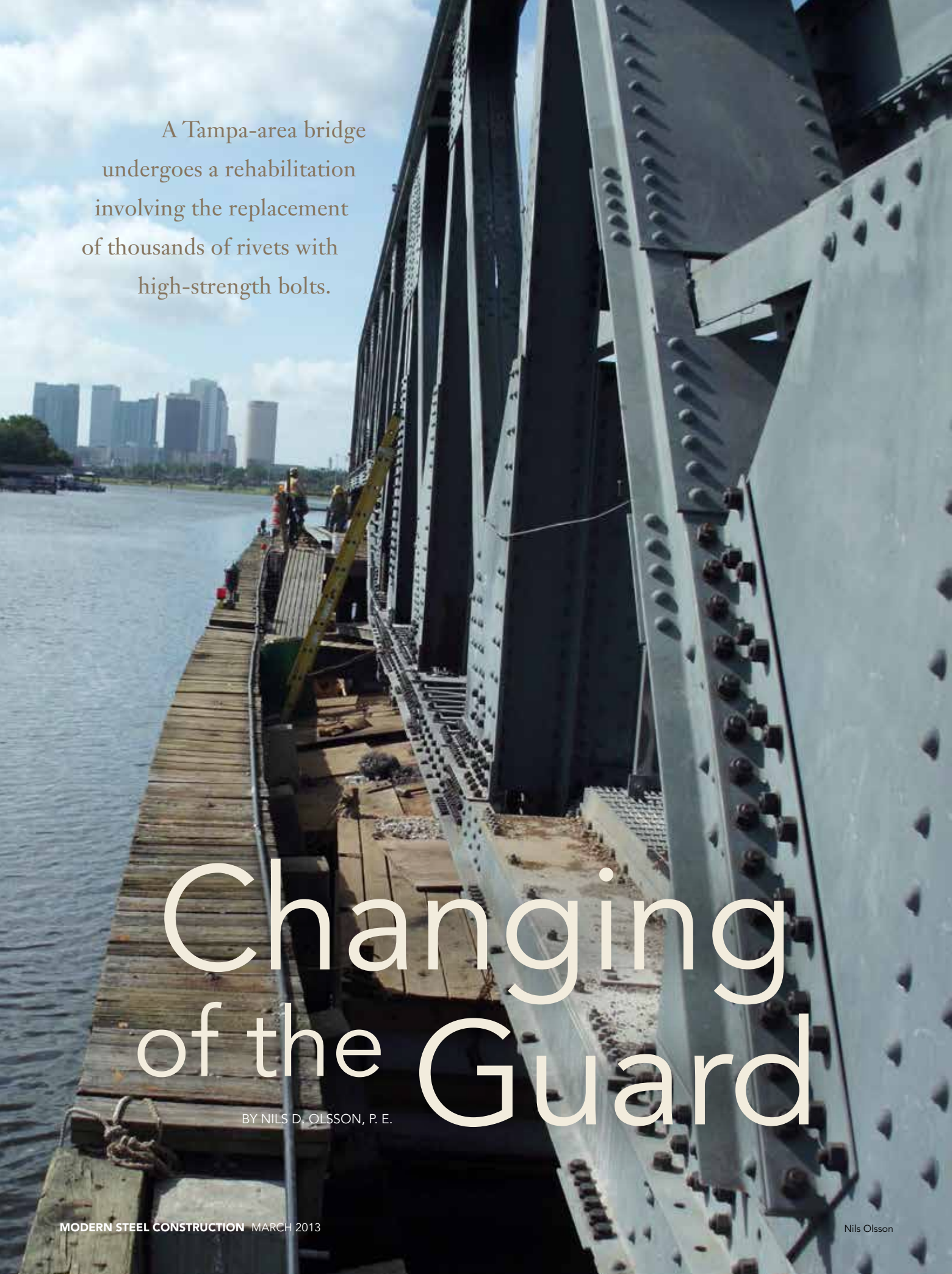

A Tampa-area bridge undergoes a rehabilitation involving the replacement of thousands of rivets with high-strength bolts.

Changing of the Guard

BY NILS D. OLSSON, P. E.

Nils Olsson

Parsons Brinckerhoff

▲ The rehabilitated swing span, in place.

▼ Rivet replacement taking place on an H-pile shoring platform.

Nils Olsson

THE RIVET IS A SYMBOL of a bygone steel construction era.

But there is a significant family of existing steel structures in America that are still held together with rivets—such as the Empire State Building and the Golden Gate Bridge.

Another one, though not as well-known as those two icons, is the Columbus Drive Bridge, which spans the south-flowing Hillsborough River in Tampa, Fla., and opened to traffic in 1927. The city of Tampa was first developed on the east side of the river, but with the influx of new residents following World War I, developers were anxious to expand into the area west of the river, so bridges were built to foster this westward expansion; the Columbus Drive Bridge (then known as the Michigan Avenue Bridge) was one of these. Early in its life, the bridge was opened an average of 10 times per day; today the openings mostly occur on weekends at the rate of three or four times per week.

The original configuration was for two lanes of automobile traffic, one track in the middle for streetcars and sidewalks on both sides. The heavily counterbalanced, 57-ft, 10¾-in. back span rotated about its pivot point in a counterclockwise direction when opening, and the 106-ft, 6-in main span responds in the counterclockwise direction to accommodate the skewed river channel. The west approach consisted of seven concrete spans, and the east side was composed of four concrete spans. Eventually, due to the decline of the streetcar, the streetcar tracks were removed and paved over to accommodate more automobile traffic, and the number of traffic lanes was increased from two to four (two in each direction).

After more than eight decades of service, the bridge had earned

◀ Originally opened in 1927, the Columbus Drive Bridge in Tampa was held together with 30,000 rivets.

▼ A mixture of rivets and bolts.

Nils Olsson

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Nils Olsson

Some of the new A325 high-strength bolts, which replaced a significant portion of the original rivets.

Nils Olsson

The bridge incorporates 128 tons of new steel.

an upgrade; the rehbilitation began last year and concluded early this year. The scope of the project included replacement of 110 tons of corroded structural elements, such as gusset plates for the trusses and angles for the many built-up sections, with 128 tons of new steel. As a consequence, nearly half of the bridge's original rivets would also be replaced with A-325 high-strength bolts.

The swing spans of the bridge consist of 740 tons of structural steel, including two side trusses, 43 ft apart, each tied together with transverse floor beams located at all 10 nodes of the trusses' nine panels, which are spaced 17 ft, 2 in. apart. Longitudinal stringers bear on these transverse members, which in turn support a steel, open-grid deck system that carries the roadway 6 ft below the top of the pony trusses. The sidewalks are cantilevered 5 ft, 6 in. off the trusses, opposite the roadway, at the 10 node points of the trusses. The trusses' back spans have a depth of 17 ft, 2 in. center to center, for three panels west of and six panels east of the pivot point. The forward part of the trusses continue east at the same depth for one panel, then taper to a shallow depth of 12 ft, 6 in. for the remaining five panels.

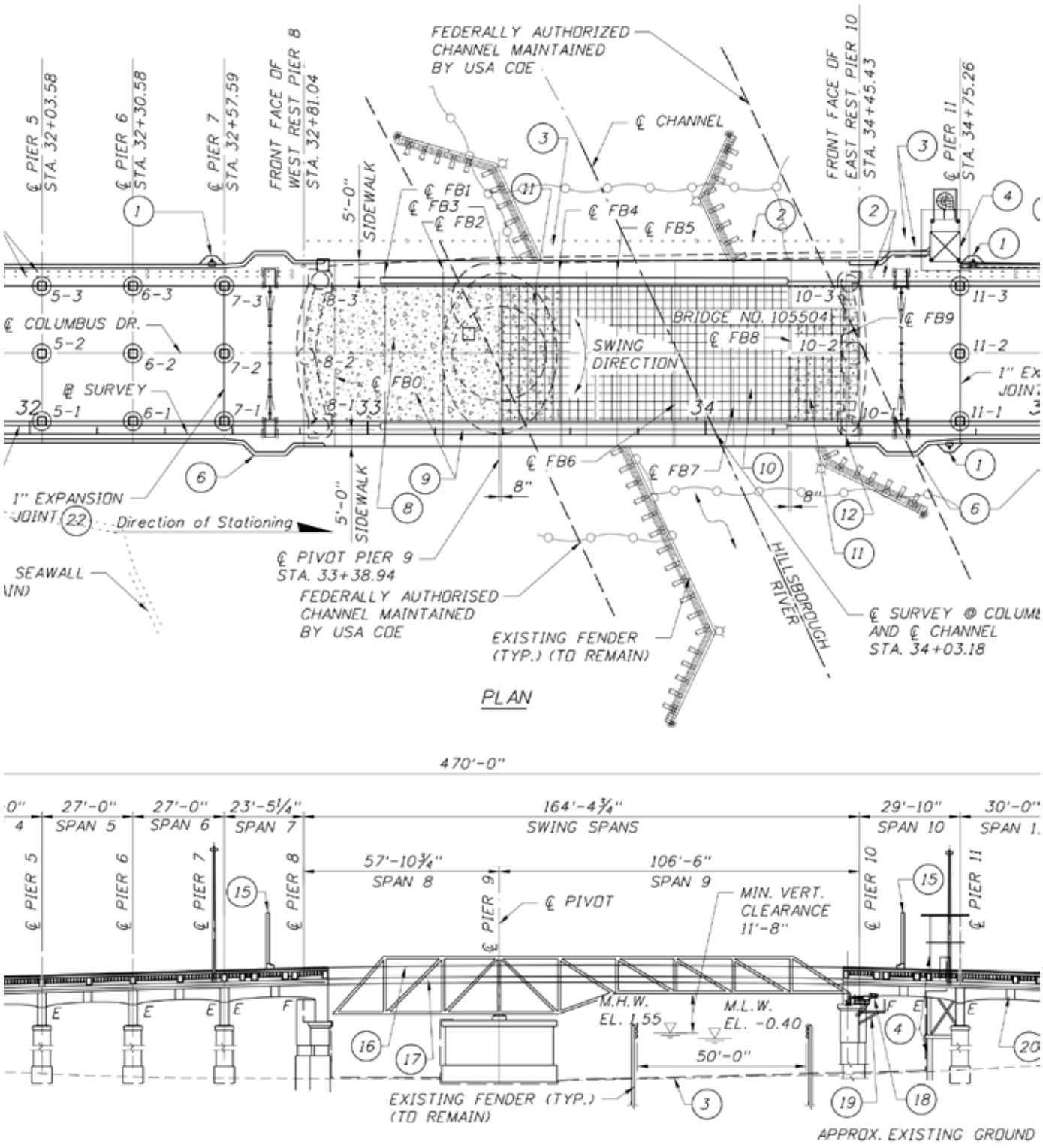
When exploring which elements required replacement, it was discovered that the lower portions of the structure had the most damage from corrosion. This was not surprising, as these areas accumulate dirt and debris, which would hold moisture and foster corrosion over long periods of time. However, corrosion seemed to develop more quickly in the eastbound lanes. A favorite theory is that boaters who used the marina on the west side of the river would pull the drain plug in their boat's hull, and when hauling their boat back over the bridge heading east, the salt water would drain onto the eastbound lane of the open-grid steel deck.

To perform the rivet replacement, the truss was lifted off its center bearing/pivot point and moved to H-pile shoring platforms immediately below the roadway; it was propped up with wood blocks to relieve dead load on the existing fasteners to facilitate the replacement process. Removing the rivets entailed grinding the battered end of the rivets, then applying a chisel to the ground head and striking the chisel with a pneumatic chipping hammer to pop off the head. Once the head was gone, a solid steel bar was matched up with the remaining rivet shank, which was then driven out of the hole by striking the steel rod with a sledge hammer. In all, 14,474 rivets were replaced (about 2,400 more than originally estimated).

While rivets aren't a common connection type with new construction, physical performance was not the cause; surging labor costs following World War II was the reason the labor-intensive rivet fell from favor as a steel fastener. Consider the iconic, steel-framed Firth of Forth Railroad Bridge—built in 1890—which spans its namesake waterway near Edinburgh, Scotland; its 6.5 million rivets serve as a testament to the structural validity of the connection.

Red Hot

The original design of the Columbus Drive Bridge was performed in accordance to the 1924 ASCE *Specification* and called for holes to be punched to a diameter of $^{15}/_{16}$ in. to receive the $^{7}/_{8}$-in.-diameter rivet. A highly skilled crew of four was required to install a single rivet. The rivet had to be heated for about 20 minutes to a cherry red color, which only an experienced eye could determine, and the required temperature of between 1,850 °F and 1,900 °F. From there, another worker would adroitly sling the hot rivet through the air to another worker, who would catch it in a handheld receptacle and insert it into the aligned holes in the overlapping plates. Once in the hole, the catcher would back up or "buck" the rivet as another worker on the opposite side of the plates would form the protruding red-hot shank into a nicely shaped dome with a pneumatic impact hammer.



Plan and south elevation drawings of the bridge.

Parsons Brinckerhoff

But when steel bridges and buildings from the riveted age do require upgrades, projects like the Columbus Avenue Bridge serve as an example of how they can be rehabilitated for continued service. The connections may change, but the structures themselves can live on regardless of what's holding them together. MSC

Owner

City of Tampa and Hillsborough County, Fla.

Structural Engineer

Parsons Brinckerhoff, Tampa

General Contractor

Archer Western, Tampa

Steel Fabricator and Detailer

Florida Structural Steel, Inc., Tampa, Fla. (AISC Member/NSBA Member/AISC Certified Fabricator)