PROJECT

BELLEAIR BEACH CAUSEWAY
BRIDGE REPLACEMENT PROJECT

by Nelson E. Canjura, HDR Engineering, John Meagher, Johnson Bros./Misener Marine Joint Venture, and Antonio Horrnik, Pinellas County Public Works Department

Incremental launching of long approach spans improves safety, reduces costs, and protects sensitive sea grass beds

The Belleair Beach Causeway provides an important link between the mainland and the beach communities of Belleair Beach, Belleair Shores, Sand Key, and North Indian Rocks Beach in Pinellas County, Fla. The causeway is a significant visual gateway for residents and visitors, provides recreational amenities, and most importantly, serves as a principal hurricane evacuation route for the barrier island.

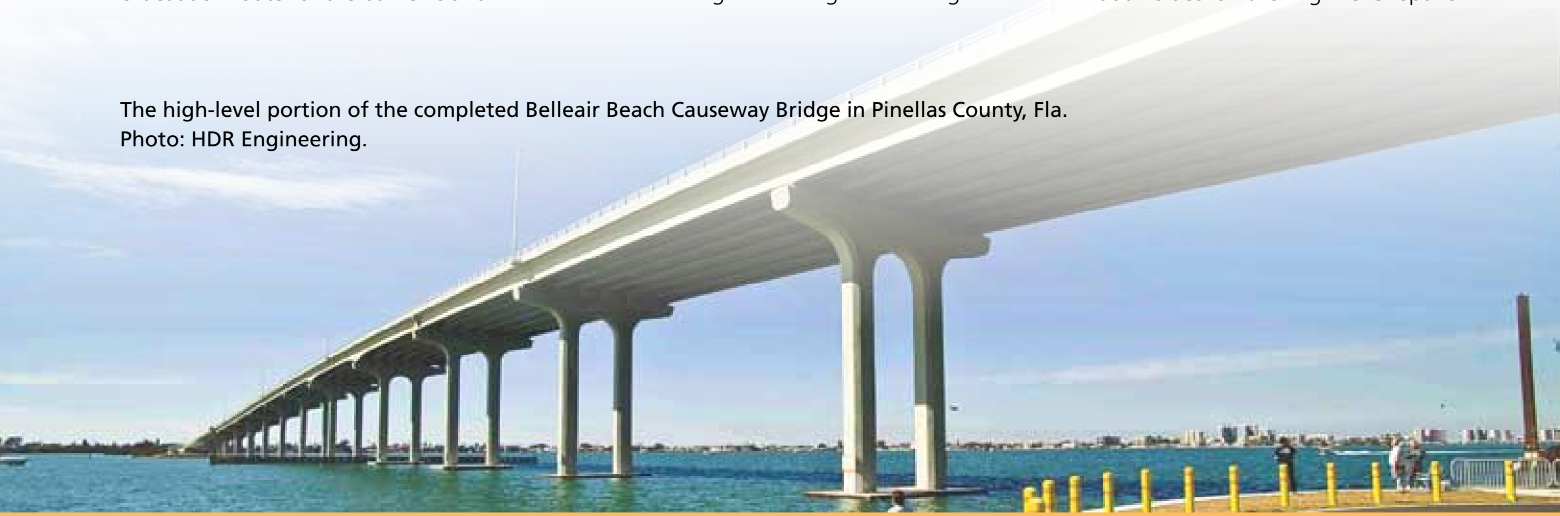
Time and the elements had taken their toll on the causeway's two existing bridges, which were completed in 1950. A 324-ft-long, low-level bridge crossed the Relief Channel at the west end of the causeway, and a 1376-ft-long structure, including a double leaf bascule and approaches, crossed the navigable channel of the Intracoastal Waterway at the east end. Both were determined to have exceeded their original life expectancy. Maintenance and operating costs had steadily increased during the past decade due to deterioration of the concrete components and the bascule's structural steel components and machinery. In addition, the existing causeway bridges did not meet current design standards and were classified as "functionally obsolete."

A preliminary bridge type study led to selection of a low-level bridge crossing Clearwater Harbor to replace the Relief Channel bridge and a high-level bridge to replace the Intracoastal Waterway bridge. Final design of the Belleair Causeway replacement bridges was completed in July 2006. Construction of the new replacement bridges started in March 2007 and the project was completed on December 20, 2009.

Incremental Launching of the Approach Spans

The new high-level bridge over the Intracoastal Waterway is 3350-ft long and can be subdivided into the following units:

- High-level spans—These spans consist of a 530-ft-long, three-span continuous structure over the navigational channel with 750-ft-long, five-span continuous units on each side.
- East and west approach spans—These spans consist of 660-ft-long, nine-span continuous structures on both sides of the high-level spans.



The high-level portion of the completed Belleair Beach Causeway Bridge in Pinellas County, Fla. Photo: HDR Engineering.

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BELLEAIR BEACH CAUSEWAY BRIDGE REPLACEMENT / PINELLAS COUNTY, FLORIDA

BRIDGE DESIGN ENGINEER: HDR Engineering, Tampa, Fla.

PRIME CONTRACTOR: Johnson Bros./Misener Marine Joint Venture

PRECASTER FOR HIGH-LEVEL SPANS: Standard Concrete Products, Tampa, Fla., a PCI-certified producer

STEEL REINFORCEMENT: Gerdau Ameristeel, Tampa, Fla.

AWARDS: *2009 American Public Works Association Transportation Project of the Year—Branch, State & National Award Winner;* Roads and Bridges *Top Ten Bridge Project of 2010*

Belleair Beach Causeway Corridor showing the two new bridges following completion. Photo: E.C. Driver and Associates.

The vertical clearance requirements for the approach spans were governed by the need to provide a parking facility below the bridge that will accommodate boat trailers.

By far the most sensitive of the wetland resources present within the project limits was the vast seagrass communities that occur along both sides of the Belleair Causeway. While construction of the high-level spans over the Intracoastal Waterway was easily accessible by cranes on barges, the west approach span posed access issues due to the limited causeway width and seagrass beds along the bridge alignment.

The east and west approach spans were originally designed using the traditional cast-in-place concrete method; however, this method had the following disadvantages:

- Safety concerns with cast-in-place operations and post-tensioning (P-T) stressing performed up to 40 ft above ground level
- Higher cost of scaffolding erection and removal due to proximity to water and difficulty with construction access due to location within existing seagrass beds
- Settlement concerns due to high loads on the scaffolding
- Falsework system judged not cost effective

As an innovative method, the incremental launching technique was selected since it offered the following advantages:

- Improved safety with all operations (casting, P-T, etc.) at ground level
- No settlement issues during casting because the casting bed is supported on piles behind the abutment
- Minimized impacts to seagrass and mangrove communities
- Lower cost with value engineering providing a $250,000 savings

The incremental launching construction method has achieved significant applications in Europe and Asia. However, only a few bridges in the United States have been constructed using this method. The Belleair Causeway Bridge is the first U.S. bridge constructed using the incremental launching approach for a superstructure consisting of post-tensioned concrete slabs.

Segments were cast and launched on a one-week cycle.

Launching System and Launching Sequences

The incremental launching system used for the Belleair Causeway project was developed by VSL. This system uses strand cables as the pulling elements. The jacking equipment—developed to exert up to 500 tons of pulling capacity—was positioned in front of the end bents/abutments and pulled the launching post, which was fixed to the far end of the segment.

Prior to incremental launching of the approach spans, a launching pad was constructed behind the abutments and supported by 24-in.-diameter temporary steel pipe piles to eliminate settlement issues. Inverted-tee caps with polished stainless steel plates on top were placed on the pipe piles to form the launching pad support beams. Two additional concrete beams were placed between the launching beams to support the steel platform, which functions as the bottom soffit formwork for the P-T slab segment. Adjustable wood side forms were used for casting the wings of the segment.

Two 500-ton launching jacks with a stroke of about 10 in. were used in

The west approach showing launching pad, permanent and temporary piers, and access issues. Photo: E.C. Driver and Associates.

SPLICED BULB-TEE GIRDER, PRECAST, PRESTRESSED GIRDER, AND INCREMENTALLY-LAUNCHED POST-TENSIONED CONCRETE SLAB BRIDGE / PINELLAS COUNTY PUBLIC WORKS, OWNER

POST-TENSIONING MATERIALS: VSL, Ft Lauderdale, Fla.

CONCRETE SUPPLIER: Florida Rock, Largo, Fla.

BRIDGE DESCRIPTION: A 3350-ft-long, high-level bridge with 75-ft vertical clearance at the navigation channel. Each 660-ft-long approach is a post-tensioned concrete slab launched incrementally; the 750-ft-long, five-span continuous units each side of navigation channel unit use Florida 78-in.-deep bulb-tees, and the 530-ft-long, three-span unit over the navigation channel uses post-tensioned, precast concrete spliced, haunched girders

BRIDGE CONSTRUCTION COST: $72.2 million (incrementally-launched concrete slab bridge approximately $120/ft^2)

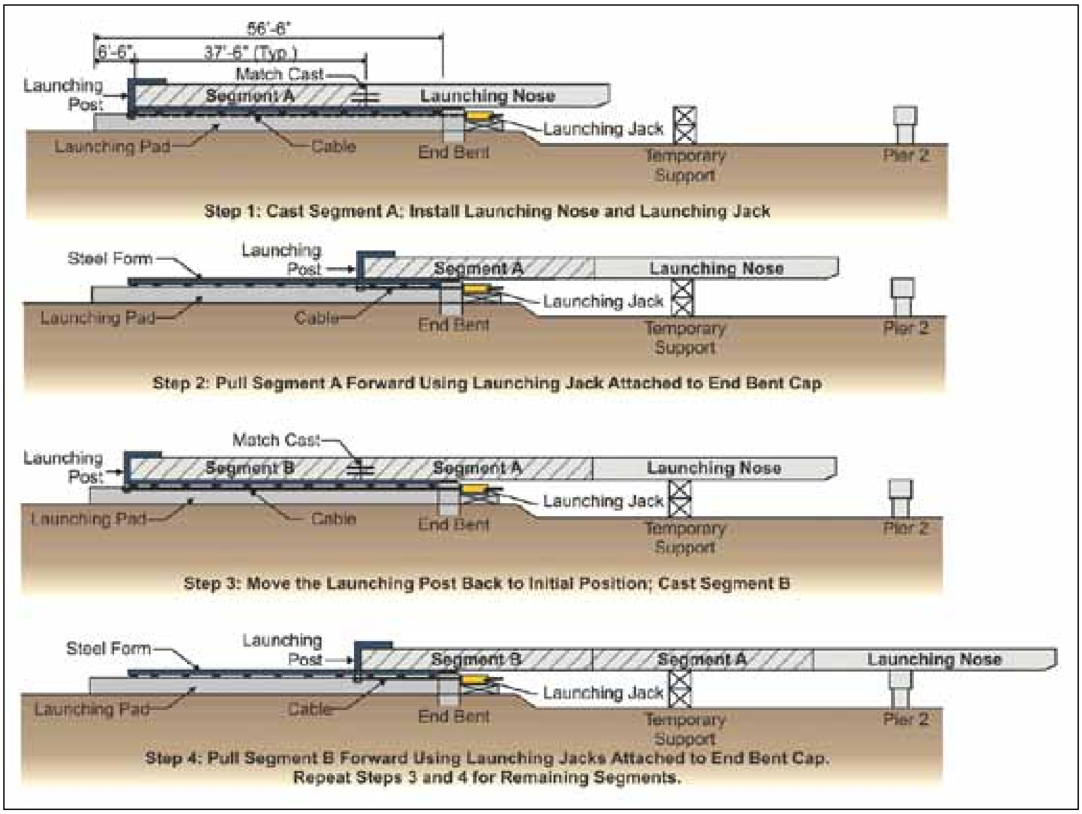

Illustration of facilities and launching sequence of the approach spans. Graphic: HDR Engineering.

front of the abutment. The jacks had a second set of wedges that held the strands and allowed the jacks to set up for a re-stroke. Depending on the section being launched, a complete launch took from 3 hours to 8 hours.

Each launching jack is connected to a launching post, which was fabricated utilizing W24x104 steel beams. Each launching post is located at the rear of each segment.

The launching nose was used to reduce the cantilever moments. The nose consisted of W36x230 sections, 50 grade steel, braced and connected by eight 1 ⅜-in.-diameter P-T bars to the leading edge of the slab.

The final bridge span lengths are 75 ft with an end span of 60 ft; however, temporary bents consisting of 2-ft-diameter steel pipe piles with a concrete cap were used to reduce the launching span to 37.5 ft. The launching nose is 24 ft long, approximately 60% of the launching span length. Compared to the slab section, the launching nose weight is approximately 5% of the equivalent slab length.

Temporary sliding bearings, consisting of ½-in.-thick reinforced neoprene with a Teflon coating, were used to allow the segments to slide over the stainless steel plates on top of the pier supports. The launching crews fed the temporary sliding bearings between the superstructure and the top of the steel plates during the launching. Lateral guides on the end bents and pier supports were installed to keep the

Launching jack in front of the abutment. Photo: E.C. Driver and Associates.

Launching pad before forms were installed. Photo: E.C. Driver and Associates.

Protecting the Environment

The Pinellas County Public Works Department has a long history of fostering environmental stewardship with respect to public works projects throughout the county (see article on Pinellas County on page 55). A prime example of this high regard towards the environment is the Belleair Beach Causeway Bridge Replacement project. A primary focus of the design and construction of the project was the protection of sensitive environmental features and endangered animal species. The decision to use incremental launching of the approaches by Johnson Bros./Misener Marine was based on maximizing safety within the limited access corridor and a commitment to minimize environmental impacts during construction. The method, while unique to the United States, showed that it can be a cost-effective means of construction while embracing improved construction quality, safety and a desire to protect the environment.

Launching nose at front of segment as it passes over a temporary pier and approaches a permanent pier. Photo: E.C. Driver and Associates.

Launching post at back end of segment. Photo: E.C. Driver and Associates.

Slab segments slide over pier supports. Photo: E.C. Driver and Associates.

View of the east approach slab from the boat ramp park below the bridge. Photo: HDR Engineering.

View of casting bed showing large number of post-tensioning ducts and ready for concrete placement. Photo: E.C. Driver and Associates.

segments moving in the desired direction as they were launched.

A ½-in. pedestal tolerance was accounted for in the launch longitudinally, with a 1-in. transverse tolerance at the pier.

The longitudinal P-T required for final conditions varied from 22 to 30 tendons. Transverse P-T was also required with tendons at 4.5 ft spacing.

Due to the requirements for concentric stresses required for incremental launching, temporary longitudinal P-T bars were provided for launching. The temporary P-T consisted of thirty-six to forty-eight 1⅜-in.-diameter bars. These bars were only required during launching, and were not accounted for in the final capacity of the structure.

Finally, segments were cast and launched on a one-week cycle. Segments were formed and the reinforcement placed on Tuesday through Thursday and concrete placed on Friday. On the following Monday, transverse P-T tendons and longitudinal temporary P-T bars were stressed, the wood side forms were removed, and the new segment was launched.

Once the launching was completed, the temporary piers were removed and a secondary concrete placement was made at the pier's supports to enhance the appearance of the pedestals. The remaining bridge features, such as the traffic barriers, pedestrian railing, and the bridge lighting support platforms were added. Incrementally launching the approaches allowed the aesthetic features of the bridge approaches to remain unchanged.

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