Three Generations of Bridging Over the Cooper River

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Summary

This paper tells a story of two parallel landmark bridges carrying US 17 over the Cooper River and Town Creek in Charleston, South Carolina. The paper discusses how the bridges underwent stringent condition/maintenance inspection, followed by a major rehabilitation, and eventually replacement with a single wider next generation signature bridge. This paper features the aspects of inspection, maintenance, and design of high-level, long-span bridges. Both the John P. Grace Memorial Bridge, built in 1929, and the Silas N. Pearman Bridge, built in 1965, were about 2.7 miles long, and provided 155 ft vertical clearance for shipping vessels. Each bridge had two steel cantilever trusses with suspended center spans, one over the Cooper River and the other over Town Creek. The Grace Bridge had a width of 20 ft (two 10 ft lanes). In 1966, the parallel Pearman Bridge was opened to traffic. The Pearman Bridge had a width of 40 ft. At the time this bridge was opened, it consisted of two lanes carrying US 17 northbound traffic, and one reversible lane. By 1979, the Grace Bridge became functionally obsolete and the South Carolina Department of Transportation started planning its replacement. In 1987, the Department awarded a consultant contract for in-depth inspection and evaluation of these two bridges.

Figure 1 - Grace Bridge on the Left and Pearman Bridge on the Right

Keywords: Bridge Inspection, Rehabilitation; Cantilever Steel Truss; Fatigue Crack; Cable-Stayed Bridge.

Bridge Inspection: Prior to the 1987 bridge inspection work, the Grace Bridge was posted for a 10-ton weight limit; trucks were not allowed on the Grace Bridge. There were no such restrictions on the Pearman Bridge. However, the inspection revealed several defects in the Pearman Bridge structure which required immediate attention. The two major defects observed

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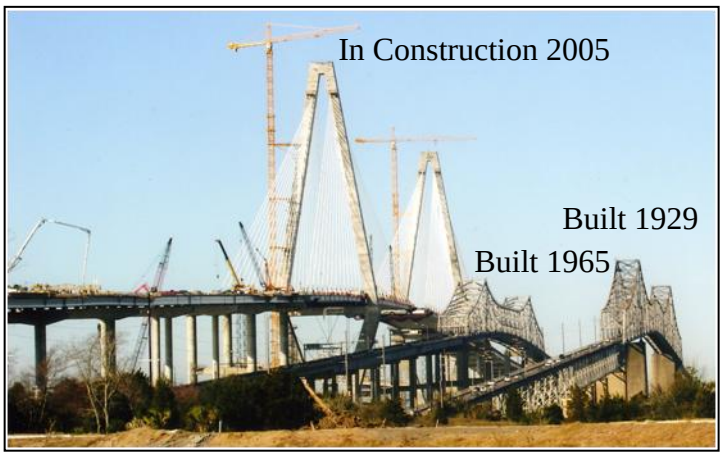
during the inspection were: 1) excessive movement, rotation and associated loud noise from the pin and link assemblies at the cantilever truss anchor supports with passage of heavy trucks; and, 2) cracks in the truss floorbeams.

Repair/Retrofit: Out of eight pin and link assemblies of the Pearman Bridge, four pin and link assemblies were replaced by 10" diameter pins (replacing the 9" diameter pins) and wider gusset plates and anchor plates. For the other four assemblies, the pin and links were replaced by a new 9" diameter pin and the existing gusset and anchor plates were utilized. The cantilever truss spans consisted of a concrete deck on continuous steel stringers supported by transverse floorbeams (40-inch deep welded plate girders) spaced at 38'-0". The floorbeams were connected to the truss plates at each end with full depth connection angles. Cracks were present at the ends of 14 floorbeam, some with cracks at both ends. The cracks initiated at the termination of the top flange-to-web welds at the notch and propagated through the web beyond the connection angles. The lengths of these cracks varied from ¼" to 10-1/4". All stringer expansion bearings (total 240) sitting on the floorbeams were replaced by bronze bearings. Additionally, three methods of retrofits were adopted. Method 1: Installed flange clip angles at floorbeam ends with no indications of cracks to connect the floorbeam top flange to the gusset plate. Method 2: Provided flange cope and installed T-connector for floorbeams with a measured crack less than 10" in length at a total of 12 locations. A portion of the floorbeam top flange and web were coped to eliminate the fatigue crack as well as the top flange notch. Angles were then added along the unstiffened edges of the web and a T-section installed to restrict top flange movement relative to the web. Method 3: Installed temporary support framing and replaced floorbeam ends under traffic where the crack was 10 inches or longer.

Bridge Replacement: The rehabilitation work extended the life of the Pearman Bridge. Neither of these bridges had emergency lanes, nor had medians. These issues created safety concerns. Also, the vertical clearance above the river could no longer accommodate the modern shipping vessels. Charleston's new bridge over the Cooper River is a cable-stayed bridge with two diamond-shaped towers, each soaring to a height of 575 feet.



The New Cooper River Bridge
Total Length – 13,200 feet (4 km)
Width – Eight 12-foot lanes plus a Bike/Pedestrian lane
Vertical Clearance – 186 feet
Opened to traffic on July 16, 2005

Figure 2 – The New Cooper River Bridge