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Union Pacific Railroad Bridge 60.97 Reconstruction

Mansoor Ahsan, P.E.
Bridgefarmer & Associates, Inc. Dallas, Texas

ABSTRACT: Union Pacific Railroad Bridge 60.97 crosses the Trinity River near Goodrich, Texas. The railroad parallels U.S. Highway 59 at this location, and the railroad bridge is immediately upstream from the highway structure. The original bridge was built around the turn of the last century, and consisted of steel truss and plate girder spans on stone masonry and steel cylinder piers. The piers were founded on timber piling. Over the years several spans had been replaced. The main river crossing in early 2004 consisted (from south to north) of steel beam span approaches, a steel pony truss, a through-plate girder swing span, and a 150’-0” long through truss. The swing span dated from the period when the Trinity River was a navigable waterway, prior to the construction of Livingston Dam upstream of the bridge. The Trinity River has a history of flooding, and the railroad has experienced prior damage to several of its crossings. Steel sheet pile cofferdams were built around each of the existing piers to provide protection for the timber piles.

1 INTRODUCTION

1.1 Emergency Repairs (2004):

The Trinity River experienced severe flooding in 2004. Scour at the bridge site extended below the pier protection and undermined the timber pile foundations. This led to failure of a pier and partial collapse of the structure *(Figure 1 & 2)*. A train was crossing the bridge at the time of the failure, and had to be removed prior to repair work. This line is a critical part of the Union Pacific system, so repair crews worked around the clock to restore the bridge to service *(Figure 3)*. Union Pacific and contracted forces removed the pony truss span (to the left in *Figure 1*) and cut back the end of the swing span (to the right in *Figure 1& 2*). Two new pile bents were constructed to support new superstructure spans. One important time-saver in this process was the use of a replacement span that had originally been fabricated for a project in Louisiana on a different railroad. The Louisiana project had been delayed, making the span immediately available. The Union Pacific “borrowed” this span, agreeing to pay for fabrication of a replacement for it *(Figure 3)*.


Figure 1


Figure 2


Figure 3

1.2 Pier Replacement (2005):

After the emergency repairs were completed and traffic restored to the line (*Figure 4)*, Union Pacific planned further work on the bridge to prevent future problems. The plans for further work included replacement of the pier supporting the truss span and swing span, and replacement of the remaining portion of the swing span. Minimizing track outages was the major operational consideration for this work. Preventing any further damage to the existing pier during construction (that would affect its ability to support train traffic) was a critical structural concern. The original foundation design for the pier utilized large diameter drilled shafts upstream and downstream of the existing foundation *(Figure 5).* Single columns of the same diameter would be constructed atop the drilled shafts to near the bottom of the existing structure. A steel cross beam was designed to be placed across the tops of these columns to support bearings for the existing truss span and the new replacement span. Union Pacific selected D.H. Blattner & Sons, Inc. as the general contractor for this work. Union Pacific selected Bridgefarmer & Associates, Inc. to provide construction engineering and construction monitoring services.

Figure 4

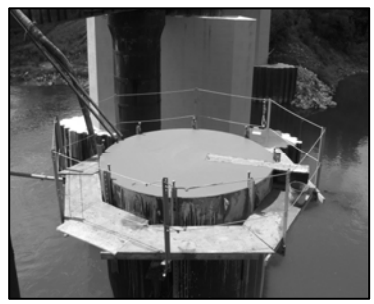


Figure 5

1.3 Foundation Redesign:

An initial concern was installation of the large diameter (10'-0") drilled shafts in close proximity to the existing pier. Given the uncertainties of the existing conditions following the flooding and the criticality of the pier, it was decided to replace the single large diameter shaft on each side of the pier with a group of five smaller diameter (36") shafts *(Figure 5)*. This would reduce the volume of earth displaced by any single shaft and also reduce the vibratory action on the foundation material. Bridgefarmer worked with Blattner and the Union Pacific to redesign the foundation for this concept. During construction of the drilled shafts, cross-hole sonic testing was used to verify the integrity and adequacy of the shafts. Nine of the ten shafts tested satisfactorily following final placement of the concrete fill *(Figure 5)*. The tenth showed indications of voids or some other form of discontinuity through several zones of the shaft. The drilled shaft subcontractor attempted repairs to this shaft, but a second round of testing still showed the anomalies in the shaft. Delay caused by the shaft condition threatened to push construction into high-water periods. Bridgefarmer engineers consulted with the Railroad and the Contractor on this issue, and two additional H-piling were driven adjacent to the problem shaft to provide additional support for the footing and allow construction to continue.

Figure 6

Figure 7

1.4 Hurricane Rita:

Events in the fall of 2005 showed that the construction schedule concerns were correct. Hurricane Rita struck southeastern Texas on September 24, 2005. The Lake Livingston Dam was damaged, leading officials to release very large quantities of water into the Trinity River to prevent a feared failure of the structure. Within hours, river flow rose from typical levels of 1,000 to 5,000 cfs to 79,200 cfs, causing high currents in the river, sudden water level increases, and significant downstream flooding. The Trinity River Bridge survived this sudden onslaught of water. However, one of the work barges was carried by the high water into the adjacent U.S. 59 Bridge, causing concern for that structure *(Figure 8 & 9)*. Within several days, the pressure on the Lake Livingston Dam was relieved and the water levels returned to normal. After some clean-up, the Contractor was able to resume work on the pier replacement.

Figure 8

Figure 9

1.5 Superstructure Span Replacement:

The unpredictability of the Trinity River demonstrated the need for an alternative means (from barge-mounted cranes) of setting the replacement superstructure span. Mammoet, a heavy lift contracting firm, teamed with D.H. Blattner & Sons to develop a unique span erection scheme. In this, high-capacity gantries were placed on the new bridge piers, allowing lifting and swinging of bridge spans without the use of large cranes. Bridgefarmer & Associates carefully reviewed the plans for the gantries and lift procedures, assessing the impact on the newly constructed piers and the loading on the existing structure.

Figure 7

Figure 8

Figure 9

2 SUPERSTRUCTURE ERECTION SEQUENCE

Bridgefarmer staff was on-site during the span replacement. This was a complex construction process performed under a tight schedule over the Thanksgiving holiday closed to train traffic only four days. The interruption to train service was minimized to prevent extensive disruption to rail traffic on the Union Pacific network.

The superstructure erection sequence included:

- Shutting down train operations
- Setting the jacking gantry units in place on the bridge and corbels
- Cutting free the existing connections
- Positioning the cross girder via rail, rotating it in place on a railcar turntable, then attaching to gantry
- Lifting the new 245k lb. & old span with the gantry through-plate girder (TPG) onto the railcar
- Transporting, via rail, the TPG and connecting it to a gantry and the existing span
- Skidding the old span onto the railcar
- Cut the tops off the existing piers
- Jack up the existing truss to allow installation of the new cross girder
- Install the new cross girder & the new TPG
- Lower and shim in place the existing truss section
- Place track panels
- Demolish remainder of the existing piers and install pier protection

The total outage time for the replacement was approximately 40 hours. At the end of this period, the bridge was reopened to traffic and has performed well since.

3 MEETING CLIENT NEEDS

During this project, Bridgefarmer & Associates, Inc. was fully committed to meeting the needs of the Union Pacific Railroad and exceeding the client's expectations. Due to the location over the Trinity River, the UPRR was faced with very specific constraints. These constraints were:

- Bridge construction must be performed in a safe manner
- Due to volatile river flows accessing the site by barge was sometimes difficult
- The Trinity river must remain navigable
- Placing the new span from the bank by crane proved impractical
- A minimal construction window was provided for the span change-out

To meet these constraints and complete the scoped tasks was priority for Bridgefarmer. The tasks involved in this included:

- Redesign of the replacement pier foundation to minimize potential impacts on the adjacent existing pier.
- Consultation on drilled shaft anomalies, leading to the recommendation to install supplemental piling in order to expedite project completion.
- On-site project support to provide detailed information to Union Pacific staff on the construction status and issues.
- Prompt turn-around of important submittals, allowing the project to continue on schedule.
- On-call consultation during Hurricane Rita.
- Review of the Contractor's innovative erection proposal, and site monitoring of this work during construction.
- Close cooperation and partnering with the Railroad and Contractor throughout the project.

4) CONCLUSIONS

This project shows the value of innovative engineering combined with dedicated customer service, and a practical approach to a problem. The pier replacement was carried to completion despite a variety of challenges. Throughout, the client's interests were served and protected by the consulting engineer, leading to the successful completion of this important project *(Figure 10 & 11)*. This project is a classic case of the owner, the engineer and the contractor working together for the same goal, bringing best engineering and construction minds concurrently to solve a problem by thinking "out of the box" an uncommon phenomenon in the US construction industry.

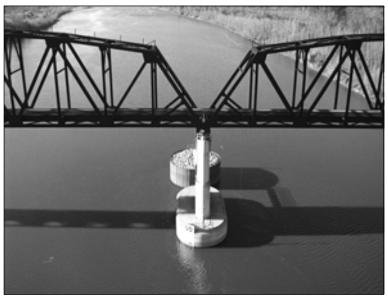
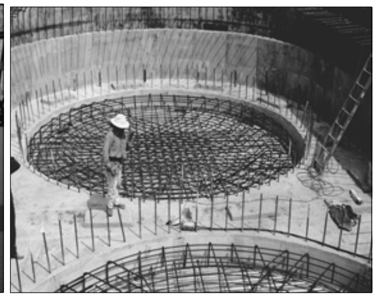
Figure 10


Figure 11

5) REFERENCES/SIMILAR WORK PERFORMED

L&A Railroad Bridge over Red River

GEC for alternative routes, design, PS&E and construction management


4,795 ft bridge consisting of: 3-through truss spans, 7-plate girder spans and 3,011 ft prestr. conc. approach spans