

## **2006-2643: FIVE MILES IN FORTY-FIVE DAYS - REBUILDING THE I-10 TWIN SPANS**

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## **5 miles in 45 Days – Rebuilding the I-10 Twin Spans**

### **ABSTRACT**

The five-mile bridge elevating Interstate 10 above Lake Pontchartrain between Slidell, Louisiana and New Orleans East has become an essential daily link for thousands of commuters since the late 1970's. On August 29, 2005, Hurricane Katrina forced a storm surge into Lake Pontchartrain causing the water level in the lake to rise 15 to 20 feet above normal. The impact on the twin spans was devastating, causing damage to nearly 40% of the pre-cast decks on both east-bound and west-bound spans, rendering the bridge impassable. Re-establishing this link to the city was critical to commerce in the city of New Orleans. Boh Brothers Construction Co., locally founded contractor with its main office in the Central Business District of New Orleans, won the job for repairing the bridge. Boh's bid included a fast-tracked 45-day schedule for completion of Phase-I of the project, which included repairing the east-bound span and opening it to two-way traffic. A combination of innovation, intimate knowledge of local conditions, and efficiency resulted in the completion of the project ahead of schedule despite extreme challenges such as an uninhabitable main office and job site evacuation for Hurricane Rita. This paper discusses the process of resurrecting five miles of drowned causeway and highlights some of the innovative means employed to complete the project in less than 29 days.

### **Introduction**

On August 29, 2005 Hurricane Katrina began to make landfall on the eastern Louisiana coastline with a north-easterly track. The eye of the storm passed just to the east of New Orleans, LA later that day creating a storm surge that caused massive damage to the five-mile long Interstate 10 bridge between Slidell, Louisiana and New Orleans East. The State of Louisiana requested bids for a three-phase emergency bridge repair project, which was won by Boh Bros. Construction Co. This paper reviews Phase I of the project, including bidding and construction challenges, in the context of a non-functioning infrastructure resulting from Hurricane Katrina. Construction challenges are broken into two types: 1) challenges that would not commonly be expected in a populated area of an industrialized country and 2) challenges that occur as a result of a fast-tracked marine construction project with an extraordinarily short amount of time allowed for planning and preparation. Specific innovations and strategies used to meet these challenges are highlighted in detail.

### **Hurricane Katrina**

Hurricane Katrina was a category five hurricane, which reached its maximum recorded strength as its pressure lowered to 902 mb (3<sup>rd</sup> lowest recorded pressure of any Atlantic storm) and its sustained wind speed increased to 170 mph on Sunday morning, August 28. Less than 12 hours later, the storm would begin its landfall and prove to be the most devastating natural disaster in US history. By this time the gulf coast was being pounded

by large surf from eastern Louisiana to western Florida, and a coastal storm surge, later measured over 15.5 ft near Pass Christian, Mississippi, was fast approaching. As Katrina made land fall near Barataria Bay, Louisiana, it weakened to a category three hurricane, with maximum sustained winds of 125 mph. With storm surge gathering just to the north of the mouth of the Mississippi River, and category three easterly winds driving the massive volume of water into Lake Pontchartrain through the Mississippi Sound and Lake Bourne, wind-speed would quickly become a secondary concern for south-east Louisiana. Lake Pontchartrain filled with water from the Gulf of Mexico that would eventually be thrust through the south-shore levies and into sub-sea level areas of New Orleans East. The massive influx of water into Lake Pontchartrain caused the water level to rise as high as 15-20 feet above normal lake levels. The sudden rise in the lake was particularly devastating to the double-span US Interstate 10 Bridge (Twin Spans), which crosses Lake Pontchartrain at its narrowest point. As a result, nearly 40% of the simple-span, pre-cast girder and deck segments of the east-bound and west-bound bridges were damaged. The damage to the bridge decks ranged from shifting to complete removal of spans (Figure 1). The local area was devastated, evacuated, and temporarily non-functional (Figures 2 and 3).



**Figure 1:** I-10 Bridge Damage



**Figure 2:** Infrastructure Damage – North Shore of Lake Pontchartrain



**Figure 3:** Infrastructure Damage – North Shore of Lake Pontchartrain

## Bidding the Repair

The Twin Spans repair project consisted of three phases. Phase I included repairing the eastbound bridge by re-aligning shifted bridge segments and transferring undamaged segments from the westbound bridge. Phase II included shifting undamaged spans of the westbound bridge to one end of the westbound bridge, and constructing portable bridge segments to complete the westbound bridge. Phase III included maintenance of the portable bridge segments installed on the westbound bridge for up to three years. Boh Bros. Construction Co. was awarded the project with the lowest of three bids issued. The cost for all phases was \$31 million, and the schedule for completion was 45 days and 120 days for Phases I and II respectively, with a \$75,000 per day bonus/penalty incentive. Second and third bidder prices were \$38 million and \$93 million, respectively.

Of particular interest with regards to the bidding process, was the accelerated bidding schedule, the monumental tasks to be completed prior to bidding, and the condition of Boh Bros. Construction Co. and the local area during the time of bidding. Prior to Katrina, the Twin Spans were the primary access corridor to New Orleans from the north shore of Lake Pontchartrain: therefore its reopening was a priority for the Louisiana Department of Transportation and Development (LA-DOTD). Consequently, all aspects of the project were accelerated including a 51-hour bidding process, ending on Friday, September 9. Tasks which needed to be completed prior to submitting a bid included a completing a damage survey of the five-mile long bridges, establishing a cost associated with repairing the damage, and developing a competitive schedule for completing the project. Allotting only 51 hours for these tasks would be considered aggressive, at best, under normal circumstances. It should be noted however, that the circumstances surrounding the bidding were not nearly normal, particularly for the winning bidder, Boh Bros. Construction Co. The storm scattered Boh employees, caused extensive damaged to Boh assets, eliminated Boh's main office as a base of operations (Boh's main office was located in the central business district of New Orleans), and required a temporary re-invention of company-wide communication. During the bidding, Boh more than doubled the occupancy of its smaller branch office in Baton Rouge, LA with staff from the main office. From the Baton Rouge office, project planners were tasked with assessing the serviceability of equipment essential to the project, locating employees, and determining the condition of the bridge in sufficient detail to provide a competitive, workable cost estimate. Accessibility to the bridge site from the Baton Rouge office also complicated the challenge. The drive to either end of the bridge, normally 1 ½ hours from the Baton Rouge office, had become a 3-5 hour drive due to heavy congestion and limited roadway access. A helicopter service was retained which reduced the travel time to approximately forty minutes. Despite extreme logistics and communication challenges, the engineers and estimators involved in the bidding process were able to produce a repair cost which was competitive and a repair schedule which proved to be achievable. The stage was set for the beginning of a fast-paced, month-long project filled with unique challenges resulting from a marine construction environment located in the wake of damage from Hurricane Katrina and in the future path of another category five storm, Hurricane Rita. Mobilization for the repair project began as soon as the ink on the contract was dry. By Monday, September 13, equipment and crews were assembled on site and work began.

## **Type 1 Challenges**

Type 1 challenges included securing the jobsite, establishing personnel, and feeding and housing the construction personnel.

### **Securing the Jobsite**

Securing a typical jobsite may normally consist of locking toolboxes and hoisting generators at the end of the workday. In this case security contingencies had to take into consideration the volatile environment surrounding the City of New Orleans after the storm. As the bridge work was beginning, other construction crews working on levee and pumping station repair projects were receiving gun-shot fire. In addition, helicopters were routinely being shot at over the City of New Orleans at the time. Without a functional police force, it became incumbent on Boh Bros. Construction Co. to hire security contractors to protect personnel and assets for the bridge project. Fortunately, the security threats in New Orleans were in the process of being neutralized during the first week of the bridge repair project, and control of the City was steadily shifting back to city and state law enforcement. Security of the jobsite was assessed day-to-day. As construction progressed without incident, it became clear that the security threat level returned to normal and security contractors were released soon thereafter. This occurred prior to the completion of Phase I.

### **Establishing Personnel**

The construction personnel consisted primarily of Boh's employees who resided locally. After the storm many of these men and women relocated to temporary housing on the North Shore of Lake Pontchartrain, Baton Rouge, or other unaffected areas. Massive flooding resulting from several levee breaches from Hurricane Katrina, and again after Hurricane Rita, prevented many of Boh's employees from returning to their homes throughout Phase I of the project. Locating a widely dispersed work force with limited communication presented an additional burden to planners of the project. This task was made more manageable by committed and loyal employees actively seeking work with Boh. It should be noted that their willingness to work twelve hours or more per day, seven days per week, without knowing the condition of their own homes or how they would resume their lives in the wake of the disaster, was essential to the successful completion of the project. The pride of these people in south Louisiana, and their commitment to rebuilding in the face of great personal loss, was truly remarkable. Without the commitment of loyal employees, the successful completion of this project would not have been possible.

### **Feeding and Housing Construction Personnel**

Since the local area near the bridge site was without electricity, restaurants and hotels that had not been destroyed or submerged during the storm remained closed for many weeks following the storm. Additionally, most local employees were displaced from their homes. Therefore, to maintain the workforce necessary to complete the project, Boh had

to feed and house construction crews at an equipment yard located approximately 10 miles from the bridge in New Orleans East. Food, water, and fuel had to be trucked to the yard. Feeding employees was done by a catering service, contracted specifically for the job, which provided 6 meals per day to two 12-hour shifts of construction crews. Jobsite accommodations consisted primarily of bunk houses at the Boh equipment yard. The equipment yard was without electricity throughout Phase I. Power to the bunk houses and catering service was provided by diesel generators during this time.

## Type 2 Challenges

Challenges related more directly to the construction process itself included handling submerged deck sections in shallow water, re-setting deck sections in a timely manner, retrofitting damaged girder ends, and installing alternative deck supports where piles and caps were heavily damaged.

### Handling Submerged Deck Sections

During the storm 39 deck sections were completely removed from the east-bound bridge and deposited in the lake adjacent to the bridge. The lake level near the bridge is between 8 and 12 feet, with a deeper channel dredged through a single high clearance bridge section located approximately one mile from the north approach. The barges used to support cranes, pile drivers, and trailers drafted between 4 ft and 8 ft of water, and tugs driving the barges drafted approximately 9 ft of water. To position the construction barges properly, submerged decks had to be located and removed prior to commencing repair operations. The removal operation was labor intensive both in and out of the water. Divers were used to locate bridge sections. Once a bridge section was located, holes in the deck (pick-points) were punched to allow for passage of slings and rigging, using an excavator-mounted hydraulic ram. Because the decks were heavily damaged, the location of the pick-points needed to be carefully selected to ensure a stable lift. Audio communication with divers was the only means of locating the position of the divers in the water. The inability to visually locate the divers in 8 to 12 feet of water from the surface created a hazard to the divers as they guided the hydraulic ram. Being pinned by barges drafting all but two feet of available water depth or seriously injured by the hydraulic hammer in the murky water were two primary hazards. After successfully rigging a deck, the work was only halfway complete. Lifting the 285-ton deck sections required the use of a Manitowoc 4600 crane with ringer attachment and a 200-ft. boom. Heavy marine lifting in the best conditions requires careful evaluation and risk management of wave action and wind conditions. In this case, the stability of the load presented a significant additional risk. Loss of deck material during the lift caused instantaneous load shifts and rupture of material being bent and then put into direct tension as the sections were being lifted (Figures 4 and 5). The result was shock loading to the crane. After removing approximately 60% of the submerged deck sections, permission to break up the remaining submerged deck sections and drive the rubble into the lake bottom was granted by the State of Louisiana. Although the objective to seeking this allowance was based primarily on safety, it resulted in a much more efficient method

of clearing debris adjacent to the bridge. Since debris removal was a critical path item, the early completion of Phase I can be attributed, in part, to the alternative method used.



**Figure 4:** Submerged Deck Removal



**Figure 5:** Submerged Deck Removal

### **Re-setting Deck Sections**

After clearing debris to allow barge access to the bridge, re-alignment of salvageable east-bound deck sections and transfer of undamaged deck sections from the west-bound

to the east-bound span began. The first method of re-aligning deck sections consisted of jacking a deck vertically onto Teflon slide plates between pile caps and girders, and jacking the decks horizontally back to their original bearing pad locations (Figure 6). Horizontal jacking was accomplished by positioning hydraulic pipe jacks at an angle between the curb of properly aligned deck segments and the curb of deck segments to be moved (Figure 7). Positioning the slide plates required the use of a barge beneath the bridge. However, horizontal jacking was done on the top side of the bridge and did not require the use of a barge during jacking operations. A relatively light demand for barge support and independence from wave action resulted in a very efficient method of re-alignment and was utilized for deck sections requiring re-alignment of five feet or less.

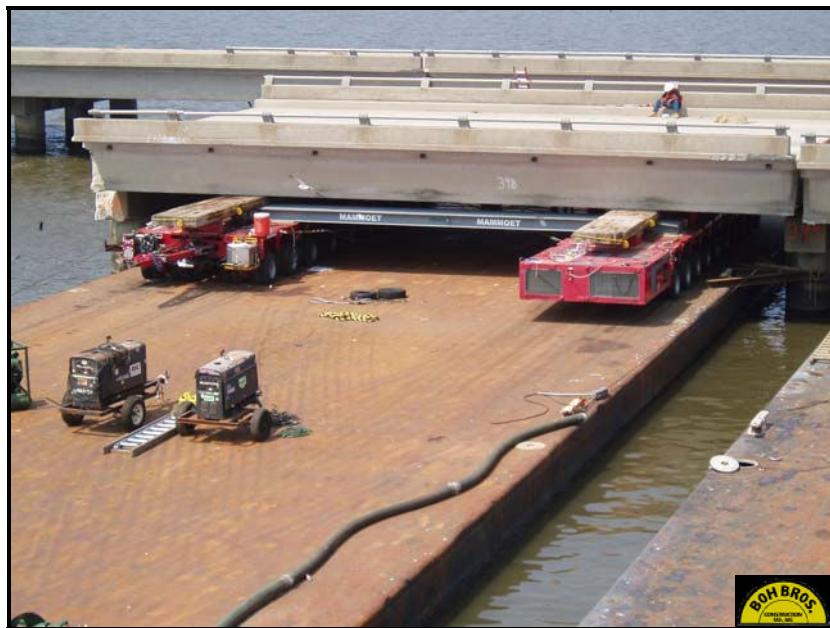


**Figure 6:** Vertical Jacking of Deck on to Teflon Slide Plates



**Figure 7:** Horizontal Re-alignment Jacking

For deck sections which were out of alignment by more than five feet, barges were used for support. An innovative trailer system on top of the barges was also utilized, which greatly increased efficiency. Similar bridge repair operations in the past consisted of providing a fixed support for a deck section on a barge deck. Moving and placing the deck segment precisely onto the bearings could then be accomplished by adjusting the location of barge. This process requires constant adjustment for lateral movements of the barge due to current, as well as vertical wave action, and is extremely time-intensive. To save time, a new concept was conceived by Boh planners. The apparatus for the concept consisted of a tri-directionally adjustable, barge-mounted trailer system (Figure 8). With the deck section jacked high enough to clear the bearings, a barge was moved to a suitable location in the bent where re-alignment was required, and then anchored to bridge piles, fixing its location laterally. The steer-able trailer system was then used to move the deck section into proper alignment. The degree of difficulty related to making fine adjustments within a tolerance of  $\pm \frac{3}{4}$  in. with a tug driven barge was thereby eliminated. The same method was used for the transfer of deck segments, cannibalized from the west-bound bridge. The innovative trailer system was cited by Boh planners as being the primary reason for completing the 45 day project with 16 days left on the schedule.



**Figure 8:** Tri-directionally Adjustable Barge Mounted Trailers

#### Retrofitting Damaged Girder Ends

Throughout the repair projects, conditions of deck sections and pile groups were evaluated to determine future load carrying capabilities. Damage to girder ends and pile caps, resulting from anchorage breaks at bearing pads, was the most common cause of unserviceable girder and support conditions. In most cases damage was primarily

confined to within 18 in. of the girder end, while the remainder of the deck and girder section remained undamaged. To create a reliable load path for the transfer of the reaction at the end of a girder to the pile cap, steel saddles were installed (Figure 9 and 10). The cap saddles provided a clear load path where the reliability of the girder or pile cap material was uncertain and prevented the need for complete replacement of many deck segments.



**Figure 9:** Cap Saddle



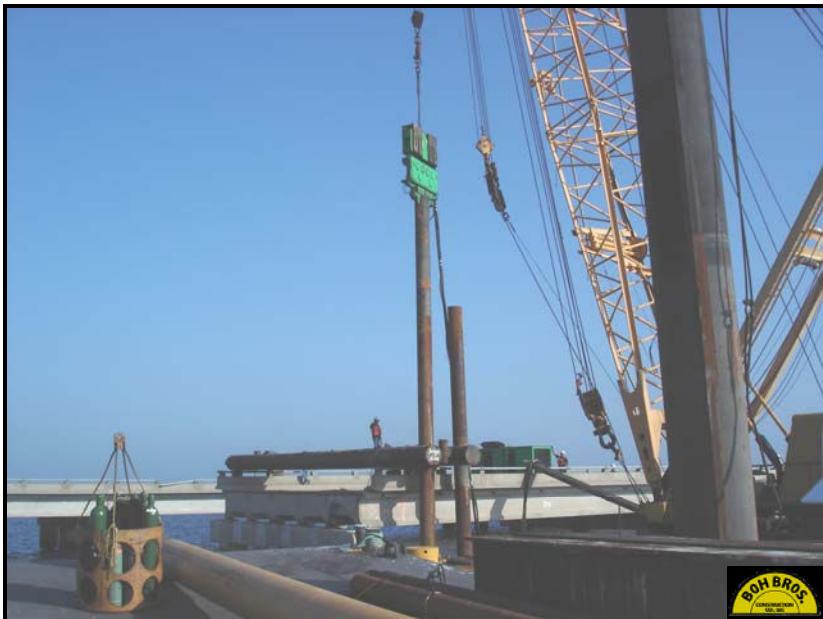
**Figure 10:** Cap Saddle

#### **Installing Alternative Deck Supports (Helper Bents)**

In addition, several piles were damaged from the impact of decks sliding into the lake. Since it was difficult to evaluate the extent of damage to these piles, steel bents were installed to add reliability to damaged pile groups. The new bents were constructed by adding one steel support to on each side of the damaged pile group (Figure 11). The supports consisted of two round hollow steel piles on each side of the bridge span. A short transfer member was installed between piles, which supported a double steel girder passing beneath the bridge and supporting the girders. These bents were able to be constructed without removing existing pile groups or deck segments, resulting in significant time savings (Figure 12).



**Figure 11:** Auxiliary Steel Bent



**Figure 12:** Pile Installation for Auxiliary Steel Bents

## Summary

The devastation inflicted by Hurricane Katrina affected every aspect of life for the gulf coast residents from the south-eastern Parishes of Louisiana to Mobile Bay. To begin the process of re-building of these affected areas, restoring critical infrastructure was of paramount concern. The challenge of providing the crippled city with necessary workers and supplies increased exponentially without critical transportation routes into the City of New Orleans. For this reason, rebuilding the I-10 Twin Spans, crossing Lake Pontchartrain between Slidell, Louisiana and New Orleans East was considered the top transportation priority in the Louisiana. After a short 51 hour bid process, a local construction firm, Boh Bros. Construction Co. won the three phase project. Phase I included a 45-day schedule to re-open the east-bound span to two way traffic. Forty percent of the bridge decks of the east-bound span were shifted or removed from the piers completely and required repair. During Phase I normal construction challenges were compounded by the non-functioning infrastructure left by the storm. Through a series of innovations, and the resolve of Boh planners, superintendents and construction crews, these challenges were met and all expectations for completing the project were surpassed as the east-bound span was opened 16 days early.