I-74 Corridor in the Quad Cities
A State of the Art Design

Mid-Continent Transportation Research Symposium
August 16-17, 2017

Presented By: Norm McDonald, Iowa DOT State Bridge Engineer
PRESENTATION OUTLINE

- Project Background
- Design Challenges
- Aesthetics and Enhancements
- Maintenance and Monitoring
- 2035 I-74 ADT = 99,800
- 45% of the Total Traffic Crossing the Mississippi
PROJECT OVERVIEW - IOWA

MOLINE

RIVER

MISSISSIPPI

NAVIGATION CHANNEL

EXISTING I-74 TO BE REMOVED

POTENTIAL TRAIL CONNECTION

BETTENDORF
EXISTING BRIDGES

Twin Suspension Bridges
EXISTING NORTHBOUND BRIDGE

Open to Traffic in 1935 - 15 Cent Toll
Construction Cost - $1.5 Million
EXISTING NORTHBOUND BRIDGE

1930’s

Source: Upper Mississippi Valley Digital Image Archive
EXISTING NORTHBOUND BRIDGE

1930’s
Southbound Bridge Construction in 1959
Converted to I-74 in 1970’s
EXISTING BRIDGES
EXISTING BRIDGES
PROPOSED BRIDGES

Twin Basket Handle True Arches
PROPOSED BRIDGES
1998: Mississippi River Crossing Study
2000: I-74 Corridor Study began
2003: Draft Environmental Impact Statement (EIS)
2005: Preferred Alternative identified
2006: Main Span Bridge Type chosen
2007: Preliminary Engineering completed
2009: Final EIS Approved & Record of Decision Received
Alfred Benesch Final Design team begins work
2014: Construction begins on Advanced Local Roads
2017: Construction begins on I-74
2021: Construction of South & Central Sections Completed
????: Construction of North Section Completed
Iowa & Illinois DOT’s, FHWA (2 divisions)

3 Cities and 2 Counties

Bi-State Regional Commission

Benesch Team

- Alfred Benesch & Co. - Prime, Bridges, Iowa Interstate
- Modjeski & Masters, Inc. - Arch, Illinois Bridges
- Hanson Professional Services - Illinois Roadway, Geotech
- WHKS & Co. - Iowa Local Roads and Iowa Viaduct
- American Surveying & Eng. - Survey, Utilities, ROW
- FluidClarity Ltd. - Drainage
- Illumination Arts LLC - Aesthetic Lighting
- Shive-Hattery, Inc. - Aesthetics, Public Involvement
- Iteris, Inc. - Intelligent Transportation Systems
- Terracon, Inc. - Geotechnical
SharePoint and ProjectWise

Support
For technical support please contact Sean Keene at i74support@hanson-inc.com

New I-74 Bridge over the Mississippi River

Team Communications
ARCH SPAN – FOOTING FOUNDATION
ARCH SPAN - SUPERSTRUCTURE

774’ – 5”

870’
ARCH SPAN - SUPERSTRUCTURE

13.5°
164'
72'
ARCH SPAN - SUPERSTRUCTURE

- Section through the arch rib at a diaphragm
  - Depth of Steel Rib (D) varies between 9’ (top) and 12’ (base)
  - Diaphragm opening for inspection/maintenance access
  - Longitudinal stiffeners are full length of rib
ARCH SPAN - AERODYNAMIC INVESTIGATION

- Susceptibility to vortex shedding vibrations
- Buffeting winds - forces and displacements
- Stability against flutter
Initially believed a need for fairings on the arch ribs

- Located at the outermost exterior corners of the ribs
- Costly and unattractive

Wing shape fairing, a Winglet, at the edge of the deck

- Multi-use trail serves as the fairing on the EB structure
- Placed on the WB structure only
- Reduced the vibrations significantly
Winglet (airfoil shape):
Wind from one direction only
Airfoil shape
NACA 0018
B-17 wing
ARCH SPAN - ARCH RIB ANCHOR BOLTS
Arch Force Resisting System

Arch Steel/concrete Interface Connection

- Combined Forces \( P + M_x + M_y \)
- Significant lateral bending
- High concrete bearing pressures
ARCH SPAN - ARCH RIB ANCHOR BOLTS

Arch Steel/concrete Interface Connection

- HPS-70W Steel
- Concrete base: $f'c = 6.5$ ksi
- Jacking Stress = 0.60 $Fu$
- $f_{pe} = 0.42-0.52$ $Fu$
- 48 – 3” $\phi$ Gr116 Bars
ARCH SPAN - ARCH RIB ANCHOR BOLTS

- 48 bolts at 8 locations = 384 anchor bolts
- Original design: Epoxy coated and grout
- Began research for stainless steel in January 2015
- Phase 1: literature review
- Phase 2: laboratory testing
ARCH SPAN - ARCH RIB ANCHOR BOLTS

- Phase 2: laboratory testing

- Ductility
- Stress relaxation
- Toughness
- Machinability
- Tensile strength

 Threshold galling stress
 Critical pitting temperature
 Stress corrosion cracking
 Hydrogen embrittlement
 Aqueous corrosion resistance
CORRIDOR - BRIDGE DECK REINFORCEMENT

- 100 year life comparison: epoxy vs stainless steel
- Life Cycle Cost Analysis completed
- User delay evaluation completed
- Stainless steel reinforcement is cost competitive!
ARCH CONSTRUCTION SEQUENCE

ASSUMED ERECTION EQUIPMENT GEOMETRY

SECTION B-B
(TOWER DRAGGING NOT SHOWN)
APPROACH SPANS AND VIADUCT PIERS

- At Normal Pool River Levels
MULTI-USE TRAIL - RIVER SIDE RAILING
MULTI-USE TRAIL - ARCH SIDE RAILING
IDENTITY ELEMENTS
IDENTITY ELEMENTS
ARCH SPAN - AESTHETIC LIGHTING
ARCH SPAN - AESTHETIC LIGHTING
ARCH SPAN - COLOR CHANGING LIGHTING
MULTI-USE TRAIL LIGHTING
PEDESTRIAN OUTLOOK LIGHTING
Walkways in every girder bay of Approach Spans

- Walkways supported by cross frames
- Move between girder bays via transverse access platforms
- Maintenance waterline in every girder bay
MAINTENANCE - INSPECTION TRAVELER

- Inspection traveler in the Arch Span
MAINTENANCE – INSPECTION TRAVELER

- Inspection traveler in the **Arch Span**
Arch Rib Walkway:

- Transversely level inspection catwalks full length interior of arch
- Access between arches through bracing struts
- Total cost of SHM system is estimated at $3.5 million

- Slow speed, long-term strain measurements
- Live load strains
- Moisture sensors in arch ribs
- Change of rotation at arch piers
- Superstructure vibrations
- Temperature gradient
ITS/STRUCTURAL HEALTH MONITORING/SECURITY

- Deck chloride sensor
- Electromagnetic sensor on cable
- Displacement at expansion joint locations
- Relative movement between stiffening girders and pier crossbeams
- Security cameras
Fort Steuben Bridge Demolition: February 21, 2012 - 7:15 AM
THANK YOU!

QUESTIONS?