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Reactivation of the Veterans Memorial Bridge in Kaukauna, WI

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Abstract

AECOM provided bridge inspection, alternative analysis, preliminary design, final design and construction support for the rehabilitation of an existing vertical lift bridge crossing the US Government Canal of the Fox River. The design was performed under a three-party agreement with the City of Kaukauna and WisDOT. The goal of the project was to open the rehabilitated lock system of the Fox River and regain function of the lift bridge, which had not moved in many years. A detailed inspection was performed through a unique partnership with a local contractor to get the bridge moving again and determine specific rehabilitation scope.

The rehabilitation of the bridge included grid deck repairs, cable replacements, sidewalk overlay, bearing replacement, brake and span lock replacements, upgrades to the electrical system, and traffic gate and barrier gates. Roadway approaches were reconstructed, pavement at the intersection of Catherine Street and Wisconsin Street intersection was replaced, curb ramps were reconfigured, and pedestrian railings were replaced. Due to funding delays, the original design plans completed in 2017 but were shelved until they could be later updated and bid. The City of Kaukauna oversaw the construction and AECOM provided construction services including resident engineering, on-site construction inspection, shop inspection, and review of all contractor shop drawings and submittals.

Construction of this work began early 2020 and continued into 2022. In 2022, the bridge was still in the break-in period. This paper will discuss the challenges associated with reactivating a movable bridge after years of inactivity and present lessons learned from issues encountered during construction.

Introduction

Construction of the Veterans Memorial Bridge in Kaukauna, Wisconsin, began in 1982 and was completed in 1984. It operated for several years, but was then deactivated after the U.S. Army Corps of Engineers closed the Fox River Locks indefinitely. In recent years, the lock system was being restored and the City of Kaukauna was required to reactivate the bridge to accommodate navigation.

Inspections

2008 Overview Inspection

A general overview-level inspection of the City of Kaukauna vertical lift bridge over the Fox River Navigation Canal was made on April 2, 2008. The purpose of the inspection was to develop an assessment of the current condition of the bridge and develop a list of recommended actions for restoration of the bridge to complete, reliable and safe operation to accommodate the Fox River Navigational System Authority's planned restoration of navigation on the waterway in 2010.

The structural, electrical and mechanical systems of the bridge were inspected by engineers having expertise with each of those specialty disciplines for movable bridges. The bridge was not operated as part of the overview inspection. The report summarized the findings from the inspection and provided recommended actions that should be performed to each system to restore the bridge for full operation.

2012 Follow-Up Inspection

A follow-up inspection was made on October 17, 2012. The purpose of these inspections was to develop an assessment of the current condition of the bridge and develop a list of potential restoration actions required to make the bridge again operable in a reliable and safe manner to accommodate the Fox River Navigational System Authority's planned restoration of navigation on the waterway, which had been delayed but was still being planned. It was understood that potentially the bridge may have been required to be operational by the spring of 2014.

In 2008, the structural, electrical and mechanical systems of the bridge were overviewed by engineers having expertise with each of those specialty disciplines for movable bridges. The more recent October 2012 inspection was made by a movable bridge structural engineer. The bridge was not operated as part of any of these inspections due to the extensive amount of work that would be needed to enable operation.

2012 Structural Recommendations

The following structural recommendations were based on the cursory visual review performed in 2008 and the follow-up site visit in October 2012. There were no major structural problems encountered. The most significant issues were the deteriorated state of the bridge live load bearings, the centering guide support plates and abutment bridge seats. Large amounts of debris had been allowed to build up in this area which is mostly hidden from view below the bridge deck. Concrete under the base plates of the bearings and centering guides was deteriorated, and the steel was corroded. The rocker bearings were

tilted excessively. The movable span was not seated down securely on the bearing base plates and it could be seen to move under traffic loads and then rebound. This improperly seated condition was also causing an abrupt transition at the bridge joints at the sidewalk.

Overall, the steel superstructure was in good condition. No significant section loss or fatigue cracking was visible. The concrete approach pavements on the north and south sides of the bridge were badly cracked. Abutments, retaining walls and fender systems were in good condition as is the bridge tender house.

2012 Electrical Recommendations

The following electrical recommendations were based primarily on the cursory visual review performed in 2008 and the expectation that the bridge would need to operate safely and reliably for the long term without the need for other significant rehabilitations. Lack of use for electrical equipment on movable bridges tends to be more detrimental than extensive use. Moisture infiltrates into equipment and corrosion and oxidation develops. Many components can become obsolete over time. Based on the type of control system for this bridge, and its general condition, it was anticipated to re-use the motor control center, the relay controls, the control console, and much of the wiring. Cleaning, repairs and modifications were required, but these components should function satisfactorily for many years. Devices such as limit switches, navigation lights, traffic signals and traffic gates were recommended to be replaced because they are highly susceptible to deterioration when exposed to the elements and the inspection revealed many signs of problems. These are always high maintenance items on movable bridges.

The main span motor drives and motors are key pieces of electrical equipment that make the bridge move. The span drives on this bridge had been obsolete for over 20 years. Obtaining parts and service for them would be impracticable. For this reason, it was recommended that they be replaced. The motors themselves were not obsolete, but would require reconditioning and replacement of their bearings. Considering this, it was recommended that new motors be installed that are an appropriate match for the new drives.

New Span Drive Motors

2012 Mechanical Recommendations

The following mechanical recommendations were based primarily on the cursory visual review performed in 2008. Lack of use for mechanical equipment on movable bridges can be more detrimental than extensive use. Bearings and bushings seize over time, moisture infiltrates into equipment, lubricants break down and seals/gaskets become hard and brittle. Replacing seals, cleaning, flushing and replacing lubricants were considered necessary to recondition the mechanical equipment.

The span locks are crucial mechanisms on lift bridges that need to function reliably to secure the bridge down in the closed position for safe passage of roadway traffic. Span locks on this bridge are located below the open grid deck on each abutment and are continuously exposed to the harsh elements. Because of this they were in poor condition and require replacement. Another critical feature is the braking system. There are six brakes on the bridge, 2 motor brakes and 4 machinery brakes. The brakes were not exposed to the elements, but had been unused for many years and are no longer manufactured. Typically, when these brakes go unused for many years, the internal fluid ports and moving parts become seized and corroded. They can be cleaned and repaired, but tend to function inconsistently and unreliably, therefore it was recommended that the brakes be replaced.

2016 Inspection

In 2016, funding was finally received to proceed with final design of the rehabilitation to reactivate the bridge and get it operational again. Two contractors were engaged, and the bridge was temporarily made operable. Finally, an in-depth inspection of all components could be made in different positions of opening. This inspection occurred on October 11, 2016 and revealed some additional work that needed to be considered.

The paint system that was visible was as expected, but perhaps worse than expected in areas of the lifting girders that were previously hidden by dirt and debris. It was decided that spot painting was still appropriate, but the overall painting area might be more extensive than we previously estimated.

Existing railing modifications were determined to be required to reduce clear openings between rails.

Several of the wire ropes were very loose, damaged beyond acceptable use and needed to be replaced. Many more were marginally damaged. Given the amount of work it takes to prepare the bridge for cable replacement, it was decided to replace all of the cables.

2016 Structural Inspection

Design

Design work was completed in 2017, but due to inadequate funding, the project was once again put on hold. The plans were shelved until late 2019 when state funding was finally allocated for the bridge. The project was put out to bid in December of 2019 and awarded in January of 2020.

Scope of Work

Structural work included spot painting, open steel grid deck repairs, polymer overlay of the lift span sidewalks, lift span bearing rehabilitation including power washing and cleaning the framing system beneath the open steel grid deck and abutment beam seats, retrofitting the lift span railings, removal and replacement of deteriorated grout from the tower column base plates, epoxy crack sealing on the roadway surface of the abutments, concrete surface repairs for spalled concrete on the south abutment, steel weather shield installation on the lift span, and balancing the structure.

Railing modifications and sidewalk overlay

Mechanical work included lubrication of mechanical components, replacement of the brakes and span locks, replacement of various gaskets and seals, rehabilitation of the speed reducers, bearings, and couplings, and replacement of the counterweight ropes.

Electrical work included replacement of the warning gates, warning signals, and barrier gates, navigation lights, electrical wiring, cabinets, span motors and drives, limit switches, and other various pieces of the electrical system.


Counterweight shoring for wire rope replacement

Roadway work included reconstruction of the intersection of Wisconsin Avenue and Catherine Street. Concrete panel replacement, curb and gutter replacements, sidewalk replacements, and curb ramp realignment were included on the project.

Construction Challenges

COVID-19

2020 was a challenging year for everyone and this project was no exception. By summer of 2020, the contractor made the project team aware that most of the scope of work for the Veterans Memorial Bridge would not be able to be completed prior to the interim completion date of August 28, 2020. COVID-19 delays for the span drive motors and traffic/barrier gates caused the bridge to remain inoperable, thus all of the following work could not be completed until 2021:

- Lifting girder repairs
- Preparation and painting of the abutment side of the lifting girder at the north and south end of the bridge
- Span balancing
- Tensioning and shimming of counterweight wire rope assemblies.
- Installation and adjustment of motor brakes
- Span motor and motor brake disconnects
- Span motor cabinet
- Span motor installation, wiring, and control testing
- Control systems for span drive motors
- Control systems for barrier gates
- Control systems for traffic gate
- Traffic gate installation, wiring, and control testing
- Barrier gate installation, wiring, and control testing

The delays and extremely long lead times associated with COVID-19 could never have been anticipated, but the above list demonstrates the effect that items with long lead times can have on a project.

Condition of Existing Elements to Remain


Refurbished alignment guide, rocker bearing & span lock receiver

During scoping inspections, the condition of the anchor rods was difficult to determine without the nuts removed, but most of the visible portions of the rods appeared to be in good condition. During construction after removing the nuts and cleaning the anchor rods, it was determined that several of the anchor rods exhibited excessive section loss and required replacement. The upper portions of the rods were removed and replaced with new rods welded to the remaining portions of the rods. The rocker bearings had more wear than anticipated and required machining to clean up the shoe surface and additional bushings. A portion of the lift girder was discovered to have severe section loss with holes in the web just above the bottom flange. Repairs were made using bent plates bolted across these areas. Sometimes the condition of structural elements that are not visible cannot be known until things are removed during construction, but consideration should be given to performing more removal during design to better ascertain the need for repairs when obstructions are removed.

Lifting Rope Tension

One wire rope at the southwest corner had significantly less tension than the other ropes in the same group. Shims were added and the rope still had less tension than the others. The rope tension could only be brought into tolerance after all the other ropes in that group were removed and rope tensioning equipment was modified to fit more shims to that rope. Had that effort been unsuccessful, a new rope likely would have been required. Wire rope fabrication, testing, installation, and shimming should all be observed closely for any signs of inconsistencies.


Jacking and shimming new wire rope

Warning-Barrier Gate Operation

Sequence of operation of the warning gate and two barrier gates was a topic of discussion. The intent was for the north warning gate to come down first, followed by the south barrier gate, then the north barrier gate. The north warning gate and barrier gate were instead wired to only one switch, thus could not be operated separately. It was decided that since the warning gate comes down first due to the speed of its operation compared to the barrier gate, this was acceptable. Warning and barrier gate operation sequences should be discussed and clearly communicated to all disciplines involved prior to installation.

Limit Switches

During construction, the limit switch for the service elevator in one of the towers was replaced with a less robust limit switch. The new limit switch was damaged causing the elevator to continue moving and disconnect from its guide rails. Careful attention should be given to ensure that limit switches are robust enough for their intended purpose.

During the “break-in” period, a span lock issue was caused by a failed limit switch in which the switch arm sheared off. A new switch was order and installed, but the faulty limit switch caused an issue with the span lock motor. The span lock motor is currently scheduled for replacement. Span locks seem to be one of the most common challenges during construction and maintenance of movable bridges. Further research in this area is warranted.

Schedule

The original partial acceptance date was to be October 17, 2020, on or before which the bridge and approaches were to be ready for traffic and the structure was to be fully functional and normal movable bridge operation restored. Due to project delays, partial acceptance was not granted until October 28, 2021. Issues arising during the break-in period with the barrier gate caused testing to be suspended and partial acceptance was not again granted until June 17, 2022.

Substantial completion, originally scheduled for November 1, 2020, has not yet occurred. A 15-day "break-in" period for bridge operation is required prior to substantial completion, and problems that limit the ability to operate the bridge during the "break-in" period, require a new "break-in" period to be initiated.

Substantial completion will initiate the 12-month warranty period for the operation of the bridge, so the final acceptance date, originally scheduled to be November 1, 2021, will likely occur in 2023.

Since they are difficult to predict and sometimes impossible to avoid, schedule delays should be communicated often to manage expectations of all stakeholders.

Conclusion

The re-activation of a movable bridge is a time-consuming and costly process. Owners considering de-activation of a movable bridge should consider the effort associated with re-activation. Funding delays during design and material procurement delays during construction are unpredictable. It is only with patience and cooperation that these issues can be resolved.