Road 17C Bridge Over Miami & Erie Canal

Beauty and Function on the Buckeye Trail
PRESENTED BY:

R. Christopher (Chris) Homan, PE
Senior Project Manager, The Mannik & Smith Group, Inc.

QUESTIONS & ANSWERS:

Travis L. Rhoades, PE
Structural Team Leader, The Mannik & Smith Group, Inc.

Jeffrey L. Snyder, PE
Geotechnical Group Manager, The Mannik & Smith Group, Inc.
PRESENTATION AGENDA

- Introduction to Project
- Project Specifics
- Hydraulic Design
- Geotechnical Design
- Plan Details (ABC Concepts)
- Construction
INTRODUCTION TO PROJECT

Project Location

Florida, Ohio
Client: Henry County Engineer

- Randolf L. Germann, PE, PS, County Engineer (Retired)
- Timothy J. Schumm, PE, PS, County Engineer (Current)
INTRODUCTION TO PROJECT
(AERIAL OF SITE)
INTRODUCTION TO PROJECT

Purpose

• Replace Aging Structure (planned for replacement)
• Located on Buckeye Trail (crosses old Miami & Erie Canal)
• Aesthetic Structure Desired (stone arch look with “canal” features)
• Improved Pedestrian Accommodations
• School Bus Route
• Primary Crossing for Business Commuters
INTRODUCTION TO PROJECT

Before & After
Primary Design Considerations

- AASHTO LRFD HL-93
- Culvert Design Preferred (for aesthetics) w/ Sidewalks
- Maumee River Hydraulic Effects (does canal or river govern)
- Geotechnical (old canal bed)
- Detour Route Length (approx. 17 miles – 2 alt. routes)
- Construction Time Constraints (summer only)
- Accelerated Bridge Construction (ABC) - a must!
Replacement Alternatives Studied

- Alt. 1 - Modified 3 Sided Arch Top Culvert
- Alt. 2 – Three (3) Sided Flat Top Culvert (2 span option)
- Alt. 3 – Long Span Arch
Alternatives Studied
Alt. 1 - Modified 3 Sided Arch Top Culvert (Preferred)
PROJECT SPECIFICS

Alternatives Studied

Alt. 2 – Three (3) Sided Flat Top Culvert (2 span option)
PROJECT SPECIFICS

Alternatives Studied
Alt. 3 – Long Span Arch
Preferred Alternative
Alt. 1 - Modified 3 Sided Arch Top Culvert (Chosen)

Table 1. Construction Time

<table>
<thead>
<tr>
<th>Structure</th>
<th>Time (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1 – Modified Three (3) Sided Arched Top Culvert</td>
<td>45</td>
</tr>
<tr>
<td>Alternative 2 – Three (3) Sided Arched Top Culvert</td>
<td>60</td>
</tr>
<tr>
<td>Alternative 3 – Long Span Arch</td>
<td>90</td>
</tr>
</tbody>
</table>

Table 4. Cost Analysis

<table>
<thead>
<tr>
<th>Structure Alternative</th>
<th>Total Anticipated Cost without Cost Savings to the Traveling Public</th>
<th>Total Anticipated Added Cost to the Traveling Public</th>
<th>Total Anticipated Costs with Savings to the Traveling Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1 – Modified Three (3) Sided Arched Top Culvert</td>
<td>$746,193</td>
<td>$0</td>
<td>$746,193</td>
</tr>
<tr>
<td>Alternative 2 – Three (3) Sided Arched Top Culvert</td>
<td>$655,598</td>
<td>$135,150</td>
<td>$790,748</td>
</tr>
<tr>
<td>Alternative 3 – Long Span Arch</td>
<td>$839,179</td>
<td>$405,450</td>
<td>$1,244,629</td>
</tr>
</tbody>
</table>
## Bid Tab Results
Alt. 1 - Modified 3 Sided Arch Top Culvert (Planned Build)

<table>
<thead>
<tr>
<th></th>
<th>Engineer’s Estimate</th>
<th>Contractor 1</th>
<th>Contractor 2</th>
<th>Contractor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL</strong></td>
<td>$667,500</td>
<td>$745,580</td>
<td>$716,237</td>
<td>$668,336</td>
</tr>
</tbody>
</table>
Actual Construction Time
Maumee River Frequently Flooded in 2015 Until Mid-July!

- Begin Construction 6/4/15
- Opened to Traffic 8/11/15 (end of day) – 68 days (*)
- Project Completion 9/12/15 (conc. staining, sealing, etc.) – Total 100 days

(*) high water affected construction duration
 Pictures From 6/30/2015 (Nearby in Napoleon)
 Maumee River Frequently Flooded in 2015 Until Mid-July!
PROJECT SPECIFICS

Pictures From 6/30/2015 (Nearby in Napoleon)
Maumee River Frequently Flooded in 2015 Until Mid-July!
Gage Reading From 6/30/2015 (Nearby in Napoleon)
Maumee River Frequently Flooded in 2015 Until Mid-July!

**Latest observed value:** 14.35 ft at 12:30 PM EDT 30-Jun-2015. Flood Stage is 12 ft.
Hydraulic Design Considerations

- Determine the Drainage Area of the canal (USGS StreamStats does not recognize the canal separately from the river)
- Maumee River Hydraulic Effects (does canal or river govern)
- Downstream dam
- Modeling a 180+ year old canal with no plans, LIDAR data, and a few cross sections
HYDRAULIC DESIGN – DRAINAGE AREA
Hydraulic Modeling

- Using a combination of LIDAR data and the limited cross sections taken near the bridge a 8,100 foot long model was created stretching from a point approx. 1,500 feet upstream of the bridge to the confluence of the canal and river approx. 6,600 feet downstream.

- A previous MSG project had surveyed the downstream dam and was imported into the model after a “QA/QC survey” was performed to confirm to elevation of the dam and the depth of the canal behind the dam.
Hydraulic Modeling

- Modeled the existing canal with only the drainage area and determined that the Maumee River controlled.

- The Maumee River 100-YR Flood overtops the canal/river separation bank and the dam (8’+) and controls flow in the canal.
HYDRAULIC DESIGN – FINAL RESULT

BRIDGE LIMITS = 59’-4"

SPAN = 57’-0"

\[ HW_{100\text{ YR}} = 664.36 \]

\[ HW_{25\text{ YR}} = 658.48 \]

\[ HW_{OHH} = 656.83\pm \]

\[ BOT.\ OF\ CANAL\ EL.\ 655.10\pm \]

\[ HW_{2\text{ YR}} = 657.11 \]
GEOTECHNICAL DESIGN

BORING LOCATIONS

- B-001-0-13
- B-002-0-13
GEOTECHNICAL DESIGN

B-001 SUBSURFACE CONDITIONS

Elev. 672
Stiff to Very Stiff A-6a
\( N_{60} = 9 \) to \( 20 \) blows per foot (bpf)
\( PP = 1.5 \) to \( 4.0 \) tsf

Elev. 657
Very soft to medium stiff A-6a
\( N_{60} = 0 \) to \( 8 \) bpf
\( PP = 0.25 \) to \( 2.0 \) tsf

Elev. 649.5
Loose A-3a
\( N_{60} = 4 \) to \( 5 \) bpf

Elev. 644.5
Medium dense A-1-b
\( N_{60} = 14 \) to \( 35 \) bpf

Elev. 639.5
Very dense A-1-b
\( N_{60} = 100+ \) bpf

Refusal @ Elev. 637.7
B-001 SUBSURFACE CONDITIONS

Elev. 672
Stiff to Very Stiff A-6a
$N_{60} = 9$ to 20 blows per foot (bpf)
PP = 1.5 to 4.0 tsf

Elev. 657
Very soft to medium stiff A-6a
$N_{60} = 0$ to 8 bpf
PP = 0.25 to 2.0 tsf

Elev. 649.5
Loose A-3a
$N_{60} = 4$ to 5 bpf

Elev. 644.5
Medium dense A-1-b
$N_{60} = 14$ to 35 bpf

Elev. 639.5
Very dense A-1-b
$N_{60} = 100+$ bpf

10 feet undercut needed for shallow foundations
**B-002 SUBSURFACE CONDITIONS**

- **Elev. 671.5**
  - Loose A-4a
  - $N_{60} = 5$ bpf

- **Elev. 667**
  - Medium Stiff to Very Stiff A-6a
  - $N_{60} = 7$ to 17 bpf
  - PP = 1.5 to 4.0 tsf

- **Elev. 657**
  - Very loose to loose A-4a
  - $N_{60} = 4$ to 7 bpf

- **Elev. 652**
  - Medium dense A-4b
  - $N_{60} = 14$ bpf
  - Very dense A-1-b
  - $N_{60} = 75$-100+ bpf

- **Elev. 648.5**

**Refusal @ Elev. 642.8**
5.5 feet undercut needed for shallow foundations

B-002 SUBSURFACE CONDITIONS

- **Elev. 671.5**
  - Loose A-4a
  - $N_{60} = 5$ bpf

- **Elev. 667**
  - Medium Stiff to Very Stiff A-6a
  - $N_{60} = 7$ to 17 bpf
  - $P_{60} = 1.5$ to 4.0 tsf

- **Elev. 657**
  - Very loose to loose A-4a
  - $N_{60} = 4$ to 7 bpf

- **Elev. 652**
  - Medium dense A-4b
  - $N_{60} = 14$ bpf

- **Elev. 648.5**
  - Very dense A-1-b
  - $N_{60} = 75-100+$ bpf
FOUNDATION DESIGN ISSUES

• Shallow foundations not feasible due to relatively deep undercuts – excavation shoring issues

• Driven piles are preferred foundation type for compatibility with arch bridge system

• However, vibration is a concern due to nearby residential structures

• Very large lateral loads – approx. 73% of the vertical loads
• Refusal in very dense soils likely would result in short piles of less than 15 feet
• Battered piles needed to resist large lateral loads
• FHWA minimum required pile length for battered piles is 15 feet
• 12-inch CIP closed-end pipe piles driven to refusal (on bedrock) in prebored holes selected to support bridge
• Prebored depth of 5 feet minimum into very dense soils
• Widening of bridge results in new fill placed – possible downdrag concerns with settlement
• Settlement evaluation revealed less than 0.4 inches settlement, no downdrag anticipated
• Piles proposed to be driven approx. 25’ to refusal on bedrock
Specifications

• Non-Proprietary General Notes for Precast System
• Required Complete Culvert Package w/ Load Rating w/ PE Seal
• Required “close conformity” to Dimensions/Shape Shown in Plans w/ Engineer (County) Approval of Shop Plans:

SHOP DRAWING SUBMITTAL

PREPARE SHOP DRAWINGS FOR THE FOLLOWING ITEMS:

ITEM 602 - MASONRY, MISC.: PRECAST REINFORCED CONCRETE FOOTING/PILE CAP
ITEM 602 - MASONRY, MISC.: PRECAST REINFORCED CONCRETE WINGWALL
ITEM 602 - MASONRY, MISC.: PRECAST REINFORCED CONCRETE HEADWALL
ITEM 611 - CONDUIT, MISC.: TYPE A REINFORCED CONCRETE BRIDGE CULVERT SECTIONS, (57'-0" SPAN X 10'-8" RISE)
ABC Specifications (in addition to precast items)

- High Early Strength Concrete Specified for Footing Voids, Sidewalks, Railings/Parapets, Curb & Gutter
- 0.90 Design Strength Specified Within 7 Days

**BRIDGE CONSTRUCTION SEQUENCE**

1. FABRICATE PRECAST SECTIONS (FOLLOWING APPROVAL OF SHOP PLANS)
2. CLOSE ROAD 17C
3. REMOVE EXISTING BRIDGE
4. EXCAVATE FOR NEW STRUCTURE
5. DRIVE PILES
6. SET PRECAST FOOTINGS (ALLOW FOR SPECIFIED DESIGN STRENGTH TO BE ATTAINED)
7. SET PRECAST CULVERT SECTIONS
8. SET PRECAST WINGWALLS
9. POUR FOOTING CONCRETE (FILL VoidS)
10. INSTALL BACKFILL (PARTIAL)
11. SET PRECAST HEADWALLS
12. COMPLETE BACKFILL
13. INSTALL CURB AND GUTTER & ROADWAY
14. INSTALL SIDEWALKS/Parapet/RAILING
15. OPEN ROAD 17C
Lesson Learned

- Precast Footing Dimensions & Pile Spacing
- “Rib” Spacing not Compatible w/ Precast Culvert Lengths (support needed)
Final Product

- Contractor Vernon Nagel, Inc. – Subcontractor/Supplier of Precast System by Contech Engineered Solutions LLC (Con/SpanO-Series)
- Very Detailed Shop Plans Submitted (important for construction)
- Cast-in-Place Footing Substituted for Precast (4’ Culvert Set Lengths)
CONSTRUCTION

Pile Driving
CONSTRUCTION

Footing Installation
CONSTRUCTION

Setting of Precast Culvert Units
Setting of Precast Culvert Units
CONSTRUCTION

Setting of Precast Culvert/Wall Units
Concrete Stain (Before)
CONSTRUCTION

Concrete Stain (After)
CONSTRUCTION

Pedestrian Railing (Resembles Canal Lock Gate)
CONSTRUCTION

Completed Roadway
CONSTRUCTION

Completed Sidewalk/Trail Connection
Completed Bridge
Contech Calendar (June 2016)

**Bridges » Precast Bridge Systems**

Henry County, Ohio
- CON/SPAN® O-Series®
- 57’ span x 10’8” rise x 40’ length
- Installation date – August 2015

Henry County, Ohio needed a quick and efficient bridge to replace an aging multi-span steel beam bridge structure that crossed the Miami & Erie Canal. A 57’ clear span precast CON/SPAN® O-Series® bridge was chosen by the Mannik Smith Group as the optimal solution because of its ability to provide a speedy, cost-effective solution for the fast-track project.

This O-Series® three-sided structure with detached headwalls and wingwalls, has an ashlar stone stained formliner finish that provides an attractive solution that blends well with its surroundings.

### June 2016

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2016</td>
<td>July 2016</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
THANK YOU!

Questions?

R. Christopher (Chris) Homan, PE (PM)
Travis L. Rhoades, PE (Structural)
Jeffrey L. Snyder, PE (Geotechnical)