PROJECT

# SOUTH NORFOLK JORDAN BRIDGE

## Virginia's new all-precast concrete bridge restores a vital transportation connection

by Jay Rohleder and Shawn Woodruff, FIGG

Less than two years after beginning construction, the new South Norfolk Jordan Bridge is open to traffic. As tall as a 17-story building, this modern bridge was constructed quickly using 856 precast concrete segments to provide an important community transportation link across the Elizabeth River between Chesapeake and Portsmouth, Va.

The previous Jordan Bridge, a steel lift span, was closed to traffic by the City of Chesapeake after being rated structurally deficient. Removing this link from the regional transportation network increased congestion throughout the area. The South Norfolk Jordan Bridge restores the connection, relieving congestion and providing added benefits to enhance the quality of life for the surrounding communities. In addition, the bridge project was accomplished using 100% private funding without the use of any local, state, or federal funding.

**The South Norfolk Jordan Bridge… enhance[s] the quality of life for the surrounding communities.**

The new bridge eliminates the lift span over the shipping channel and an at-grade active railroad crossing. The bridge also crosses local roads with long spans, allowing for the continuous flow of all vehicular and pedestrian traffic on top of the bridge while ships, trains, and other vehicles pass below.

One of the challenges of replacing a lift span bridge in this location with a high-level fixed span and pedestrian friendly bridge was establishing the bridge geometry. The site constraints included clearance requirements over the river for navigation, railroad easements on both sides of the river, and existing tie-in points to surface streets. After extensive analysis, the final bridge layout provides the required United States Coast Guard (USCG) navigation clearance of 145

## profile

**SOUTH NORFOLK JORDAN BRIDGE** / CHESAPEAKE AND PORTSMOUTH, VIRGINIA

**BRIDGE DESIGN ENGINEER:** FIGG Bridge Engineers Inc., Tallahassee, Fla.

**PRIME CONTRACTOR:** FIGG Bridge Builders, Tallahassee, Fla.

**CAST-IN-PLACE CONCRETE SUPPLIERS:** Atlantic Metrocast Inc., Portsmouth, Va., and Titan America, Norfolk, Va.

**PRECASTERS:** Atlantic Metrocast Inc., Portsmouth, Va.; Bayshore Concrete Products, Cape Charles, Va.; and Coastal Precast Systems, Chesapeake, Va., all PCI-certified producers

**POST-TENSIONING CONTRACTOR:** VSL, Hanover, Md.

ft vertically and 270 ft horizontally, gentle grades for pedestrian access, and appropriate rail clearances, while integrating the bridge seamlessly into the existing transportation network, including I-464.

The final bridge layout is 5375 ft long and consists of 35 spans. The bridge approach spans are typically 150 ft long, while the main span unit, over the navigation channel, features span lengths of 190, 385, and 190 ft.

## Precast for Quality, Speed

Precast concrete segmental technology was used to construct the new bridge. Each element of the bridge—the foundations, piers, and superstructure—were manufactured in local precasting facilities and then assembled on site. Precasting offered many benefits including speed of construction and factory quality control. Precasting the 323 pier column segments and 533 superstructure segments took just one year, from March 2011 to March 2012.

The South Norfok Jordan Bridge opened to traffic on October 29, 2012, restoring a vital transportation link in the Hampton Roads regional transportation network. All photos: FIGG.

### Substructure

Bridge foundations consist of 24-in.-square, prestressed concrete piles for land piers; 54-in.-diameter, prestressed concrete hollow cylinder piles for piers in the water; and 66-in.-diameter, concrete cylinder piles for the bridge fender system. The use of pile foundations with above-ground footings avoided excavation of potentially contaminated soil in an existing superfund site along the west bank of the river. Pile foundations were selected for the entire project as a cost-efficient solution for the soil conditions along the alignment. A total of 961 piles were manufactured at the local precasting facilities and then installed to support the bridge piers, embankments, and fender system. The first pile was installed in the river during a groundbreaking ceremony on December 16, 2010, and the last pile was installed one year later in December 2011.

Each of the 10 by 16 by 9 ft concrete box segments for the columns were precast adjacent to the bridge site. The column segments were cast in two precasting beds using self-consolidating concrete with a specified compressive strength of 5.5 ksi. Column segments were match cast to ensure a proper fit. The precast concrete box column segments were stacked in place and then post-tensioned vertically to build piers ranging in height from 18 ft 9 in. to 144 ft 10 in. at the main span.

Precast concrete segmental balanced cantilever construction using a barge mounted crane was used to construct the bridge's long main spans over the river.

### Superstructure

The bridge's single-cell box girder superstructure consists of segments with a constant depth of 9 ft 2 in. for the 32 approach spans and variable-depth segments for the main span unit. These range in depth from 9 ft 2 in. at midspan to 18 ft 5 in. at the piers. All the segments are 51 ft 8 in. wide to accommodate the bridge's two 12-ft-wide travel lanes, two 8-ft-wide shoulders, and an 8-ft-wide barrier-protected pedestrian sidewalk. Superstructure segments also include a 1.5-in.-thick integral wearing surface for enhanced durability.

Superstructure segments were also match cast for proper fit and geometry control. Six casting beds were used; four for the approach segments and two for the main span segments. A concrete compressive strength of

SOUTH NORFOLK JORDAN BRIDGE LLC, OWNER

**PRIME SUBCONTRACTOR:** The Lane Construction Corporation, Cheshire, Conn.

**MAJOR SUBCONTRACTOR:** McLean Contracting Company, Chesapeake, Va.

**BRIDGE DESCRIPTION:** A 5375-ft-long precast concrete segmental bridge over the southern branch of the Elizabeth River. Typical spans were 150-ft long and built span-by-span. The 385-ft variable-depth main span was built using the balanced cantilever method over a navigation channel. Two 12-ft-wide lanes with 8-ft-wide shoulders on each side and an 8-ft-wide, barrier-protected sidewalk were also included.

**STRUCTURAL COMPONENTS:** 533 precast concrete segmental box girder superstructure segments, 323 precast concrete box column segments, and 961 54- and 66-in.-diameter precast concrete piles

**BRIDGE CONSTRUCTION COST:** $90,000,000

Span-by-span construction techniques were used to build typical spans. Precast concrete segments were delivered across previously built portions of the bridge and placed on triangular trusses, working from the completed bridge.

6 ksi was specified by the design for the majority of the bridge superstructure; 8 ksi was specified for portions of the main span superstructure. Compressive strengths well over those specified were achieved for the precast concrete superstructure segments.

Span-by-span construction, with twin triangular underslung trusses, was employed to build each of the 32 approach spans. Segments were delivered over the completed bridge, loaded onto the trusses, and then post-tensioned together. The bridge's smallest horizontal curve radius, 750 ft, is one of the smallest used with span-by-span methods and underslung twin trusses.

The main span unit over the river was built using balanced cantilever construction. The precasting facility adjacent to the bridge site offered easy water access. Segments were barged to the bridge site and then lifted into place. Balanced cantilever erection near the navigation channel required close coordination with the USCG to allow vessels in the channel to keep moving.

Precasting the bridge elements allowed for construction of the piers, approach spans, and main spans simultaneously. Pier erection started on the west end of the bridge working toward the east, while superstructure segments were being cast. To allow for delivery of precast concrete segments, approach span construction also proceeded from west to east, following pier erection. The approach span-by-span trusses reached the main span unit in early May 2012, just as the last balanced cantilever segment was being lifted into place. The trusses then were advanced past the main span unit to continue working toward the east end of the bridge.

Span erection proceeded quickly with multiple headings, and was completed in less than 14 months. At peak production, crews achieved two approach spans per week and erected six variable-depth main span segments per day.

Mother Nature was an ominous force throughout construction. The project site faced flooding, winter storms, and severe weather. On August 23, 2011, a magnitude 5.8 earthquake, the strongest to hit the east coast in 67 years, originated less than 150 miles from the site. That same week, Hurricane Irene made landfall in the Outer Banks of North Carolina, 100 miles south of the bridge, bringing strong winds and rains to the region. The bridge stood strong through each event without any issues.

Eco-friendly features of the new bridge include a nano-technology coating, applied to the concrete barriers, that removes pollutants from the air and provides a self-cleaning surface through a photocatalytic reaction with the sunlight. The bridge is lit at night using low maintenance, low-energy LED lights. To honor the military, the barrier rail color is designated as "dress white" in recognition of the United States Navy, a neighbor to the project.

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*Jay Rohleder is a project manager with FIGG and was on-site during construction of the South Norfolk Jordan Bridge. Shawn Woodruff is a bridge engineer with FIGG in Tallahassee, Fla.*

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Column segments for piers in the river, including the 145-ft-tall river piers, were precast at the adjacent casting yard and barged to the site. They were then stacked, epoxied, and vertically post-tensioned.