INNOVATIVE DESIGN

OF

BRIDGE RAILINGS FOR

TEMPORARY STEEL BRIDGES

Field Review Report

Replacement of Bridges #1 & #86, San Juan, Puerto Rico

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Introduction:

The purpose of this report is to document an innovative design of bridge railings for temporary steel bridges. In addition, to provide feedback to the people who provided information and assisted in the development of this design.

The Puerto Rico Highway and Transportation Authority (PRHTA) is replacing two bridges over the San Antonio Channel. These bridges provide access to the capital city of San Juan. Two temporary steel bridges (Acrow type) were assembled paralleled, and side by side, as part of the temporary traffic control. One bridge has three lanes, and the other has two lanes, for a total of five lanes in one direction. After the construction of the first proposed bridge and during the construction of the second proposed bridge, the traffic will be detoured thru the temporary bridges, this time in the opposite direction. This mean that the temporary bridges will remain in place and open to the public for few years (2 -3 years).

The PRHTA was concerned about the protection of the temporary bridges longitudinal trusses in case of an accident, due to the high traffic volume on this road, including heavy truck traffic generated by the Port of San Juan. The problem was **how to install bridge railings to the structures**, because these bridges did not provide bridge railings. These type of bridges were not designed with bridge railings, due to the nature of their intended low speed temporary/military use.

The Puerto Rico Division and the PRHTA conducted several safety field reviews in order to improve the safety at these temporary steel bridges. The FHWA Eastern Resource Center (ERC) and the FHWA Eastern Federal Lands Division (EFLHD) provided valuable information from a similar situation with temporary steel bridges at the Baltimore-Washington Memorial Parkway. The pictures provided by the EFLHD's Construction Area, and the technical assistance provided by the ERC were very helpful in the solution of the problem.

Findings:

1. The safety on this high speed, high volume, extremely important NHS route, deserved special attention before opening to the public.

2. The gap distance (approx. 12 inches open space) between the bridge curb and the longitudinal trusses created a big drop off that was very dangerous.

3. The bridge approaches were a mayor concern due to the geometry of the temporary alignment, which included sharp curves at both ends of the bridges.

4. If an accident on this bridge damaged a longitudinal truss, then the structural integrity of the bridge could be jeopardized. As a consequence, the closing of this bridge could block the entrance/exit to the city of San Juan, causing a mayor grid lock.

5. The gap distance between the bridge curb and the longitudinal trusses was different for each bridge, requiring a different solution for each bridge.

6. The connection/installation of the proposed bridge railing system to the bridge represented a challenge, because bridge railing post could not be attached or bolted to the bridge deck.

7. The bridges are exposed to a severe salt water environment.

Recommendation:

The PRHTA should design a bridge railing system for these bridges in order to protect the longitudinal trusses and to protect motorist from falling at the big gap between the bridge curb and the longitudinal trusses. It is extremely important to have the face of the w-beam aligned flush with the bridge deck curb. An innovative connection of the bridge railing to the longitudinal trusses is required. The bridge railings shall be corrosion proof, due to the salt water environment.

Safety Improvements Implemented:

The ERC and the EFLHD provided pictures from some temporary steel bridges located at the B/W Parkway. Based on these pictures, the PRHTA designed a unique bridge railing system (see Picture #1). However, the B/W Parkway design was also used.

The entrance or approaches to the bridge were a major concern (due to the geometry), and the PRHTA wanted a rigid system (minimum deflection) at these location. Consequently, the PRHTA's design was used at the bridge approaches only, and the B/W Parkway design was used at the middle/remaining of the bridge. Picture #2 depicts the transition from the PRHTA's design (left side) to the B/W Parkway design (right side).

The design of the bridge railing at the B/W Parkway called for a mechanical connection of the thrie-beam plank and block out to the **middle** of the longitudinal truss (see Picture #10 for detail). The PRHTA supplemented this design by adding a post and mechanically connecting this post to the **top** of the trusses, instead of having only a block out and the plank attached at the middle of the truss. The PRHTA designed the bridge railing system using the criteria from the AASHTO's Standard Specifications for Highway Bridges. The structural designer used the loads specified for the design of bridge railings. See Picture #1 for a front view of the PRHTA's bridge railing design.

The PRHTA's design consisted of a longitudinal steel beam, bolted from transom to transom. The bottom of the bridge rail post is welded on top of this longitudinal beam (see Picture #7 for a sectional view). The top of the bridge rail post is mechanically connected to the top of the longitudinal trusses (see Picture #8-9 for a top view). The thrie-beam guardrail plank is attached to the post as usual (see Picture #6 for a front view). This bridge rail design has the guardrail thrie-beam plank flush with the bridge curb (see Picture #9 for a top view).

The gap distance from the bridge curb to the longitudinal truss was slightly different on each bridge. Consequently, the PRHTA's design was modified by adding a steel blockout at the top of the post (see Picture #7). The bridge with the smaller gap distance did not use the blockout at the top of the post (see Picture #8-9 for detail). This modification was necessary in order to maintain the guardrail beam flush with the bridge curb on both bridges. Find a sketch drawing of the PRHTA's design on Appendix A.

The PRHTA's bridge railings design was used at the bridge approaches only, and the B/W Parkway design was used at the middle/remaining part of the bridge (see Picture #3-4 for a front view at the middle of the bridge, B/W Parkway design). As mentioned above, the B/W Parkway design had the thrie-beam plank attached to the middle of the longitudinal truss only (see Picture #10-13 for details of this connection).

The following are advantages of the PRHTA' bridge railing design:

1. This bridge railing is portable, and can be use in the future. The bridge railing could be easily unbolted from the longitudinal trusses and transom, for future use on similar bridges. The bridge railing become part of the temporary bridge parts inventory.

2. Meets AASHTO's Standard Specifications for Highways and Bridges (designed for 10 kips load).

3. The bridge railing was painted with epoxy paint, making it resistance to corrosion. The hardware (bolts, nuts, and washers) are galvanized steel for corrosion protection.

4. It provides effective protection at the entrance and exit of the bridges, were it is most needed due to the geometry of the bridge approaches.

Summary:

With the technical assistance from the ERC, EFLHD, and the Division Office, the PRHTA was able to improve the safety at the temporary bridges by designing and implementing an innovative bridge railing.

Appendix A