prop. Girders

END DIAPHRAGM STA. 2+68.64
3.71' LT.

7'-5" 

2 SPACES @ 15'-0" = 30'-0"

6'-5"

93°22'12"
(SEE NOTE 13)

45°6'

90°00'00"
(TYP. GBR)

45°47/8'

REFERENCE CHORD A

REFERENCE CHORD B

EXISTING PLATE GIRDERS (TYP.)

END CROSSFRAME (TYP.)
Cantilevered Diaphragms – 7/16” Bent Plate
HAM-50-1903R : Design Challenges

Proposed Framing – Constructability Issues

- **Diaphragm Erection**
  - Access
  - Equipment

- **Torsional Effects**
  - Torsional Stresses
  - Out-of-Plane Bending
    - Fatigue

- **REVISE PROPOSED FRAMING**
HAM-50-1903R : Design Challenges

Revised Framing

Deck Edge

Prop. Girders

Ex. Brg. Reused

Ex. Girder Removed
HAM-50-1903R : Design Challenges

Revised Framing
HAM-50-1903R : Design Challenges

Revised Framing
HAM-50-1903R : Design Challenges

Proposed Framing

Right Horizontal Curvature

Left Horizontal Curvature
HAM-50-1903R : Design Challenges

Waterline – Straddle Pier Solution
Pier 5AS and 6S
Substructures
Cofferdam Installation

- Contractor designed PZC 18 braced cofferdams at both pier locations.
- Both pier locations had to extend over existing footing (bowtie)
- Numerous obstructions encountered during sheeting installation.
- Change order for approximately $2.2M to remove obstructions for sheeting installation.
- Divers were used to locate obstructions and place material to seal sheeting.
$500,000 Sixth Street Viaduct Dedicated
SPAN ACROSS MILLCREEK AND RAILROAD

Looking East Frontwards

TO OPEN NEW VIADUCT TOMORROW

1940 Bridge Structure
Pier 5AS

Sheeting Installation – Summer/Fall 2012
Pier 5AS
Pier 5AS Exposed Footing

January 2013
Winter / Spring 2013 Flooding
Pier 5AS

May 2013 Sheeting Movement
Sheeting Modifications

- Additional Walers Installed
- Sheeting Joints Reinforced
Pier 5AS

Flash Flooding – July 2013
Pier 5AS

Sheeting Distress – August 2013

- Work Stopped
- Lower Waler Bowed in Weak Axis
Pier 5AS Cofferdam Distress

Sheeting Distress – August 2013
Pier 5AS and 6S Redesign

- Leave sheeting in place for long-term protection
- Seal the cofferdams with a concrete tremie seal
- Support the footing on micropiles 15’ into rock
- Raise the bottom of footing elevation
- Pier 5AS: 30 micropiles, 63 ft. long
  - (48’ cased + 15’ rock socket)
- Pier 6S: 24 micropiles, 62 ft. long
  - (47’ cased + 15’ rock socket)
- Total micropile length = 3,378 ft.
Micropile Plan View (Pier 5AS)
Typical Micropile Pier Detail (Pier 5AS)
Tremie Pour

Pier 5AS – Nov 2013
Pier 6S- Dec 2013
Installation of Guide Sleeves

- Permitted Use of Large Drilling Equipment on Top of Cofferdam
- More Efficient Production
- 12” Diameter
Backfill around Sleeves

Pea Gravel Utilized to Create Working Platform
Drilling of Micropiles

- 9-5/8” Diameter Casing
- 0.435” Wall Thickness
- 15 ft. Rock Socket (8”)
- #11 DYWIDAG bar centered
- 4,000 psi grout

Pier 5AS = 30 piles
Approximately 63 ft.
1,890 ft. Total

Pier 6S = 24 piles
Approximately 62 ft.
1,488 ft. Total

Total Micropile Length
3,378 ft.
Drilling of Micropiles

Drilling Occurred Feb – April 2014

- Temperature & Flooding Delays
Micropile Testing

- Pre-Production Verification Testing (1 per Pier)
- Proof Test (3 at ea. Pier)

Design Loads
- 5AS = 84 kips
- 6S = 105 kips
Spring Flooding April 2014
Finished Product
Completion of Piers

- Placed Pea Gravel above Footing
- Capped with Geotextile Fabric
- Placed RCP over Geotextile
- Finished Columns July 2014
Pier 6S Complete
Flooded March 2015
Piers 5AS & 6S Timeline

- June 24, 2012 – Started Pier 5AS Cofferdam.
- January 2013 – Pier 5AS exposes old footing.
- May 2013 – Sheeting distress observed.
- August 2013 – Work stopped due to sheeting concerns.
- December 2013 – Tremie seals poured.
- February – April 2014 – Micropiles installed.
- May – June 2014 – Pier footings and columns complete.
- Bridge opened 31 days past scheduled date. – Dec 2014
Cost Summary

- Sheeting obstruction removal = $2.2M
- Additional cost to modify Piers 5AS and 6S to micropiles = $1.62 M
- Micropile cost = $475 per foot (with tremie seal)
- Additional Sheeting left in place = $125,000
- Project schedule was significantly impacted by flooding as well as footing re-design.
- Painting and sealing of the structure non-performed under this contract to save overhead costs.
- Second contract let in June 2015 to complete work.
Conclusions

**Constructability Addressed**
- Torsion Concerns
- Out-of-Plane Bending

**Mill Creek**
- Subsurface Investigations
- Identify Buried Obstructions

**Micropiles**
- Structural & Cost-Effective Alternative