TECHSUMMARY *September 2018*

State Project No. 30001020 / LTRC Project No. 13-4ST

I-10 Girder Repair Using Post-Tensioned Steel Rods and Carbon Fiber Composite Cables (CFCC)

Figure 1
Distance view of the eastbound bridge

Figure 2
Carbon-fiber composite table

INTRODUCTION

The I-10 Littlewood Bridge is a two-bound 250-ft. span prestressed concrete girder bridge. Each bound consists of six prestressed cornet girders. Portions of the girders have been submerged in relatively stagnant water since completion of construction. As a result, these girders experienced severe corrosion in the prestress strands and spalling of the concrete in the submerged portion of the girders (See Figure 1). Several of the strands were observed to be broken. The Louisiana Department of Transportation and Development (DOTD) decided to externally reinforce the girders to ensure the safety of the bridge. The external reinforcement consisted of steel reinforcing bars. There was a concern on the use of unprotected steel reinforcing bars that will be exposed to a wet environment most of the time. It was determined that one of the spans (all six girders) would be reinforced with carbon fiber composite cables (CFCC) due to their excellent corrosion resistance property (see Figure 2). A 30 kips tension was applied to the CFCC cables. Results from a previously funded study, LTRC 07-3ST, titled "Repairing/Strengthening of Bridges with Post-tensioned FRP Materials and Performance Evaluation," where theoretical work was performed and CFCC was used as a reinforcing system designed to strengthen a load posted bridge, were used on this current project.

OBJECTIVE

The objective of this research was to continuously monitor the stress changes in all external reinforcement to ensure the safety of the bridge structure. This monitoring effort assisted the Department in the future operation of the bridge. In addition, since both the traditional steel reinforcement and CFCC were used, comparisons of the long-term performance of the two materials were made.

SCOPE

Researchers continuously monitored the stresses in the external reinforcement for changes that could impact the performance of the bridge to ensure public safety. Specifically, the work included:

LTRC Report 579

Read online summary or final report:
www.ltrc.lsu.edu/publications.html

PRINCIPAL INVESTIGATOR:
Ching Tsai, Ph.D., P.E.

LTRC CONTACT:
Walid Alaywan, Ph.D., P.E.
225.767.9106

FUNDING:
State: TT-Reg

Louisiana Transportation Research Center

4101 Gourrier Ave
Baton Rouge, LA 70808-4443

www.ltrc.lsu.edu

- Routinely monitoring data to ensure the system is working order;
- Observing the behavior differences between steel rods and CFCCs, if any;
- Observing behavior changes of the repaired bridge; and
- Analyzing the data to provide recommendations for the future implementation potential of CFCC for external post-tensioning.

METHODOLOGY

The research approach consisted of the prepararing an instrumentation plan for the strengthening rods to be used in strengthening the bridge. Once the CFCCs (carbon fiber composite cables) were acquired and installed, data were collected to assess the performance of the reinforcement. Collected data were evaluated on a weekly to bi-weekly basis to determine the effectiveness of the repair.

CONCLUSIONS

This project explored using only external post-tensioning elements to extend the life of a heavily deteriorated bridges. To study the effects on the external reinforcement, two types of material were used: steel and CFCCs. The findings can be separated into two categories: structural safety and material behavior differences.

The following conclusions can be drawn:

- The current state of the bridge appears to be safe for the traveling public.
- Even after the repair, the bridge structures continued to deteriorate.
- The rates of deterioration for the steel reinforced girders are insignificant.
- There is no indication that the external steel reinforcing bars have experienced any corrosions with the monitoring period.
- Based on the data, minor warping (bending not along the direction of the maximum resistance) has been observed in some girders.
- It appears that some girders at CFCC reinforced span deteriorated at a higher rate than the other monitoring girders. It is possible that the difference between the CFCC reinforced girders and steel reinforced girders is due to the pre-existing conditions.
- Most severe warping was also observed on Girders 4 and 5 of the CFCC-reinforced span.
- With the two layer of insulations for the CFCCs, the temperature effects on the CFCCs are insignificant.
- The external steel reinforcing bars are strongly affected by the ambient temperatures.
- The behavior differences between the steel and CFCC may be attributable to the temperature responses and structural conditions.
- There is no evidence of corrosion of the external reinforcing steel during the monitoring period. Note that, as of the time of this report, the reinforcement system had only been installed for less than 2 years. The long-term effectiveness of the galvanization on the steel cannot be determined with such a short-term observation period.
- The relative short observation period precludes the determination of the suitability of either material.