TITLE

Huey P. Long Bridge - Innovative Truss Erection Procedure

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ABSTRACT

The Huey P. Long Bridge crosses the Mississippi River in New Orleans, Louisiana. Built in 1935, it is an 1840-foot three-span continuous cantilever truss bridge with an adjacent 530-foot simple span through truss which carries rail and vehicular traffic. This project will widen the bridge by adding two widening trusses to the existing trusses that form an integrated system (figure 1).

This stretch of the Mississippi River is a heavily traveled shipping channel, so one of the primary project goals was to minimize the risk of ship impact to falsework in the river. This gave rise to an innovative method to erect the primary trusses span by span that requires no falsework in the river.

The Huey P. Long Bridge erection will be a method never before attempted for spans of this magnitude. This paper outlines the erection of the widening trusses as well the rationale behind the selection of the erection method. It also describes the elements required to assure that the navigation closures will be held to the minimum.

Temporary stabilizing frames that span between the bottom chords of the proposed widening trusses brace the compression chord of the truss while lifting. The whole system is lifted at the four corners by strand jacks supported on the top of the widened pier trusses. Once the trusses are lifted 150
vertical feet, the stabilizing frames telescope inward to move the widening trusses transversely and then lower them slightly onto their permanent bearings.

**INTRODUCTION**

A viable span by span erection scheme must include a plan that minimizes the navigation outages. This is particularly important in this location as the shipping traffic into the New Orleans port is extremely heavy at this bridge. Efficient execution of the lifts to stay within the 54 hour navigation closure is accomplished by paying close attention to the details. Quick connections must be made. Systems must have back up plans and the plan must be carefully laid out. This paper describes the connections and movable parts needed to accomplish a well executed lift that will assure that the process is accomplished within the allotted window. But first, a discussion of what caused consideration and the eventual implementation of this concept is warranted.

In 1916, Ralph Modjeski likely stood on the bank of the Mississippi River and envisioned a great accomplishment. He began to design a high level bridge carrying freight and passengers via steel rails and concrete roadways; a critical link for the growing city of New Orleans. There was significant barge traffic at the time and also ocean going vessels, but he likely also imagined massive ocean going vessels someday lining the river, passing beneath his proposed engineering marvel. 19 years later that bridge opened to traffic in 1935.

72 years after it opened, in 2007, those responsible to widen this bridge stood on the bank of the Mississippi river near this great bridge and wondered how they could keep these now ever passing massive ocean going vessels from colliding into the temporary shoring towers needed to widen this landmark. They now had much more at stake than the temporary set back to
construction the original builder faced if the falsework were to be hit. The bridge now carries more than 50,000 vehicles a day by road and countless tons of freight by rail.

The challenge they faced now was complicated by the fact that they must widen the bridge while dodging large ships and significant barge traffic. Not to mention the constant passing of trains and bumper to bumper traffic or the potential, if they did not take care during construction, of harming the existing 75-year-old truss that must be tied into.

PRE-BID ERECTION PLANNING

In the spring of 2007, prior to the bid to widen the Huey P Long Bridge; HNTB, Massman, Traylor and IHI worked together to brainstorm alternate methods of erecting the truss widening panels. During this process they looked at building the widening panels on falsework, building in balanced cantilever, hoisting with derricks, and hoisting off of the existing trusses. They considered these alternate methods of erecting the truss at a very high level. They looked at the stick build on falsework method as outlined in the plans in detail to assure themselves that this method was feasible. They carefully reviewed the manner in which they would connect to the existing truss while building the widening panels, knowing that some panel points would be as much as 11 inches higher or lower than the existing truss during construction until they displaced into their final position level with the existing bridge.

Normally when erecting a long span truss bridge one considers building the primary and secondary superstructure members down on the ground and floating the entire span out and lifting it into place. For a completely new bridge this is possible since the bridge is stable as it is lifted. In the case of the widening of the Huey P. Long Bridge this method is not possible as the existing bridge impedes such a lift. Therefore, when it was initially considered to raise large
sections, the thought was to raise each single-plane truss panel up individually. With each method that was considered to do this, the team ran into roadblocks that kept them from exploring these alternates further. In June of 2007, MTI submitted a bid settling for the stick build on falsework method that they knew was difficult to execute but possible to build. The submitted method was very similar to the method used to construct the original bridge (figure 2).

POST-BID ERECTION PLANNING

After the bid, they took more time to study alternate methods of erecting the primary truss widening panels. To do this, they knew that the top chord must be braced so that it would not buckle. So they investigated the traditional bow string method often used to brace the top flange of a plate girder element. Unfortunately, since the truss sections they planned to lift were over 500 ft long and nearly 100 foot high the bowstrings became so large that significant weight was added to the system and the stabilizing bow strings needed to be stabilized and so on. It was quickly realized this was not a viable solution. So another idea was considered: raising the single panel trusses from multiple picking points by installing picking beams to the existing truss above. This method became unattractive quickly as the size of the picking beams were heavy and simply erecting those beams took a sizable crane and put undesirable loads into the existing truss during the lift. So a balanced cantilever solution was considered.

The Balanced Cantilever method afforded the benefit of reducing the likelihood of ship impact. However, it did not completely remove this possibility as the diagonal strut members required at the piers would infringe on the navigation window and could be struck by a vessel that traversed the channel next to one of the main piers. The weight of the balance cantilever temporary structure at the piers was significant and the geometry was also complex. This method
also did not eliminate the large predicted displacements of the widening truss during construction
that would occur with the stick build method.

Finally, after exploring countless alternate erection methods that had fatal flaws, a
method that would link both of the trusses together in a manner analogous to a through plate
girder Railroad Bridge was considered. However, in this case, the through plate girders were
nearly 100 feet high, over 500 feet long and the “girders” were 160 feet apart. These “girders”
also had to be moved transversely after they were raised, so the trusses and their braces had to
have the ability to telescope inward. It was clear that this was a viable span by span erection
method (figure 3), it had its challenges, but the challenges could be overcome.

**BENEFITS OF THE SPAN BY SPAN SOLUTION**

**Falsework** - The elimination of falsework in the navigation spans was one of the primary
reasons to look at alternate methods to the stick build method. Water depths are about 100 feet,
the truss is 150 feet above the water and the soils are weak. Therefore, the shoring towers would
have a total height of 350 feet from pile tip to the bottom of the truss. Given the size of vessels
that traverse the channel and the importance of maintaining the integrity of the existing bridge
during construction, significant temporary dolphins would have been required to protect the
falsework during construction (figure 4). The clear benefits to the span by span approach are that
the risk to the traveling public and rail traffic due to vessel impact to the falsework is completely
removed, and the cost of the falsework and protection cells is eliminated.

**Impact to Navigation** - Erecting the Huey P. Long piece by piece would have required
significant time in the navigation channel. It would have been a little like trying to paint the
traffic lines on a roadway in live traffic with a paint bucket and a hand brush. Running in and out
of traffic is dangerous and time consuming. With the span by span method, the major lifts will require a maximum of 54 hours of river closure 3 times instead of hundreds of six-hour River closures required for the stick build method of erection.

**Improved Fit-Up of Secondary Members** - In the construction of new trusses on falsework, the primary trusses displace together as they are built incrementally. The precise final deflected shape is not as critical. However, when building a new truss panel next to an existing truss panel, displacement of the new truss has a great effect as the secondary members must account for the differential displacement. For this bridge it was predicted that the differential displacement could vary by as much as 11 inches. This required temporary connections with long slotted holes and the ability for rotation at the connections. One of the major concerns is that these connections would have frozen up and would have induced additional load into the existing truss and potentially overstressed the existing truss. This was the primary reason for including a truss monitoring program into the contract. The span by span method has less than 3 inches of differential displacement at any time and less than one inch once the permanent secondary members are connected between the existing and proposed widening trusses.

**Reduced Exposure to Hurricanes** - The span by span method affords the opportunity to quickly brace an entire panel to the existing truss, so that it is stable in the event of a hurricane. The stick build construction method nearly always resulted in a situation where a partially built truss existed and would need to be secured in the event of a tropical storm.

**Improved Schedule and Safety** - The span by span method allows a significant portion of the truss to be built near the ground and without the need for temporary connections and slotted holes. This allows for better production on the erection of the truss and improves worker safety.
THE SPAN BY SPAN LIFTS

The first span to be lifted by the span by span method will be the East Bank anchor arm. The first step to the Span by Span method will be to erect the stabilizing frames on the barge assembly, which consists of two main floor beams and three dimensional space frames at each end that support the top chord of the widening trusses against buckling. The barge assembly will be moored next to the bank along the East Bank north of the bridge. Next to the barge, there will be a platform to support a crane and provide access to the barge assembly. After the stabilizing frames are constructed the widening trusses will be erected on the barges, using the stabilizing frames to support the trusses laterally during stick by stick erection on the barge.

While the trusses are being erected on the barges, lifting frames will be erected on the edges of the permanent pier trusses. The purpose of the lifting frames is to provide a lifting point base for the strand jacks that clear the permanent pier trusses (figure 5). These consist of a four legged tower that supports a double box beam that cantilevers roughly 20 feet past the front legs of the tower, over the edge of the pier trusses. Since the back tower legs will be in tension during the lift, they will be post-tensioned to the pier trusses prior to the lift with 8-2 ½ inch diameter 150 ksi bars. The double box beams support the strand jacks that are mounted to a sled that can be pulled transversely. The sleds under the jacks have Teflon adhered to the underside of the skid and will ride on stainless steel that is mounted to the top of the lifting frame beams. Prior to the lift, the strands will be installed in the jacks and pulled out of the way next to the piers temporarily. On the end of the strand a lifting point assembly will be attached that will allow a quick pin connection to each of the four corners of the truss assembly to be made. Temporary lifting plates are bolted to the end gusset plates of the widening trusses to provide a lifting point connection that will be pinned to the strand end connecting plates.
Navigation Closure Window - Critical to the success of this erection plan is the effective and efficient movement of the trusses from the shore of the Mississippi River to their final resting place on their bearings. A combination of tug boat and anchor lines will move the lifts into position in a controlled manner. Once the assembly is positioned for the lift, details that allow quick connections to be made and facilitate “rapid” movement of the trusses both vertically and laterally are the first part of an efficient lift. At the four corners of the assembly are the lifting point connections. These connections are made by driving a pin through teardrop shaped holes in the “L0” gusset plates and the ends of the lifting blocks. The strands are terminated in a lifting block that is welded to two gusset plates that have teardrop shape holes. The “L0” gusset plates have also been modified so this pin can be driven though a complimentary teardrop shape hole. The shape of the holes are teardrop shaped to allow the pins to be installed quickly and when the strands begin to lift the pin slides up into the narrow portion of the teardrop hole to provide full bearing between the pin and the lifting plates. This system will allow the strand jacks to engage the 2,800 ton load quickly and began the lift soon after the assembly is in position (figures 6 and 7). Once the assembly is clear of the barges, the trusses are adjusted to grade and then raised 150 feet to an elevation about 6 inches above its final elevation.

At this point the stability frame floorbeams will be blocked against the bottom chord of the existing truss by horn guides that were pre-installed to the stability frame floorbeams. This stabilizes the system and prepares the stabilizing frames to begin to telescope the truss widening panels transversely. The components that are utilized to do this are the horizontal jacks mounted to an anchor and anchor lug assembly (figure 8) that will be connected by pins through the anchor lug and the top of the lifting beam. Once the jack goes through a full stroke and pulls the widening truss laterally, the pins will be removed and the jacks will be extended to their new
preset location, pins will be re-placed and the jacks will begin their second stroke. A similar attachment is designed for the horizontal jacks mounted to the top of the stabilizing beams that go between the trusses. The widening truss panels then pull the truss panels transversely about 15 feet until they are positioned directly above their final bearing location. Hillman rollers mounted to all four interior surfaces of the sleeve assembly allow this system to ride along the floorbeams and translate laterally. These jacks have to pull the frames laterally in concert with the horizontal jacks on top of the lifting frame beams. Six jacks per truss panel for a total of 12 jacks have to work together to pull the trusses laterally simultaneously.

Once the trusses are above their final location, the strand jacks lower the trusses to their final bearing location. Then the pre-installed horn beams from the top chord of the existing truss to the top chord of the widening truss are fastened by quick end connections that engage the widening trusses at four locations along the truss, moments after the trusses have landed on their permanent bearings (figure 8). Temporary floorbeams with quick pin connections at the ends are then installed. After these horizontal braces are installed the new widening panels are braced against buckling and construction wind loads. At this time, the stabilizing frames will be lifted slightly by the jacks that have been pre-installed to the outboard side of the permanent gussets on the widening truss directly above the stabilizing floor beams. The pins that connect the stabilizing frames to the trusses will be driven out and the trusses will then be free to be lowered back down on the barges.

The stabilizing frames are taken back to shore and re-used to raise the suspended span and the simple through span truss. Both of these spans are similar in length and the stability frame was designed to accommodate each of these trusses. The stability frames are used a total of three times.
After the primary truss panels are erected a smaller crane will be placed on the bridge and the secondary members will be erected from a temporary platform mounted to the new floorbeams. This crane will erect floorbeams and secondary members ahead of it and then it will swing a second temporary platform ahead of itself and walk ahead. It will continue to move ahead in this manner until all the secondary members are erected.

CONCLUSION

The widening of a truss bridge of this magnitude has not been attempted before and has a number of unique challenges. The intent of this paper is that through the study of this process, the readers will be challenged and inspired to come up with innovative solutions on the projects that they are involved with. Arriving at a viable solution for this project was only achieved after many other inferior concepts were explored. Critical to the success of this project is effective execution of the method to assure that the navigation channel closure is held to a minimum. The plans have been established, safety measures put in place. The remaining elements are careful construction and quality control to assure that the temporary works are built as planned and the construction sequence is carried out in accordance with the plan.

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FIGURES

Figure 1 – Rendering of Widening Trusses Erected

Figure 2 – Existing Bridge Under Construction

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Figure 3 – East Span Lift

Figure 4 – Stick Build with Falsework and Dolphins

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Figure 5 – Lifting Frame and Strand Jack

Figure 6 – Lifting Point Connection
Figure 7 – Teardrop Hole Detail

Figure 8 – Horizontal Jack – Anchor Lug Assembly