Milton-Madison Bridge Project
Module 2 - Preliminary Engineering & Owner’s Consultant Oversight

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Presentation Outline

- Overview
- Environmental Study
- Pier Assessment
- Preliminary Engineering
  - Pier Rehab
  - Scour Countermeasure
- Contract Requirements
- Consultant Oversight

The Challenge

- Existing Bridge
  - 80+ year old bridge, with $10+ million spent on recent repairs
  - Structurally Deficient
  - Functionally Obsolete
  - Sufficiency Rating of 6.5
  - Remaining life <10 years
- Construct Affordable Replacement (75-year) Bridge
### Preliminary Eng/Env Timeline

- **June 2008** - Kickoff BTS Process
  - August 2008 – Superstructure Replacement
  - January 2009 – Pier Evaluation
- **February 2009** - BTS meeting
  - Superstructure Replacement
  - Lower costs/Less impacts to the historic district
- **Apr/May 2009** – Final Alternatives Developed

### Preliminary Eng/Env Timeline

- **August 2009** – Proposed Action
- **September 2009** – Tiger Application Submitted
  - Pursuit of TIGER Grant (completing in 2012)
  - No R.O.W./minimal utilities
  - Design-Build allows engineering and construction to occur at the same time.
- **January 2010** – RFC Submission
- **June 24th 2010** Advertisement
- **September 2010** Letting

### Initial Bridge Location Alts

**ALL alternatives considered**

- National Landmark Historic District
Bridge Alternatives

- Do Nothing
- Rehabilitation
- Bridge Replacement
- Superstructure Replacement
  - Potential game changer
  - Lower costs
  - Less impacts to the historic district
  - But is it Feasible?

Superstructure Replacement

- Pro’s
  - No R.O.W.
  - Less time
  - Span length
  - $50 million savings
  - TIGER Grant

- Con’s
  - 12 Month Closure!!!

Superstructure Replacement Minimal Approaches

Superstructure Replacement

- Proposal
- Strengthen Existing Pier
- New Pier Cap
- New Pier

Navigation Channel does not need to be widened
Pier Rehabilitation Goals

- Designed For 75 Year Service Life
- Feasible
  - Pier strengthening report
  - Constructible within 1 year closure
- Permittable
  - Maintain Navigation Channel
- Visually Acceptable
  - Develop Design Criteria To Ensure Commitments To The Community
Typical Existing River Piers

- Existing Pier stem reinforcing extends 12’ into caisson
- Un-reinforced Caisson
- Un-reinforced Rock Socket 1.7’-6.7’ deep
- Boulders
- 20’ Water
- 60’ Soil

Pier Construction Methods
Pier Testing and Inspection

- Vertical Coring (Jan-Feb 09)
  - KYTC Cored piers 6-9 thru the deck and 50’ into bedrock
  - Cores were extracted for laboratory testing

Detailed Inspection of Piers

- Physical Inspection Feb-Mar09
  - NDT, Lab Testing of Samples
  - Existing Condition
  - Service life Assessment
- Results, Generally good
  - Some durability concerns
**Design Considerations**

**Pier Demand Concerns**
- Heavier Truss
- Increased Pier Weight
- Wind Loading
- Larger Live Loads
- Vessel Collision (not in original design)

**Pier Response Concerns**
- Pier cap tie in to existing pier
- Tension in stem and interface
- Tension in unreinforced caisson
- Foundation/Geotechnical Design

**Conventional Analysis of Piers**

Ignore Soil:
1. Contraction Scour
2. Local Pier Scour
3. Softer soil response compared to rock

Apply Loads

Results:
1. Inadequate in Strength and Extreme Limit States.
2. Refine Wind and Barge Loads
3. Refine Analysis Method

\[ e = \sum M / \sum V = 21 \text{ feet} \]

\[ V = 20000 \text{ kips} \]

**Refined Barge Impact**

\[ AF = (N) (PA) (PG) (PC) (PF) (3.145-1) \]

20% Reduction from Method 1
Realistic Wind Loads

Computational Fluid Dynamics Simulation

Basic Wind Speed Reduced from:
• 100 MPH to 67 MPH (Trans)
• 58 MPH (Longitudinal)

Viable Foundation Options

Encasement Drilled Shafts Soil Response

Scour Mitigation Measures

Rip Rap with Filter Articulated Block Mat Jet Grouting
Improve Foundation Resistance

- **Refined Approach**
  - Utilize Soil in Response
  - Provide rip rap scour protection
  - Place below contraction scour

- Make 12’ thick to resist bedforms
- Use geotextile and size rock to resist local scour

Pier Finite Element Model

- Pier Stem (Elastic Solid)
- Unreinforced Caisson
- Stem & Caisson: Elastic Solid
- Soil/Rock: Mohr Column
- Soil/Structure: Friction Interface

Validation

- MIDAS GTS Analysis
- LPile Analysis

- Loose to M. Dense Sand Below Water
- $\phi = 30^\circ$
- 5’ diam. X 50’ long drilled shaft
- Soil/Rock: Table
- Lime"
Other Pier Response Concerns

Tension in stem and at interface between stem and unreinforced caisson
Tension in unreinforced caisson

Tension in unreinforced caisson

Tension Criteria (Perf Criteria SP)

- Existing Pier Stem and Caisson Capacity
  - Existing pier stems and caissons considered non-reinforced.
    - $f'_c = 7$ ksi  $E_c = 4,810$ ksi.
    - $f = 0.23f'_c = 608$ psi
  - Maximum tension $485$ psi (STR), $205$ psi (EXT-CV), $139$ psi (SERV)
Established Criteria for 75yr Service Life

- 0 psi tension for any SER limit state
- 95 psi tension for all STR and EXT
- Where either is not met, the caisson/stem shall be strengthened.
- Strengthening shall be continued to the point of limit plus development length.
- Stem - Minimum encapsulation of 24” HPC

Pier Strengthening

1. Drill holes into ex. caisson
2. Grout Rebar into Caisson
3. Add Stem Reinforcement
4. 2’ thick encapsulation
5. Pier Cap Reinforcement
6. Cast new Pier cap
7. Scour Countermeasure

Key Project Documents

In-depth Engineering Study resulted in criteria and information documented in the following:

- A. Scope of Services
- B. Project Special Provisions
  - Structure Performance Criteria
  - Strengthening of Existing Piers
- C. Contract Bridge Drawings
  - Ensure stakeholder commitments are incorporated
- D. Contract Plan Details
  - Prescribed Scour Mitigation
Project Reports

- E. Binding Project Reports
  - Vessel Collision Study (Michael Baker)
  - Wind Engineering Study (RWDI)
  - Geotechnical Overview (KYTC/Michael Baker)

- F. Other Project Specific Reports (Information Only)
  - Pier Strengthening Report (Michael Baker)
  - Existing Piers Service Life Assessment (CTLGroup)
  - Final Environmental Assessment Report (WSA)
  - Preliminary Hydraulic And Scour Analysis (WSA)

Permits

- Pre-Construction
  - USCG Bridge Permit
  - IDEM, KDO 401 permits and USACE 404 permit
  - FAA and KAZC permits
  - IDNR Construction in a Floodway

- DBT Responsibilities
  - Compliance with the permits
  - Revise/Amend as needed (ex. 401 & 404)
  - Obtain Permits
    - Rule 5 Erosion Control Permit
    - KY Pollution Discharge Elimination System permit
  - No increase in contract time.

Owner’s Consultant Oversight

- Michael Baker International (Prime)
  - CDMSmith (Environmental Compliance)
  - American StructurePoint
  - VS Engineering, Inc.
  - TesTech
  - Pennoni Associates Inc. (Shop Inspection)
  - Doe Anderson (Public Involvement)
Design Review

- Compliance with Contract requirements
  - Plan and Specification Review
  - Design Hold Points
    - DBT Buildable Units
    - Initial, Intermediate, and Final Submittals
- Construction Submittals
  - Temporary Works
  - Lifts and Slides
- RFP Requirements
  - Contract Documents can’t cover everything.

Construction Oversight

- Field Observation and Testing
  - Challenging in Design Build
  - QA Testing Role
- Temporary Construction
  - Temporary Works
  - Lifts and Slides
  - DBT Responsible for QC and Means /Methods

Lessons Learned

- Buildable Unit Soup...
  - Any combination of things that can be built
- Same but different...
  - Accommodate new ideas and differences in the structure without impacting performance
- Change is Good!
  - Reevaluate provisions/requirements/conditions when changes are proposed
- RFI’s – RFP needs to Address
- Document Controls!