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NEW LADOTD BOBTAIL SWING SPAN OVER DOULLUT CANAL

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ABSTRACT

As design for this swing span replacement was wrapping up in the fall of 2005, Hurricane Katrina walloped southern Plaquemines Parish and damaged the existing swing span. The existing swing span was immediately removed after Katrina, and the removal left a hole in the community. To residents and businesses that were rebuilding in the area, the bridge outage was a sign that things are not quite back to normal. All were very eager to finish the bridge project.

The new bridge was finished 6 ½ years after Katrina in May 2012, and is powered by a simple hydraulic system utilizing push/pull cylinders, and swings on a roller thrust bearing. This paper presents the trials and achievements during design and construction of the bridge.

INTRODUCTION

New Bridge Description

Location

The bridge is located on Louisiana Highway 11 over the Doullut Canal in Plaquemines Parish. The bridge provides a crossing over the canal for local community access. East of the bridge is the Empire lock at the Mississippi River levee. (Figure 1) The Empire locks provide access from the Mississippi on the east to Adams Bay on the west. At the west end of Doullut Canal a high level bridge on LA Highway 23 provides the primary crossing over the canal. (Figure 2)

Figure 1 - Empire Locks

Figure 2 - LA Highway 23 Bridge

The Doullut Canal Bridge is 240’-6” in total length and includes one 160’ – 6” movable span and four 20’ concrete slab approach spans. The movable span is an unequal arm (100 ft. / 50 ft.) plate girder swing span. When open, the swing span provides 60 feet of horizontal clearance for navigation. Users of the bridge are primarily businesses in the area and consist of fisheries and pipeline industries. The new bridge shown in Figure 3, replaced a 191 foot long bridge that included a 70 foot bascule span. That bridge was constructed in 1950.

Figure 3 - New Doullut Canal Bridge

Project Timeline

The existing bridge was deemed deficient in 2001, and needed to be replaced. HNTB took the structural design and plans to the 95% completion level in 2003. The mechanical and electrical design was originally to be performed by the LADOTD, but because of a heavy work load they asked HNTB to perform the mechanical and electrical design in early 2005. The structural, mechanical, and electrical design was completed in early 2006.

- 2003 Structural design nearly complete
- 2005 Hurricane Katrina
- 2006 Mechanical/Electrical Design complete
- 2006 Existing Bascule Span removed
- 2008 Construction kickoff
- 2008 1st Shop drawings received
- 2012 Bridge re-opened to traffic

DESIGN

Mechanical Design

General

The machinery was designed prior to the U.S. Customary Units version of the AASHTO LRFD Movable Specification, so the 2000 (revised in 2002) SI version of AASHTO LRFD Movable Specification was used. The SI units were converted to U.S Customary for presentation in the plans and specifications.

The time to open the span 83 degrees under full power is 83 seconds. The time with one pump out is double or 166 seconds. The time to operate the endlifts and center wedges is approximately 20 seconds. The machinery is designed for 30 openings per day, 365 days per year, and 50 years.

Center bearing

LADOTD wanted to use a thrust roller bearing to support the swing span, and established the design requirements for the bearing. The department wanted to have a common bearing for all of their swing spans, so only one type would be purchased for spares for their swing spans. Design parameters and loads were given to SKF so that a bearing could be selected. After consultation with SKF it was determined that two standard bearings would be desirable. One for 1000 kip deadload (DL) spans, and one for 1400 kip DL spans. Once a bearing was selected, HNTB designed the bearing housing used on the Doullut Canal Swing Span.

To minimize the horizontal load on the center bearing, different cylinder orientations were studied. A parallel opposite acting cylinder configuration was found to have the least horizontal load.

Center Wedges

The initial plan was to use fixed (non-operable) center wedges at the center pier. The device would not lift the span at the center, but would provide some live load resistance. The deflection at the center of the span from the endlift operation was found to be too high. It was thought that the deflection could cause the centerwedges to be non-acting, so a movable wedge was designed.

Hydraulic system

The hydraulic power unit (HPU) is mounted on an under-deck platform that spanned from the east main girder to a longitudinal W18x50 framing member. Space on a swing span is always at a premium. For the HPU to fit, the equipment was divided up so that it did not interfere with the roadway stringers or the roadway deck above and the lateral bracing below. The HPU components were spaced to clear the obstructions and placed on a skid for ease of installation.

The HPU uses two variable swash-plate piston pumps to supply power to the span drive cylinders. The swash plate position is controlled by a small electric motor. Each pump provides 0-19 gallons/minute at 1900 psi and with losses provides 1500 psi at the cylinders. The pumps for the lifts and wedges are also variable flow pumps. Each pump provides 13.3 gallons/minute at 2400 psi, and with losses provides 2000 psi at the cylinders. The pressure relief valves are set to 2200 psi and 2700 psi for the span drive and wedge circuits, respectively.

To reduce the number of possible leak points all of the HPU check valves, pressure relief valves, and control valves are mounted on a common stainless steel manifold.

The HPU has pressure, level, and temperature switches that provide warnings or actions for the electrical control system. The warning switches consist of filter bypasses, low temperature, high temperature, and low fluid level. The control switches that provide actions for the control system consist of adequate pressure in system, turn on heat exchanger, high temperature shutdown, and low fluid level shutdown.

An electrical control system is used to control operation and monitor the condition of the HPU. The control system starts the motor and first determines if nominal pressure exists in the circuits. Position control valves are used to sequence operation. First center wedges withdraw, and then the end lifts. Simultaneous withdrawal of all at once was not employed because of span deflection. Once the end lifts are withdrawn, the swash plate motor is energized and strokes the swash-plate and pistons from minimum to maximum flow. Span position is monitored through a rotary limit switch mounted on the span. Once the span reaches near open, the swash-plate motor reduces the flow. The actions are reversed for closing.

The piping for the hydraulic system is stainless steel. Flexible hoses are used at connections to cylinders and the HPU. The hoses have a working pressure of 5000 psi and have SAE-62 O-ring fittings.

Figure 4 - Doullut Canal after Hurricane Katrina

Modifications due to Hurricane Katrina

Control House

Several weather proofing modifications were made to the control house after Hurricane Katrina. Based on the storm surge level in the area, the control house was raised 2 feet. The generator louvers on the first floor were removed and the generator radiator was placed outdoors.

Existing Bridge

The entire area was severely damaged by Hurricane Katrina, and so was the existing bascule span. The Louisiana DOTD prepared a separate contract to remove existing bridge. An aerial view of the area after Hurricane Katrina is shown in Figure 4.

CONSTRUCTION

Contract Award and Mobilization

In March 2008 the Louisiana Department of Transportation and Development awarded Coastal Bridge the contract to construct the New Doullut Canal Bridge. As general contractor, Coastal Bridge performed the site preparation, foundation construction, approach span construction, field erection, and control house construction. Coastal Bridge selected: PDM Bridge to fabricate the swing span, Hardie Tynes to fabricate the machinery, and Trinity Power to fabricate the electrical control system. Hardie Tynes in turn selected Huber, Inc. to fabricate the hydraulic components. The bid price was $11,000,000.

Construction Resident Engineering and Inspection was performed by ECM Consultants.

Substructure Construction

High River Levels

Due to the close proximity of the Mississippi River Levee, the USACE stipulated pile driving operations could only be performed when the river stage was under +11 feet NGVD at the Carrollton Gauge located in New Orleans, La. The river did not cooperate with the timing of the pile driving and Coastal could not drive piles until September 2008. Figure 5 shows the Carrollton gauge level for 2008 and 2009.

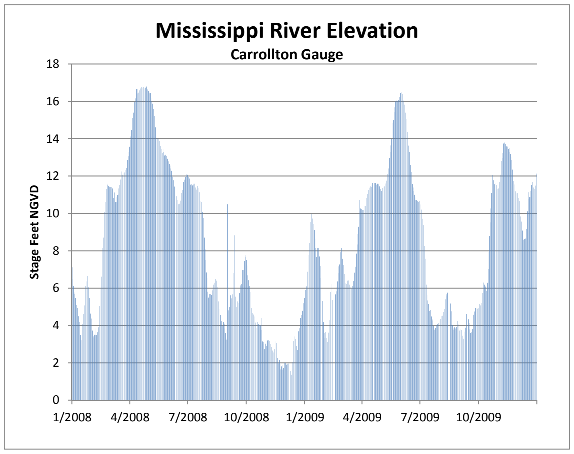

Figure 5 - Mississippi River Levels

Pier 2 Pile Relocation

The pre-cast reinforced concrete piles for Piers 1 and 3 were driven to depth. While driving piles for Pier 2 (pivot pier) an obstruction was encountered. The battered pile being driven contacted the Pier 3 battered pile. Pier 2 piles were relocated to avoid the interference.

North Approach Fill.

The new north approach fill kept settling due to the existing soil. It was said “like putting oyster crackers on gumbo”. There were no problems with the South approach fill. Eventually the settling stopped.

Mechanical Long lead items

During early construction the hydraulic power unit was progressing. It was determined that the span drive pump would take 60 weeks for a delivery of 2 pumps, and the wedge pumps would take 52 weeks for delivery. At the time this was going to put the project schedule in jeopardy. This was prior to the Mississippi river level delay. Recall this pump has a small integral motor on it to move the swashplate to the correct position. The specified motor and corresponding electrical design assumed a 480 volt motor. This size motor was not readily available in 480 volts and was the reason for the long delivery time.

Huber proposed a closed loop hydraulic system using different pumps, but due to uncertainties about changes in the electrical system this was not pursued. The original pumps were ordered, and spare hydraulic pumps were ordered for the Parish maintenance staff to have on hand.

Control House

The control house is a steel column/steel girder supported structure with masonry walls. The house sits on a reinforced concrete slab supported by concrete piles. A generator is located on the first floor. The operator gains access to the control room on the second floor by an exterior staircase. See Figure 6.

Figure 6 - Control House

After Hurricane Katrina, it was suggested to eliminate the generator louvers to make the building more hurricane resistant. The louvers for the generator were removed and the radiator was placed remotely outside of the building. During generator installation, the ECM mechanical inspector pointed out that the engine heat from the generator could raise the temperature to a level high enough to damage electrical components. It was agreed that this was a possibility, and louvers were added to the building. The walls where the blocks were removed were reinforced to withstand wind load.

Bridge opening

The bridge was opened to roadway traffic in May 2012. Punch list items and generator louvers were completed in June 2012.

CONCLUSION

After Hurricane Katrina, residents and businesses were slow to move back to the region. The region is still not as populated as it was pre-Katrina. Since the main highway bridge offered an alternate route over the canal, replacing the existing Highway 11 Bridge was not a great priority. To the residents in the area it was a reminder of the damage the hurricane had caused. All in the area were relieved the day the bridge was open to traffic.

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