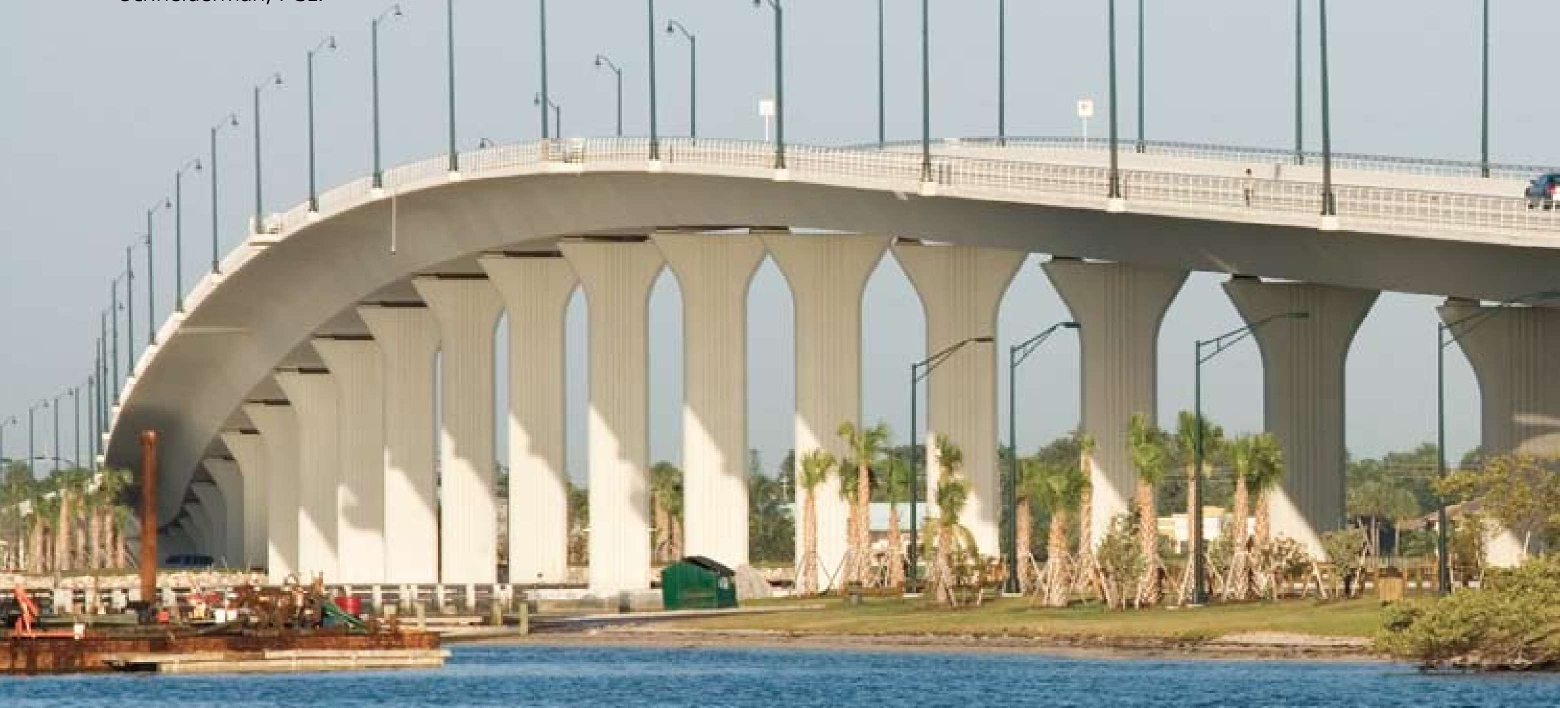
ERNEST F. LYONS BRIDGE

The project was completed within budget and more than 8 months ahead of schedule.

In July of 2003, PCL Civil Constructors Inc. (PCL) was the low bidder on a $46 million lump sum design-build contract for the Ernest F. Lyons Bridge Replacement project in Stuart, Florida. The main scope of this Florida Department of Transportation (FDOT) project was the construction of a new high-level segmental bridge over the Intracoastal Waterway in Martin County, Florida. The project site is located on Florida's East Coast, approximately 45 miles north of West Palm Beach.

The new Ernest F. Lyons Bridge is a 4600-ft-long, 31-span, two-lane, precast segmental bridge built using the span-by-span method of construction. With the exception of the first span, which is 100 ft long, all spans are 152 ft in length. Typical segments were 10 ft long, 10 ft deep and 61 ft wide and weighed approximately 80 tons. Pier segments were split into two half-segments, each 5 ft long, to reduce their weight for handling. A typical span consisted of 15 precast segments that were post-tensioned together using ten 19-strand tendons. Five tendons ran along each web wall. The spans were subsequently made continuous into six-span units.

The 32 foundation units for the segmental bridge used between ten



The Ernest F. Lyons replacement bridge is a 4600-ft-long, 31-span, precast segmental bridge built using the span-by-span method of construction. Photos: Jim Schneiderman, PCL.

profile

ERNEST F. LYONS BRIDGE REPLACEMENT / STUART, FLORIDA

DESIGN ENGINEER: Parsons Transportation Group, Jacksonville, Fla.

PEER REVIEW ENGINEER: Corven Engineering, Tallahassee, Fla.

PRIME CONTRACTOR: PCL Civil Constructors Inc., Tampa, Fla.

READY MIX CONCRETE: Tarmac, West Palm Beach, Fla.

POST-TENSIONING: VSL, Springfield, Va.

SUBSTRUCTURE FORMWORK: Symons Corporation, Des Plaines, Ill.

AWARDS: *Florida Transportation Builder's Association "Best in Construction" award in the Major Bridge Category and an award of excellence from the Design-Build Institute of America (DBIA)*

REPLACEMENT PROJECT

by Jim Schneiderman,
PCL Civil Constructors Inc.

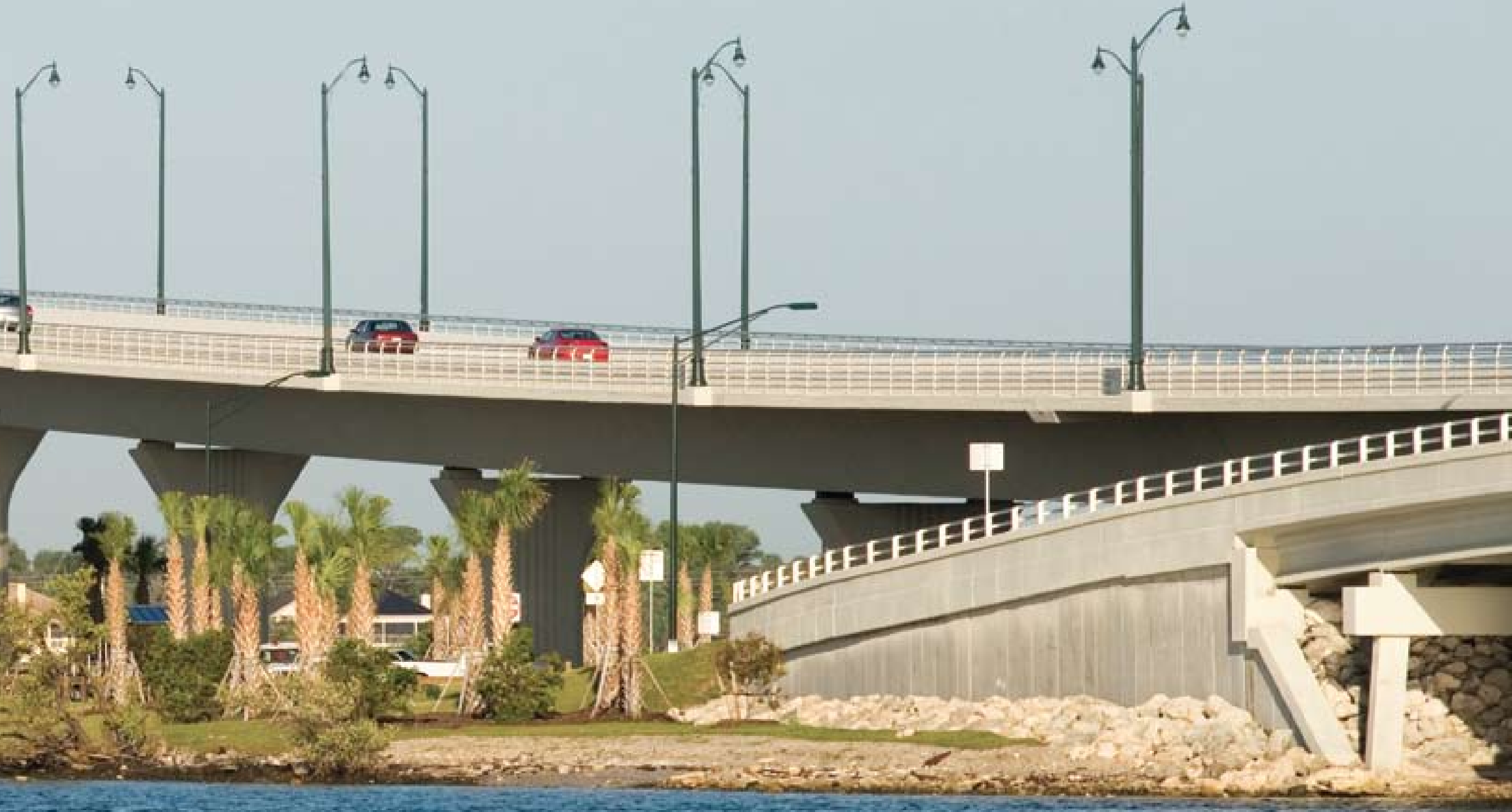
and fourteen 24-in. square prestressed concrete piles ranging in length from 75 to 105 ft. The bridge piers consisted of a single pile cap and a single flared column. Column heights ranged from 12 to 60 ft above the top of footing, thereby making the vertical clearance of the bridge 65 ft at the navigation channel per U.S. Coast Guard requirements.

In addition to construction of the segmental bridge, the project scope included construction of two low-level AASHTO girder bridges. Each bridge consisted of ten 50-ft spans and was constructed to provide recreational access onto spoil islands within the project limits. The two-lane bridges consisted of 24-in. square prestressed concrete piles, cast-in-place concrete bent caps, AASHTO Type II beams, and a 50-ft-wide, 8.5-in.-thick cast-in-place concrete bridge deck.

Additional improvements were also required adjacent to each of these small bridges. Specifically, 1600 ft of precast concrete sheet pile wall and 3500 tons of bank and shore riprap were installed on the approach roadways. Finally, over 2500 lin. ft of new roadway was constructed to connect these two new structures to the segmental bridge alignment.

The final phase of the scope included extensive landscaping improvements, as well as demolition of the existing bascule bridge structure constructed in 1950. The contract required all concrete portions of the existing bascule bridge to be removed and transported seven miles offshore into the Atlantic Ocean, where they were disposed of as an artificial reef.

PCL subcontracted the design services for the project to Parsons Transportation Group and the project team received the Notice to Proceed on October 2, 2003. The total project duration was 1580 days, providing for a contract completion date of February 12, 2008.



PRECAST CONCRETE SEGMENTAL / FLORIDA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: 4600-ft-long, 31-span, precast segmental bridge built using the span-by-span method plus two low-level recreational access bridges

SEGMENT FORMWORK: Southern Forms Inc., Guild, Tenn.

ERECTION TRUSS: DEAL, Udine, Italy

SEGMENT LIFTER: Somerset Engineers and KWH Construction Corp., Vancouver, B.C., Canada

PRECASTER FOR LOW-LEVEL BRIDGES: Standard Concrete Products, Tampa Fla., a PCI-Certified Producer

STRUCTURAL COMPONENTS: 501 precast concrete segments, 30 flared columns, and 32 foundation units with precast concrete seal slabs and ten to fourteen 24-in.-square prestressed concrete piles ranging in length from 75 to 105 ft for the main bridge and 24-in.-square prestressed concrete piles, CIP bent caps, AASHTO Type II beams, and CIP bridge deck for the low-level bridges

BRIDGE CONSTRUCTION COST: $46.5 million

501 segments were cast at a rate of three per day.

Typical segments were 10 ft long, 10 ft deep, and 61 ft wide, weighing about 80 tons.

PCL was responsible for obtaining environmental permits for the project and no construction could begin until all permits had been obtained. Despite PCL's aggressive efforts to obtain all environmental permits in a timely manner, the permitting process took two months longer than anticipated. The final permit was received in August 2004, thereby allowing construction activities to begin.

Hurricane Hazards

On September 4, 2004, Hurricane Frances—a Category 2 storm—made landfall on the project site just weeks after construction had begun. The jobsite sustained minimal wind damage and a fair amount of washouts to the existing roadway caused by rain and/or wave action. Shortly after the work resumed, Hurricane Jeanne—a Category 3 storm—made landfall on September 25, 2004. The official landfall location of Hurricane Jeanne was within 2 miles of Hurricane Frances; however the damages incurred due to Hurricane Jeanne were significantly greater than those caused by the previous storm. Despite these back-to-back hurricane events, the project team recovered quickly and proceeded with substructure production work.

Foundation and substructure operations progressed uneventfully on the project between October 2004 and October 2005. As the bottom elevation of all land foundations was well below the water table, land foundations were constructed using a mud seal and sheet pile shoring system that allowed crews to dewater the excavation for footing construction. Water foundations were constructed using a precast concrete seal slab that was hung from the piles and served as the bottom form for the footing concrete. Footing and column formwork systems were designed to withstand 10 ft of liquid head during concrete placement. By doing so, crews were able to place all columns in a single lift.

Of the 32 foundation units on the project, 15 were located on land and 17 were located in the water. All piling was driven using a Delmag D-46 diesel pile hammer with a Manitowac 4100W Series 2 crawler crane. 4100W Series 2 cranes were also used in construction of the footings and columns on both land and water. In addition to the standard equipment required for land-based operations, water foundations also required the use of crane barges, material barges, and push boats to shuttle labor forces, materials, and equipment between land and water.

On October 24, 2005, another hurricane, Hurricane Wilma—a Category 1 storm—passed yet again over the project site. Fortunately, damage during this storm was not as severe as that caused by the first two hurricanes. The project team made the necessary repairs and was back on track by November 2005 making preparations to begin segment erection.

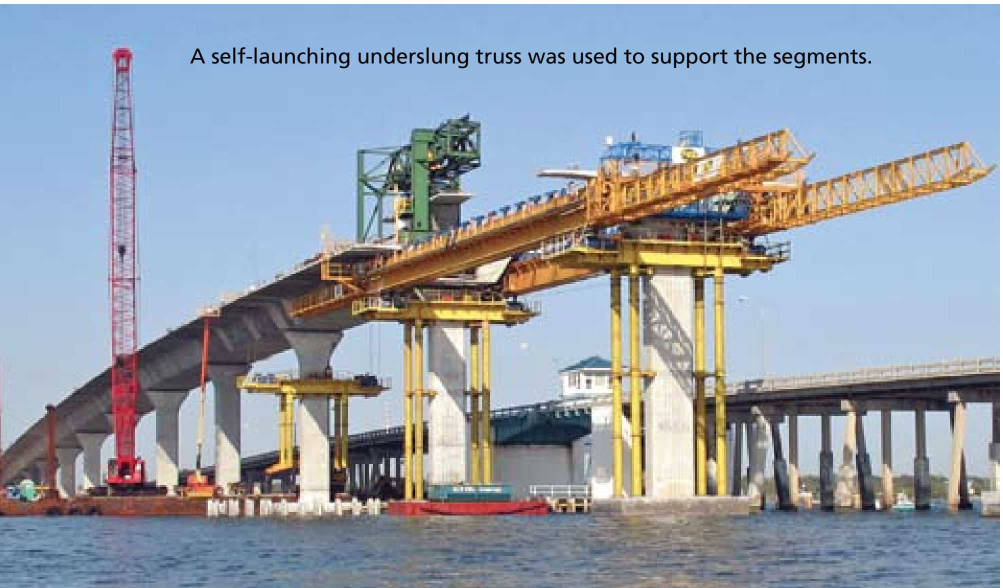
PCL's casting yard for the project was located in Fort Pierce, Florida, approximately 30 miles north of the project site. Three casting beds were used to construct the 501 segments for the project. Two casting beds were set up to construct typical segments, while a third bed was set up to be interchangeable for pier segments and expansion joint segments.

Although the design compressive strength of the concrete for bridge segments was 5500 psi, transverse post-tensioning of the top slab could be performed once concrete had reached 2500 psi, thereby allowing the segment forms to be stripped. With the use of high early strength concrete, PCL was able to perform transverse post-tensioning and strip the forms approximately 12 hours after casting. By doing so, crews were able to cast one segment per day with each casting bed for a total of three segments per day (two typical segments and one pier or expansion joint segment). Although this rate of production is common for typical segments, it is quite an accomplishment for pier or expansion joint segments due to the large amount of reinforcing steel and post-tensioning hardware required in these segments.

Segment Erection

Due to shallow water depths on site and strict environmental permit conditions regarding protected seagrasses, PCL chose to erect the bridge segments using a top-down method. As a result, all segments were trucked individually from the casting yard in Fort Pierce to the project site.

Load limit restrictions dictated the haul route for transporting the segments from the casting yard to the project site. In addition, transportation permits only allowed segments to be delivered between 9:00 p.m. and 5:00 a.m. Due to these transportation



A self-launching underslung truss was used to support the segments.

restrictions, PCL was only able to deliver six segments each night. In order to maintain production cycles, the project team designated an area on-site with sufficient room to store one complete span of segments. As soon as the transport crew had delivered enough segments to complete one span, the erection crew was ready to erect those segments. It was a delicate balancing act that required close coordination between the transport, segment storage, and erection crews.

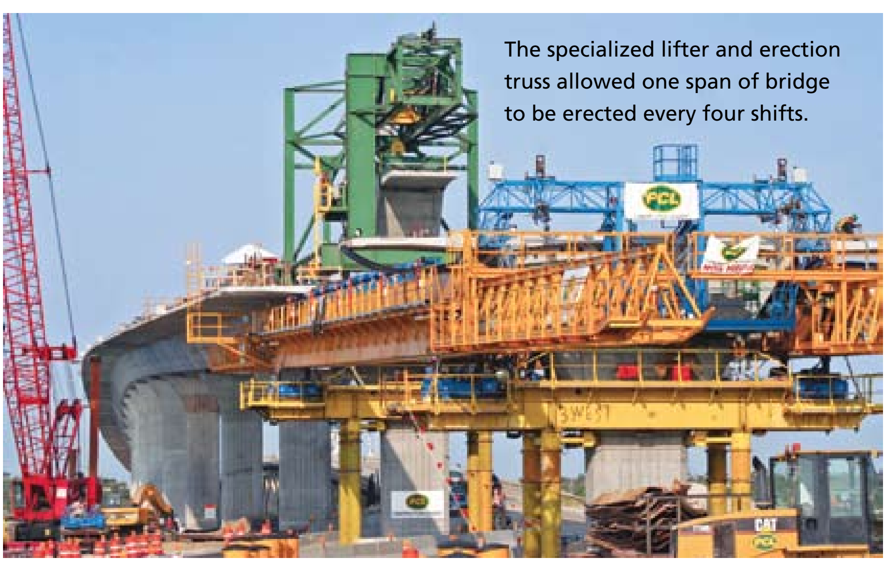
Also located within the on-site segment storage area was a temporary building constructed to store all bridge components that were sensitive to the elements. Specifically, this temporary structure provided storage for post-tensioning strand, cable grout, HDPE duct, and other miscellaneous but important components. Without any one of these components, segment erection would come to a halt. Therefore, it was crucial to efficiently manage the limited storage area available while maintaining sufficient inventories of each of these components.

The erection truss used by PCL during segment erection was a self-launching underslung truss. The truss was fabricated in Italy and assembled on the project site. To perform the top-down erection of segments, PCL used a specialized segment lifter. These specialized pieces of equipment coupled with the methods of erection allowed crews to consistently erect one span of bridge every four shifts.

The Ernest Lyons Bridge project was the first project to be constructed using FDOT's new post-tensioning specification. Some of the requirements of this new specification included shear transfer devices on all steel pipes within the pier segments, duct couplers at each steel pipe connection of the split pier segments and more stringent pressure tests on each tendon prior to grouting.

The segmental bridge was opened to traffic on September 18, 2006. Upon completion of the bridge, crews immediately began the final phase of the project including demolition of the existing bascule bridge. The project was officially completed and accepted by the FDOT on May 19, 2007, with a grand opening ceremony and many accolades from local residents.

Each typical span consisted of 15 segments post-tensioned together.



The specialized lifter and erection truss allowed one span of bridge to be erected every four shifts.

Despite numerous challenges encountered, the Ernest F. Lyons Bridge Replacement project was completed within budget and more than 8 months ahead of the contract schedule. In 2007, the project received the Florida Transportation Builder's Association "Best in Construction" award in the Major Bridge Category. The project also went on to receive an award of excellence from the Design-Build Institute of America (DBIA). It is truly a bridge of which the concrete industry can be proud.

Jim Schneiderman is Construction Manager with PCL Civil Constructors Inc., Tampa, Florida.

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

Preserving Endangered Species

This project was located in an aquatic preserve with the presence of an endangered species of seagrass and as a result, the environmental permitting requirements became quite involved. As a condition of the South Florida Water Management District (SFWMD) and U.S. Army Corps of Engineers (USACOE) permit applications, PCL was required to perform a seagrass survey to document the presence of seagrasses within the project limits. Due to the growing season of seagrass, this survey could only be performed during the month of August each year. As mentioned in the above article, the FDOT did not issue the Notice to Proceed for the project until October 2003. In an effort to expedite the permitting process, PCL performed the initial seagrass survey at their own risk during August 2003. Had PCL not performed the seagrass survey at this time, the permitting application could not have been completed until August of the following year.

The Revised FDOT
POST-TENSIONING SPECIFICATIONS
by Clyde Ellis, VSL

The Ernest F. Lyons Bridge is one of the first post-tensioned bridges in Florida to be constructed under the latest Florida Department of Transportation (FDOT) post-tensioning specifications. The FDOT rewrote the state's specifications into a five-part strategy with a goal of producing a design, construction, and maintenance environment that consistently produces durable post-tensioned bridges.

The first part of the strategy requires the use of enhanced post-tensioning systems. To ensure compliance, the FDOT approves all post-tensioning systems and lists them on the state's Qualified Product List (QPL). The qualities that constitute an enhanced post-tensioning system include: a three-level system of corrosion protection; tendons placed within plastic ducts; positively sealed duct connections; prebagged and preapproved grout for post-tensioning tendons; post-tensioning tendons capped with permanent, heavy-duty plastic caps incorporating an O-ring seal; elastomeric coating over pour-back areas; as well as pressure testing of all post-tensioning tendon ducts.

The second part requires all post-tensioning tendons to be completely filled with grout during construction. This requirement also includes the condition that all anchorages must be accessible for stressing, grouting, and inspection throughout all processes of installation and protection. To meet the third requirement of the strategy, all post-tensioning tendon anchors must have a minimum of four levels of corrosion protection. The fourth part states that the decks of post-tensioned bridges must be watertight. Finally, the fifth part of the requirements states that post-tensioned bridges must be designed to provide increased redundancy with multiple tendon paths using a greater number of smaller-sized tendons.

On the Ernest F. Lyons Bridge, the post-tensioning system, supplied by VSL, has anchorages with galvanized protection and ducts made of UV resistant-plastic to meet the new specifications. To ensure proper grouting, the anchorages have dual inspection ports through which inspectors use a borescope to determine visually if the anchorages are completely filled with grout. The system utilizes a combination of mechanical couplers and/or heat-shrink sleeves to create water and airtight connections. All admixtures used to grout the tendons are premixed and prebagged with the cement.

Florida's specifications for post-tensioning are available at Section 463 of their Standard Specifications for Road and Bridge Construction (www.dot.state.fl.us/specificationsoffice/2007BK/TOC.htm).

Clyde Ellis is Branch Manager with VSL's Washington, D.C., office.