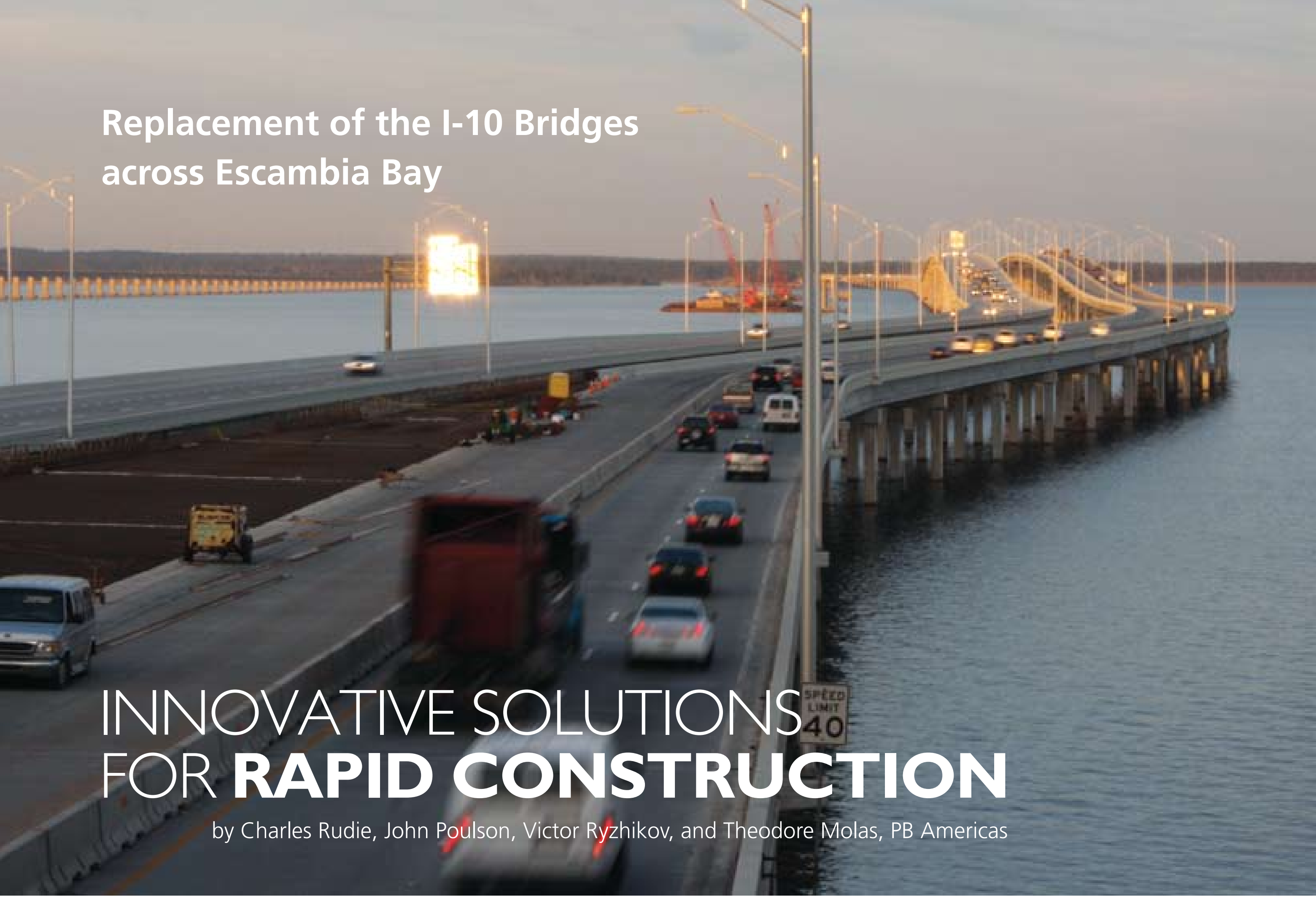
Replacement of the I-10 Bridges across Escambia Bay



INNOVATIVE SOLUTIONS FOR **RAPID CONSTRUCTION**

by Charles Rudie, John Poulson, Victor Ryzhikov, and Theodore Molas, PB Americas

Following Hurricane Ivan, emergency repairs were made to the westbound bridge using spans from the eastbound bridge. All Photos: Charles Rudie, PB.

Hurricane Ivan struck Florida's coast in September 2004 near Pensacola with devastating results. More than 50 spans of the existing 3-mile-long, I-10 bridges across Escambia Bay were washed into the bay and another 60 were permanently dislocated. In order to reopen I-10 to the public as quickly as possible, missing spans on the westbound bridge were replaced with entire spans from the more heavily damaged eastbound bridge. With the westbound bridge reopened, work shifted to the eastbound bridge. By replacing the missing spans of the superstructure with a temporary metal structure, the eastbound bridge was brought back into service, but for only one lane of traffic.

The Florida Department of Transportation (FDOT) quickly released a request for proposals (RFP) for the design-build replacement of the I-10 bridges. The request mandated that all traffic be moved onto the new structure by the end of 2006, and that the bridges be brought to their final condition consisting of three 12-ft-wide lanes of traffic with two 10-ft-wide shoulders no later than the end of 2007. The width of this typical section allowed for one bridge to temporarily carry four 12-ft-wide lanes and a center barrier until the second structure was finished.

Design-Build Approach

With notice to proceed given on April

profile

I-10 BRIDGE REPLACEMENT / ESCAMBIA BAY, FLA.

ENGINEER: PB Americas, Tampa, Fla.

PRIME CONTRACTOR: Tidewater Skanska Flatiron, Milton, Fla.

PRECASTERS: Standard Concrete Products Inc., Tampa, Fla., a PCI-certified producer; Gulf Coast Pre-Stress Inc., Pass Christian, Miss., a PCI-certified producer

POST-TENSIONING CONTRACTOR: VSL, Hanover, Md.

AWARDS: *2007 PCI Bridge Design Award for the Best Bridge with Spans Greater than 150 ft.*

25, 2005, the design-build team had less than 21 months to design and build the first new bridge. Both bridges would need to be completed in just 33 months. These milestones forced the design schedule to be very aggressive and to be split into several submittals. This allowed the precaster and the prime contractor to begin operations earlier than a traditional process would have allowed. The first submittal was delivered on May 20, 2005, clearing the way for pile fabrication and driving. The entire plan set was completed in September, just 5 months after notice to proceed.

Substructure

Several options were considered for the foundation, but 36-in.-square precast concrete piles were determined to be the most efficient and economical. The typical span could incorporate five piles located directly under five girders, allowing for a more efficient pile cap design.

The use of precast elements was instrumental in achieving the project's milestones. Precast elements not only eliminated time-consuming cast-in-place (CIP) construction on the water, but also allowed the contractor to utilize two precasters. The majority of the substructures consisted of precast pile caps resting on five piles. The other substructures were piers with waterline footings, which increased in size as they approached the channel. For a large number of the piers, two precast footings resting on three piles were used. This arrangement kept the weight of the footings to 80 tons, allowing the contractor to use the same equipment to erect precast piles, caps, footings, and girders.

The 36-in.-square piles have a 22.5-in.-diameter void throughout the length of the pile, except for a 4-ft solid section at the tip. This was done primarily for reduction in material and weight, but it also presented the opportunity to utilize precast pile caps and footings. The connection between the substructure element and the pile was made by inserting a rebar cage into the top 10 ft of the pile that extends into the pile cap, or footing. With a plug that extends 6 in. below the cage, the void was then filled with concrete. The length of connection was controlled by the stress transfer between the precast concrete of the pile and the CIP concrete of the plug.

Production piles were completed for the channel piers first. This was done because the spliced girders required substantially more time to erect than the rest of the superstructure. The footings for these piers needed to be cast-in-place, and the contractor employed a very clever method to accomplish this. First, a concrete seal slab was cast in the yard to create the bottom form. Next, a prefabricated rebar cage was placed on the seal slab. Steel side forms were then connected to the seal slab. The tops of the side forms were connected to each other with a series of steel girders. These girders were then connected to the seal slab with four steel tie rods. These rods were placed inside PVC pipes to accommodate removal after casting. This entire system was then lifted into place and set on top of the piles. The steel girders rested on top of steel pipes, which were placed on the piles. This process eliminated the need for friction collars on the piles and transferred the entire load down to the pile through compression. After the concrete was cast and given time to set, the steel pipes and tie rods were removed and the remaining holes filled.

After the footings were finished, work proceeded on the remainder of the substructure. Except for the previously mentioned precast pile caps, the remainder of the substructure was cast-in-place. The majority of the reinforcement in the columns, caps, and struts was pre-tied in the yard, or on a barge. As the formwork was erected, these pre-tied cages were set into place, making the elements ready for concrete quickly.

Spliced post-tensioned haunched girders with a drop-in span were used for the 250-ft-long main spans.

PRECAST, PRESTRESSED CONCRETE / FLORIDA DEPARTMENT OF TRANSPORTATION, TALLAHASSEE, FLA., OWNER

BRIDGE DESCRIPTION: Two 2.6-mile-long parallel bridges with precast, prestressed concrete beams and cast-in-place concrete deck with the first bridge completed in 20 months

STRUCTURAL COMPONENTS: 1024 78-in.-deep Florida bulb tees, 71 AASHTO Type II girders, 6 AASHTO Type I girders, 130 pile caps, 64 pile footings, 1346 3-ft-square piles, and 8 2-ft-square piles

DESIGN AND CONSTRUCTION COST: $245.6 million

Precast, prestressed concrete girders with a cast-in-place deck were the obvious choice.

Superstructure

The superstructure selection was heavily influenced by the RFP's requirement that the typical span length of the bridge had to be a minimum of 130 ft and the channel span length had to be a minimum of 250 ft. This span arrangement, and the aggressive environment created by the saltwater in Escambia Bay, made precast, prestressed concrete girders with a cast-in-place deck the obvious choice for the superstructure. For the typical span, five 78-in.-deep Florida bulb tees at a 12 ft 6 in. spacing and a length of 136 ft were the most economical. A three-span post-tensioned spliced girder based on the 78-in.-deep Florida bulb tee was chosen for the channel span.

The spliced girder is comprised of five sections: two haunched sections over the center piers, two end sections, and a drop-in girder between the haunched sections. The haunched sections over the center piers increase to a maximum depth of 112 in. The system contains four draped post-tensioning ducts to house twelve 0.6-in.-diameter Grade 270 low-relaxation strands. To handle the bursting stresses associated with these strands, the end beams contain an approximate 2-1/2-ft-wide by 10-ft-long anchor block over the full depth of the beam.

A deck stripper was used to remove the steel formwork from the underside of the deck.

Before erection of the segments could occur, two temporary shoring towers were constructed to support the system between the end girders and the haunched girders. After the haunched and end girders were erected, the drop-in section was set into place between the haunched girders. The drop-in segment rested on two strong-backs supported from the tops of the haunched girders. Once all the segments were in place, the strands in the first two post-tensioning ducts were stressed. At this point, the deck was placed. After the deck achieved sufficient strength, the strands in the last two ducts were tensioned. This erection sequence afforded minimum disturbance to the barge traffic in the channel.

Deck Construction

After the girders were set and diaphragms cast, work shifted to the CIP deck. Two methods were employed for the placement of formwork utilized in the deck construction. The first was a removable steel formwork system, which was installed with a track-driven formwork placer. The tracks for the placer were temporarily placed on the girders. The placer used a system of winches to lift formwork, drive it into position, and hold it in place as workers tightened a series of turnbuckles to allow the formwork to rest on the bottom flange of the girders. After casting the deck, the formwork was removed by a formwork stripper. The stripper drove over the deck on rubber tires and employed an under-slung arm to access the formwork from below the deck. The stripper used a system of hydraulic jacks, winches, and a sliding platform to remove the formwork and transport the sections to the top of the deck for future use. At the peak of construction, this method allowed the contractor to place over 10,000 ft^2 of bridge deck per day.

The second formwork method utilized was corrosion resistant stay-in-place (SIP) forms. The use of SIP was approved for the approaches and over the channel to allow deck construction from multiple fronts.

A track-driven placer was used to install the steel formwork for the deck.

Working on multiple fronts was not unique to deck construction. The extremely aggressive schedule associated with the project required the contractor to utilize this philosophy on all aspects of construction. At the peak of construction, over 20 cranes were on site with a work force of over 350 people working day and night to complete the first bridge.

Conclusion

Interstate 10 provides the traveling public with a vital link between Florida and the southeastern United States. I-10 functions as a major corridor for the delivery of goods and services, and also as an essential evacuation route. The importance of reestablishing this link could not be said more simplistically and truthfully than as stated by the former governor of Florida, Jeb Bush, at the ribbon cutting ceremony for the eastbound bridge, "This was a big damn deal!" These bridges will stand as a testament to what can be accomplished when a crisis challenges the tenacity and perseverance of the bridge building community.

Charles Rudie, senior structural engineer; John Poulson, vice president; Victor Ryzhikov, senior supervising engineer; and Theodore Molas, senior structural engineer are all with PB Americas, Tampa, Fla.

For more information on this or other projects, visit www.aspirebridge.org.

Precast concrete seal slab with side forms
for the channel pier footings

Photo: Charles Rudie, PB.

Precast pile footings with reinforcement cages in the piles reduced the amount of cast-in-place concrete construction over water.

Photo: Charles Rudie, PB.

Precast concrete pile caps were used with a cast-in-place connections.

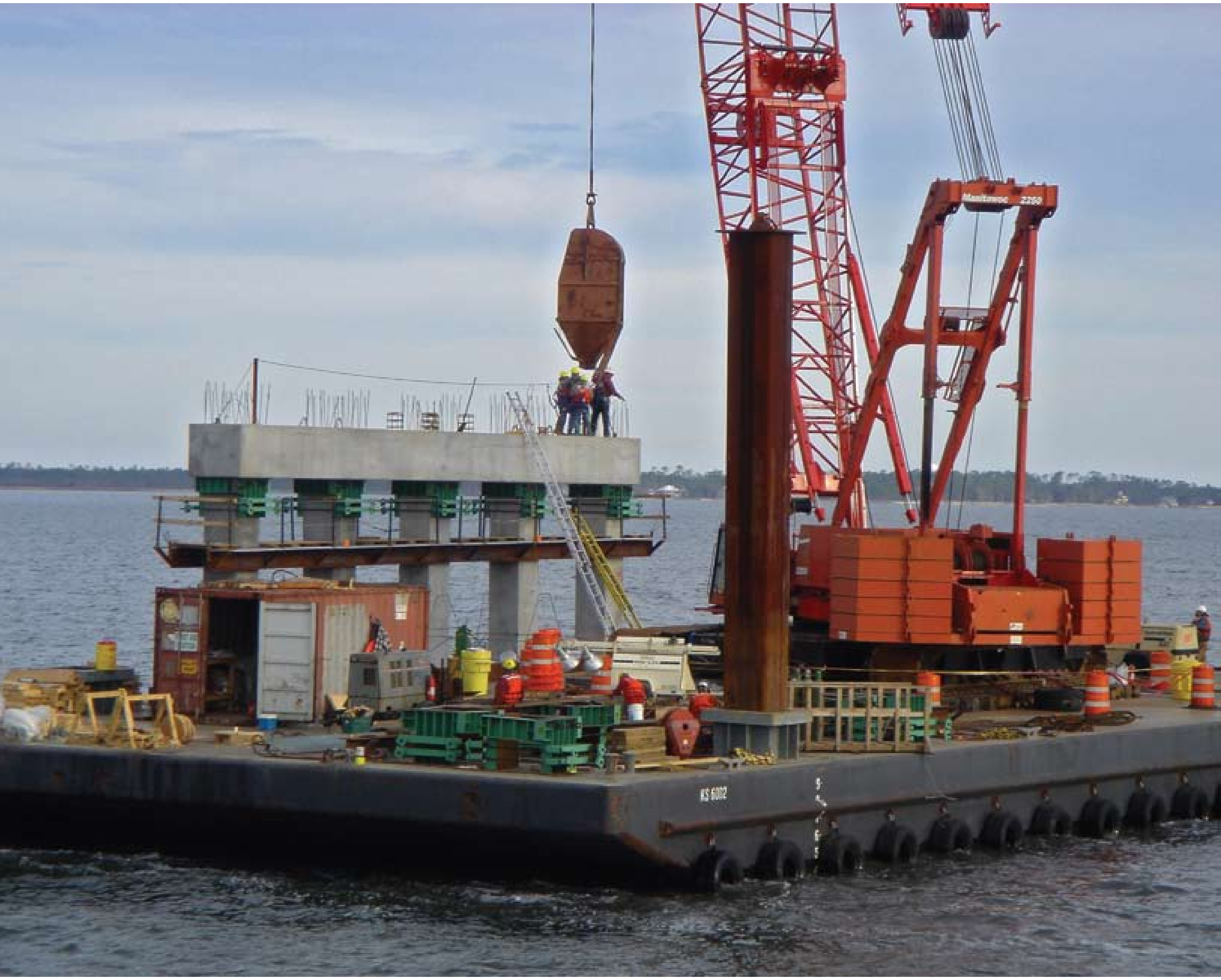


Photo: Charles Rudie, PB.

Typical pier configuration.

Photo: Charles Rudie, PB.

The first of the twin bridges was completed in 20 months.

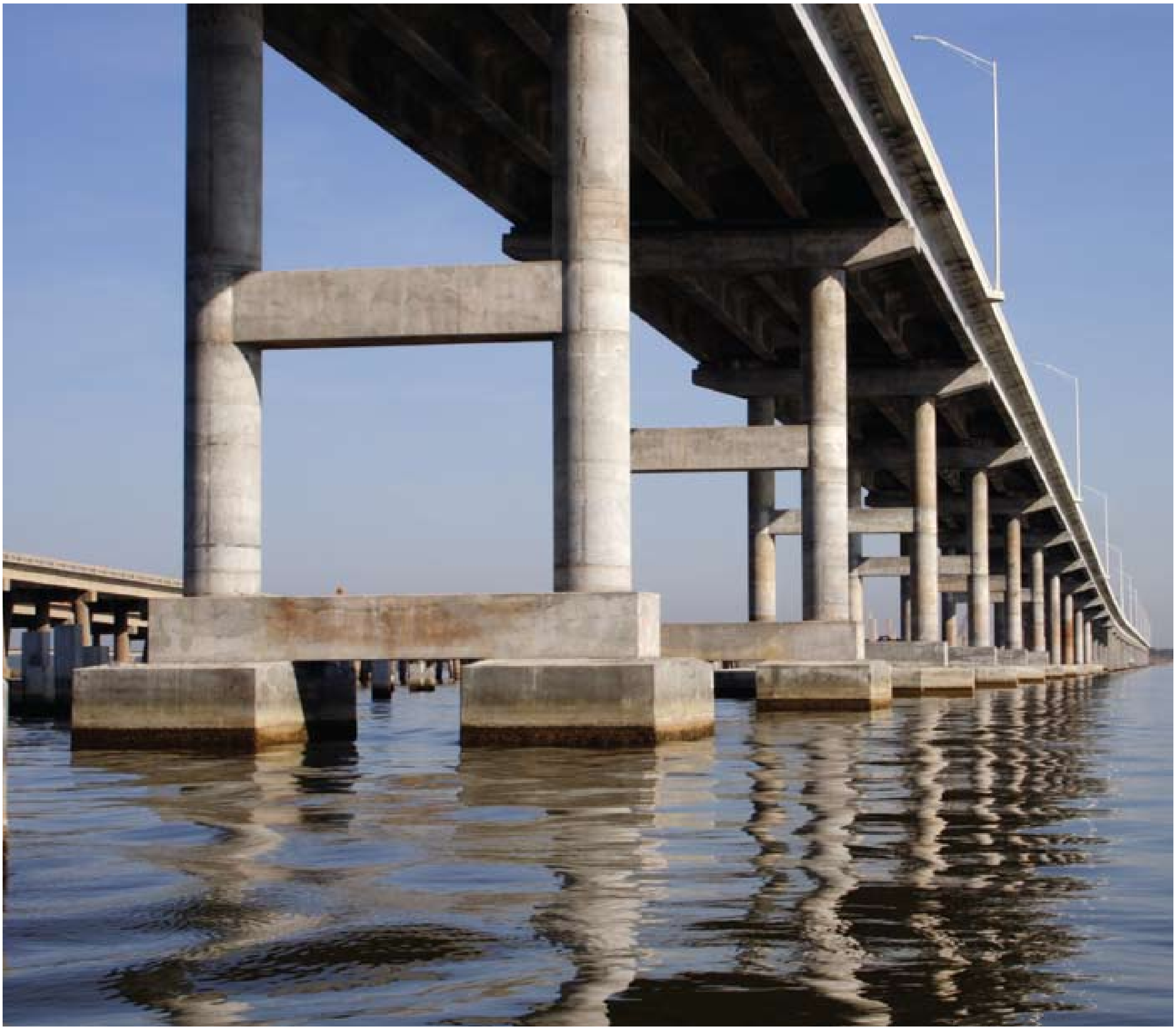


Photo: Charles Rudie, PB.

Low-level pile bents.

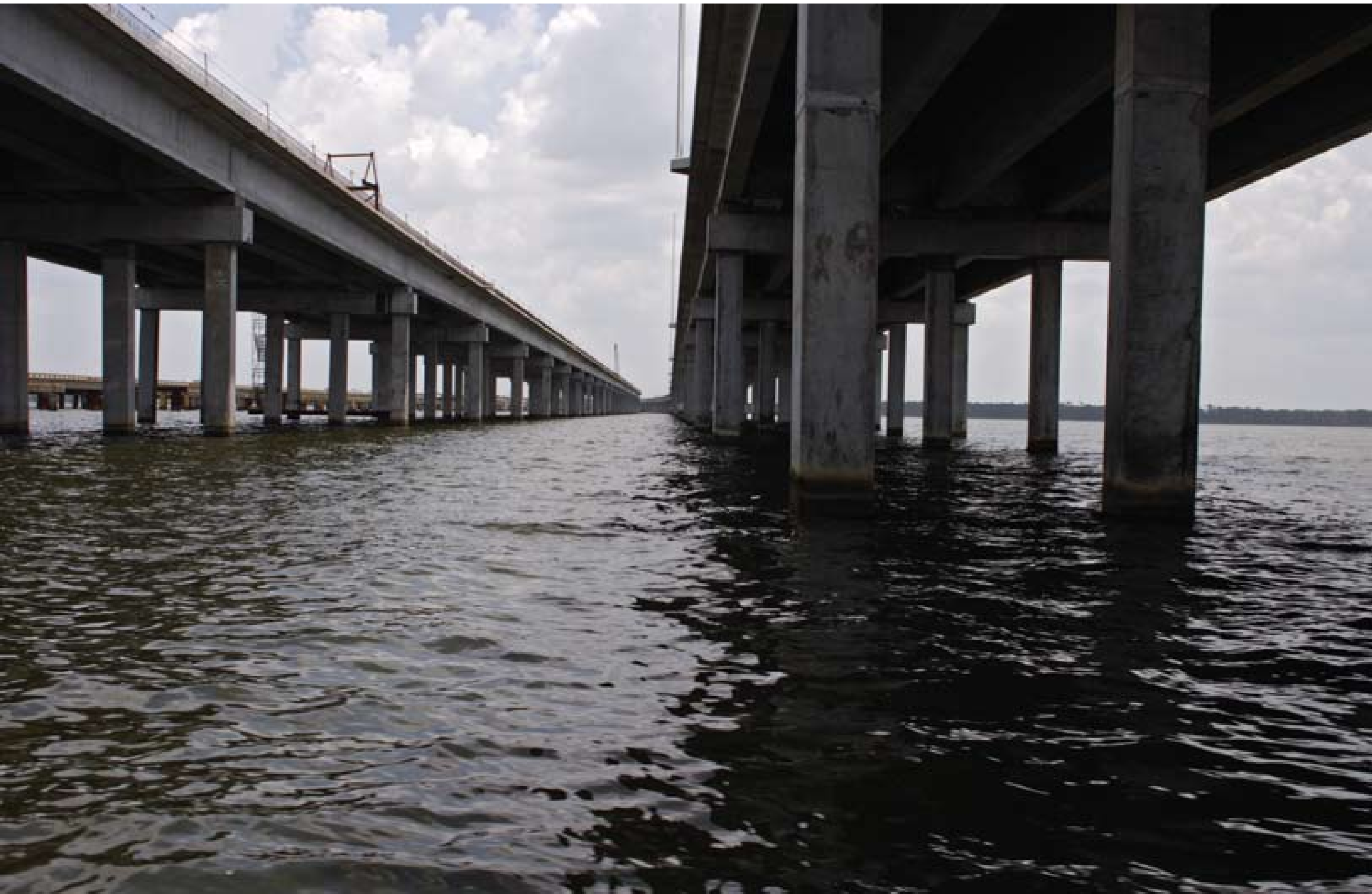


Photo: Charles Rudie, PB.