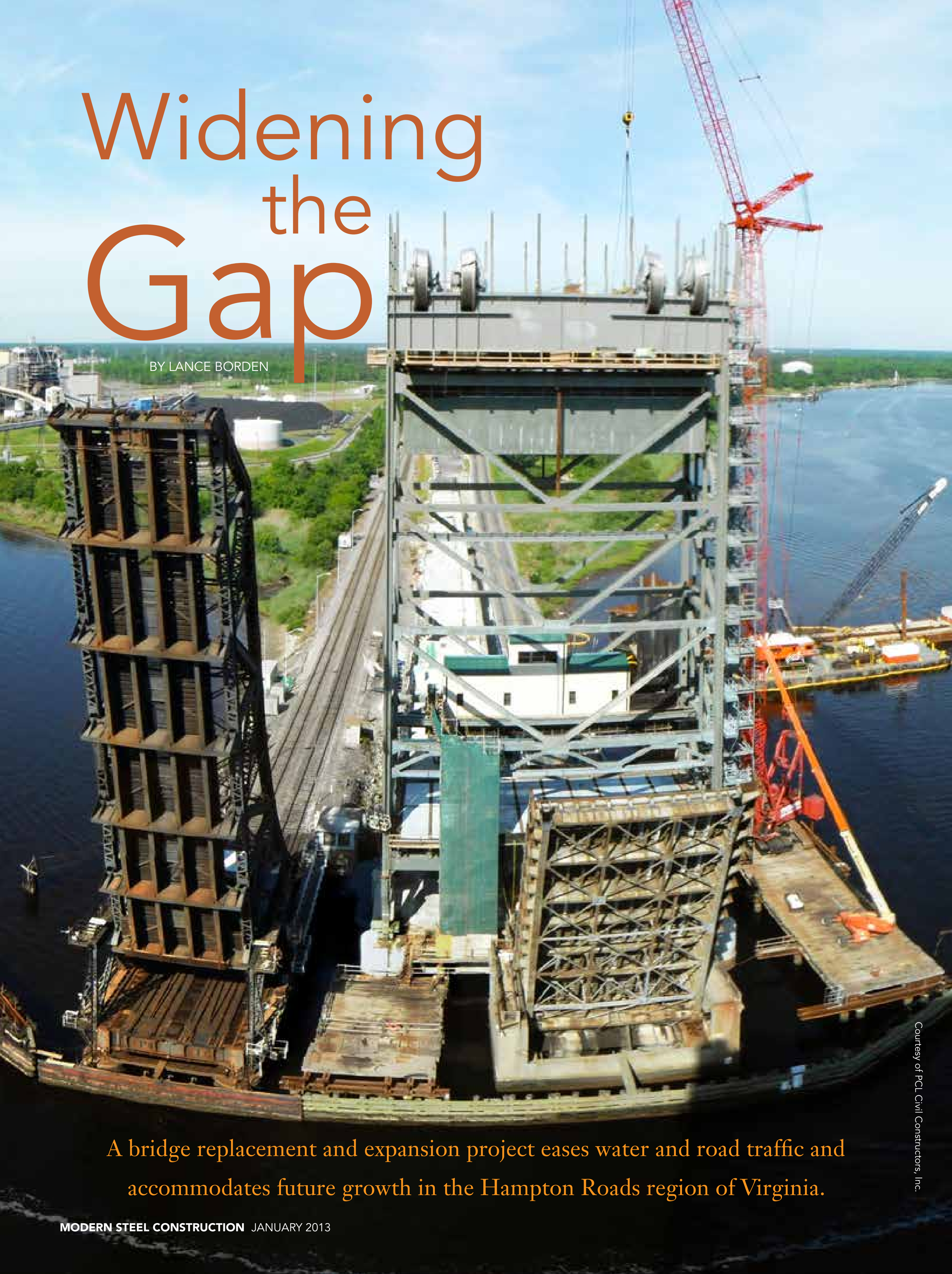
Widening the Gap

BY LANCE BORDEN



Courtesy of PCL Civil Constructors, Inc.

A bridge replacement and expansion project eases water and road traffic and accommodates future growth in the Hampton Roads region of Virginia.

Courtesy of Modjeski and Masters

Only 25 ft separate the Gilmerton Bridge from an adjacent railroad bridge.

ONE OF THE WORLD'S largest natural harbors and home to 1.7 million people, the Hampton Roads area in southeastern Virginia, is known for its year-round ice-free waterways, high concentration of military bases and shipyards, and miles of waterfront property.

The Henry G. Gilmerton Bridge is one of five critical bridges connecting the region and carries approximately one million travelers every month. In the late 1990s, nearly 70 years after the bridge was originally constructed, the City of Chesapeake recognized the need to replace the aging span to accommodate future growth in an area becoming increasingly congested both on the land and in the water.

The original bascule span's 11-ft clearance required a large number of bridge lifts, making it the most frequently opened bridge in Hampton Roads at 7,500 openings per year. It also carries Military Highway over the Elizabeth River and thus needed to assist with expanding the highway to help facilitate the area's increasing motor traffic.

As such, the City of Chesapeake embarked on a $134 million replacement project. Early plans called for building a new bridge on a separate alignment, then later demolishing the original bascule span. However, it was determined that any alternate alignment would further impact already tight navigational tolerances at the site. The city turned to bridge engineering firm Modjeski and Masters for the complex design assignment—one that required the new bridge to be built on the exact same alignment. Doing so, however, would potentially create a significant disruption of traffic. Military Highway is a critical artery in the Hampton Roads region, carrying more than 35,000 motorists every day,

The new bridge's two main lift towers, 207 ft tall, were erected directly over live traffic.

Lance Borden is a senior associate and design project manager with Modjeski and Masters. You can reach him at **lvborden@modjeski.com**.

The Gilmerton Bridge and railroad bridge, before construction.

and any lengthy disruption to traffic could significantly impact travel and commerce.

Above and Below

The design team thus came up with a plan that involved building the bridge above and below the existing structure, with the original bridge remaining functional until the float-in of the new span. The new bridge was originally proposed as a bascule span, but was later designed as a vertical lift bridge to accommodate the necessary increase in bridge length and width.

Construction of the new bridge began in late 2009, following completion of final design, and it is scheduled to be completed in 2014. As one of the challenges with the replacement project was minimizing impact on the traveling public, construction was not only coordinated around morning and evening rush hours but also around peak summer travel when both marine and motorist traffic are heavy.

With construction underway, the teams faced several challenges, starting with the proximity of a nearby railroad bridge. The railroad bridge, which is owned by Norfolk Southern, is a primary route for the coal industry and is heavily used. With only 25 ft between the Gilmerton Bridge and the railroad bridge—coupled with the necessity to create wider foundations for the new bridge—setting the foundations, constructing the substructure and demolishing the original bridge would need to be done in a way that did not disrupt the railroad bridge or its foundations. The team used seismic instruments to monitor and identify potential settlement impacts to the railroad bridge foundations during installation of the new drilled shafts. Fortunately, it was determined that the vibrations from a typical freight train passage were greater than those produced from the installation of the shafts.

Laying the foundations also presented a challenge for the construction and design teams. The Gilmerton Bridge is located in the Great Dismal Swamp, a marshy area on the coastal plains region with less than desirable soil conditions. To effectively support the new lift span, a total of eight 12-ft-diameter drilled shafts were needed. The drilled shaft foundations were designed to reach 120 ft below ground level, a feat that would require special equipment and a team of industry experts. The contractor, PCL Civil Constructors, used a specially made massive oscillator to drill the foundations, and the project features some of the largest drilled shafts ever constructed using the oscillating method.

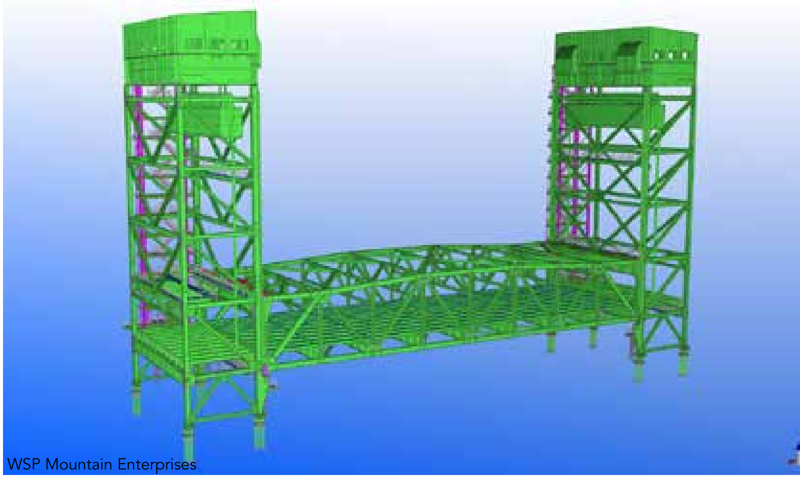
Above ground, 207-ft-tall steel main span lift towers were erected directly over live traffic. The towers span from 38 ft from center of front column to center of rear column and are 89 ft center to center, transversely, to match the lift span. The tower columns and horizontal braces are box shaped, with I-shaped diagonal bracing members. The new steel towers exceed the required 135 ft of vertical clearance for the 250-ft long and 85-ft wide lift span, which ended up being one of the widest lift spans ever designed. Due to the exceptional bridge width, four 15-ft-diameter sheaves, each carrying twelve 2¼-in.-diameter wire ropes, were required on each tower to support the load of the lift span and counterweights—twice as many as typically necessary.

The front and rear tower columns incorporate jacking brackets that allow the tower, with the full weight of the lift span and counterweight, to be jacked and shimmed should there be any differential settlement of the drilled shafts. Finger shims will

Courtesy of PCL Civil Constructors, Inc.

The new lift span has a vertical clearance of more than 35 ft in the closed position, compared to the original bridge's 11-ft clearance.

A 3D Tekla Structures model of the bridge.



WSP Mountain Enterprises

be placed under the tower bearings to bring the tower back to vertical and at the correct elevation.

It is typical on a vertical lift bridge for the bottom panel of the tower to be designed as a portal frame, because bracing cannot be used in order for the roadway to pass through the tower. On the Gilmerton Bridge the bottom panel is located where the existing bridge passes through the tower and the second panel is located where the new bridge roadway passes through the tower. Therefore, the two bottom panels of the tower are designed as portal frames. To relieve the moments in the tower columns that are realized by wind loading, the front and rear transverse floor beams were designed with full moment connections. In addition, the anchor bolts are post-tensioned in order to provide a fixed support at the base.

Wind loads control many of the bracing members in the towers. An aerodynamic study of the main span was performed during the design phase, which revealed that some of the tower bracing members may be susceptible to wind-induced vibrations. To solve this problem the flat plates that would normally make up the flanges of the I-shaped members were replaced with channels in order to increase their out-of-plane stiffness.

The bridge itself also needed to be designed and built in a way that would accommodate increased traffic and expansion of Military Highway. Again, proximity to the adjacent railroad bridge created challenges. A hard bend in the river south of the bridge eliminated the possibility of expanding in that direction, so Norfolk Southern's willingness to yield some of its right-of-way was the only way the wider bridge could be constructed. Ultimately, the new bridge is designed to carry six travel lanes, while the existing bridge carries four. Both outside lanes will be striped, allowing them to operate as shoulders before the necessary expansion.

The float-in of the lift span is scheduled to take place early this year, and the project is expected to finish later in the year. The new six-lane bridge is 1,908 ft long and 85 ft wide, with the lift bridge portion measuring 335 ft long. The final lift bridge will use a total of 5,000 tons of structural steel and 650 tons of miscellaneous steel. The new lift span has a vertical clearance of more than 35 ft in the closed position, compared to the original bridge's 11-ft clearance. Increased clearance will lead to fewer annual lifts, easing the strains placed on this movable bridge and facilitating maritime traffic flow by allowing more vessels to pass without additional bridge openings. It is predicted that the new bridge will see 40% fewer openings each year, easing traffic and marine congestion alike. MSC

Owner

Virginia Department of Transportation

Structural Engineer

Modjeski and Masters, Mechanicsburg, Pa.

General Contractor and Erector

PCL Civil Constructors, Inc., Chesapeake, Va.

Steel Team

Fabricator

Banker Steel Co., LLC, Lynchburg, Va. (AISC Member/ AISC Certified Fabricator/NSBA Member)

Detailer

WSP Mountain Enterprises, Inc., Sharpsburg, Md., (AISC Member)