PROJECT

# Route 36 Highlands Bridge Replacement

The reverse curve alignment of the completed eastbound bridge is shown as observed from Pier 8 on the east bank. The westbound structure will follow the same plan and profile.
All Photos: J.H. Reid General Contractor, Unistress Corporation, or Dywidag Systems International–USA Inc.

by Dominic E. Salsa, J.H. Reid General Contractor and Joseph E. Salvadori, Dywidag Systems International–USA Inc.

## New Jersey's Twin Precast Segmental Bridges

New Jersey's second precast concrete segmental bridge will serve as a gateway to the seashore towns of Sea Bright Borough and Sandy Hook and connect with Highlands Borough on the mainland, in Monmouth County, N.J. The nine-span twin bridges have main spans of approximately 232 ft. Each structure will be approximately 1611 ft long with a deck width of approximately 46 ft. The bridges cross the Shrewsbury River and will ultimately replace a functionally obsolete and structurally deficient 75-year-old, double-leaf bascule bridge. The eastbound structure is complete and open to traffic. The remainder of the bridge is scheduled for completion in 2010.

Until it was demolished earlier this year, the bascule bridge had 11-ft-wide lanes and lacked shoulders. The bridge's obsolescence created extensive congestion especially during the summer months when the shores along the Atlantic Ocean are visited by beach goers. The bridge opened twice an hour for maritime traffic on the Shrewsbury. The new bridges will provide 65-ft minimum vertical clearances above mean high water in the navigation channel and upgrade the width of the travel lanes to 12 ft and add 8-ft-wide shoulders.

From the onset, community participation was important to the New Jersey Department of Transportation (NJDOT). In 2001, NJDOT established the Community Partnering Team (CPT) to inform community stakeholders and the public of project development and progress. As defined by NJDOT, the membership of the CPT included municipal, organizational and agency members, invited guests, special task forces, and NJDOT staff. A steering committee comprised representatives from the Federal Highway Administration, NJDOT, local government, and the design consultant. CPT Task Forces were created for aesthetics, bike/pedestrian connections, environmental coordination, traffic, and communications. For more than a decade, NJDOT conducted numerous meetings with local officials and residents via the CPT.

In addition to the new bridges, the project will also include intersection improvements in Highlands and Sea Bright, pedestrian/bicycle access paths on and off the bridges, construction of two pedestrian bridges, and modifications to the Gateway National Recreational Area toll plaza at Sandy Hook.

profile

**ROUTE 36 HIGHLANDS BRIDGE OVER THE SHREWSBURY RIVER** / BOROUGHS OF HIGHLANDS AND SEA BRIGHT AND TOWN OF SANDY HOOK, MONMOUTH COUNTY, NEW JERSEY

**DESIGN ENGINEER:** Jacobs Civil Inc., Iselin, N.J.

**CONSTRUCTION ENGINEER:** McNary Bergeron & Associates, Old Saybrook, Conn.

**CONSTRUCTION CONSULTANTS:** GPI, Lebanon, N.J., and T.Y. Lin International, Alexandria, Va.

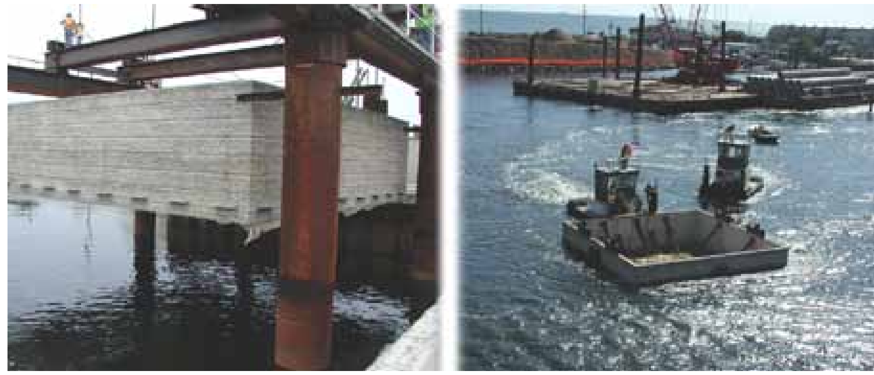
**PRIME CONTRACTOR:** J.H. Reid General Contractor, South Plainfield, N.J.

**POST-TENSIONING CONTRACTOR:** Dywidag Systems International–USA Inc., Pompton Lakes, N.J.

**CONCRETE SUPPLIER:** Ralph Clayton & Sons, Wall Township, N.J.

## Substructure Design Features

Seismic isolation bearings were the chosen superstructure supports at all substructure units due to the bridge's importance classification and the project seismic zone. The abutments are the conventional stem and backwall configuration and are supported by mass concrete pile caps on 14-in.-square precast, prestressed concrete piles. The concrete piles have a 5000 psi design compressive strength and have 75-ton and 169-ton allowable and ultimate capacities, respectively.



A precast concrete coffer dam shown as it is lowered into the water for the short trip to a bridge pier. The granite form-liner finish was required to match existing work at the site.

The piers were designed and constructed using precast concrete segments. Pier heights range from approximately 12 ft near the abutments to 58 ft at the navigational channel.

Each mainline pier comprised hollow precast rectangular match-cast box segments. The segments measure approximately 16 ft by 8 ft and range in height from 6 ft to, typically, 10 ft.

Piers 1, 2, and 8 are founded on 24-in.-square precast, prestressed concrete piles with a specified concrete compressive strength of 5000 psi and have 200-ton and 450-ton allowable and ultimate capacities, respectively. Foundation demands for the remaining piers required 6200 lin. ft of 54-in.-diameter cylinder piles with 7000 psi design compressive strength concrete and allowable and ultimate capacities of 475 tons and 950 tons, respectively.

The concrete pile cap footing on the cylinder piles was formed using floating concrete box forms that also served as templates to drive the piles. Contract drawings allowed either steel sheet piles or precast concrete. The contractor chose to use concrete. Twelve concrete box forms were cast by the contractor on the jobsite due to their size. The 10-ft-high boxes were 35.5 ft square, 22 ft by 35.5 ft, or 22 ft by 50 ft.

**The new bridge will provide 65-ft minimum vertical clearances.**

## Superstructure Design Features

Featuring a reverse curvature horizontal alignment with 1000-ft and 650-ft radii, the bridge mainline superstructure is a nine-span concrete match-cast, single-cell, trapezoidal box girder. Each structure has a total length of 1610 ft 8 in. Span lengths range from 109 ft 4 in. for span 1 to a maximum of 231 ft 7 in. over the navigation channel. Remaining spans vary in length from 172 ft to 179 ft. The 65-ft vertical clearance over the navigation channel is achieved with vertical gradients of +5.7% to -6.5%.

Segment depths range from approximately 11 ft at piers 3, 4, and 5 and taper to a constant 7 ft in spans 4 and 5. Elsewhere, a constant depth of 8 ft is maintained, except at the east abutment end of span 9 which tapers down to 7 ft 6 in. to accommodate vertical clearance requirements under the structure.

Post-tensioning tendons were required to have a substantially high level of corrosion protection. Therefore, a post-tensioning system designed for extended service life structures was provided. Corrugated, high-density polypropylene post-tensioning ducts were supplied for all internal tendons.

The tendon anchorages could accommodate four, twelve, or nineteen 0.6-in.-diameter strands. The actual number of strands used in each anchor varied based on application, span length, and structural demands. Generally

Precast pier segment erection proceeded quickly. Post-tensioning bars used to apply compression as the piers were erected are shown being inserted into the new segment. The bars were stressed after each segment was placed and then coupled to engage the subsequent segment.

TWIN, 1611-FT-LONG, PRECAST CONCRETE SEGMENTAL BOX GIRDER BRIDGES WITH PRECAST CONCRETE SEGMENTAL BOX PIERS / NEW JERSEY DEPARTMENT OF TRANSPORTATION, OWNER

**PRECASTER, PIER AND BOX GIRDER SEGMENTS:** Unistress Corporation, Pittsfield, Mass., a PCI-certified producer

**PRECASTER, CYLINDER PILES:** Bayshore Concrete Products, Cape Charles, Va., a PCI-certified producer

**PRECASTER, SQUARE PILES:** Precast Systems Inc., Allentown, N.J., a PCI-certified producer

**STRUCTURAL COMPONENTS:** 384 box girder segments 10-ft long by 46-ft wide with varying depths, 98 box pier segments 8 ft by 16 ft by 10-ft tall, 54-in.-diameter precast, prestressed concrete cylinder piles, 14-in.-and 24-in.-square precast, prestressed concrete piles, and precast concrete cofferdams

**BRIDGE CONSTRUCTION COST:** \$51,000,000 for the superstructure (\$340/ft$^2$) and \$36,000,000 for the substructure

A match-cast superstructure segment shown at the Unistress precasting plant.

Segments were shipped from the precasting plant to the bridge site by barge, and were erected using a ringer crane and specially designed spreader beam. The stressing and installation platform was attached to the segments prior to lifting.

Segment erection was performed using the balanced cantilever construction method.

**A post-tensioning system designed for extended service life structures was provided.**

speaking, cantilever tendons ranged from fourteen to nineteen 0.6-in.-diameter strands while the bottom slab continuity tendons comprised eleven, fifteen, or eighteen 0.6-in.-diameter strands. The four 0.6-in.-diameter strand tendons were of the flat anchor style and were used transversely in the top slab and longitudinally for top slab continuity. The average segment is 10 ft long and 46 ft wide. Each segment required four transverse tendons that were installed and stressed by the precaster prior to shipment.

## Segment Fabrication and Erection

The contractor is using a barge-mounted crane to erect the precast girder segments and pier column segments, which are manufactured in Pittsfield, Mass., and barged to the jobsite.

Segment casting began in September 2008 with the eastbound pier column segments and was completed in December 2008. Westbound pier casting began in May 2009 and was completed in December 2009 bringing a close to production of 98 substructure segments required for the project.

During pier segment erection, four 1⅜-in.-diameter post-tensioning tendons are used to obtain the required compressive stress across the segment joints. The bar tendons are continuous from footing to pier cap and are stressed as segments are placed. Bar couplers are used to lengthen the bars after each stressing operation in order to engage the subsequent segments. Once topped out, the piers are permanently post-tensioned with nineteen 0.6 in.-diameter and twenty-seven 0.6-in.-diameter vertical loop tendons. Designers elected to use epoxy-coated, 7-wire strands for these tendons. All tendons were grouted, including the 1⅜-in.-diameter bars, after stressing was completed.

Casting the 384 superstructure segments began in October 2008 and continued through June 2010. Production of the eastbound superstructure segments was completed August 2008.

Superstructure erection uses the balanced cantilever construction method. Although the river current and coastal tide presents a daily challenge while erecting segments, the contractor has managed this challenge successfully. After epoxy adhesive is applied to the segment face, the segment is lifted from the barge. Similar to the segmental pier construction, six 1⅜-in.-diameter bars are used to apply the necessary compression across the superstructure segment joints. Over 615 tons of 0.6-in.-diameter strand (120 tons epoxy coated), as well as over 163,000 lbs of 1⅜-in.-diameter, GR150 bars are being supplied for the project.

Segment erection of the westbound river piers started in March 2010, with superstructure erection not far behind. Superstructure and substructure segment erection will occur concurrently and anticipated project completion is the end of 2010.

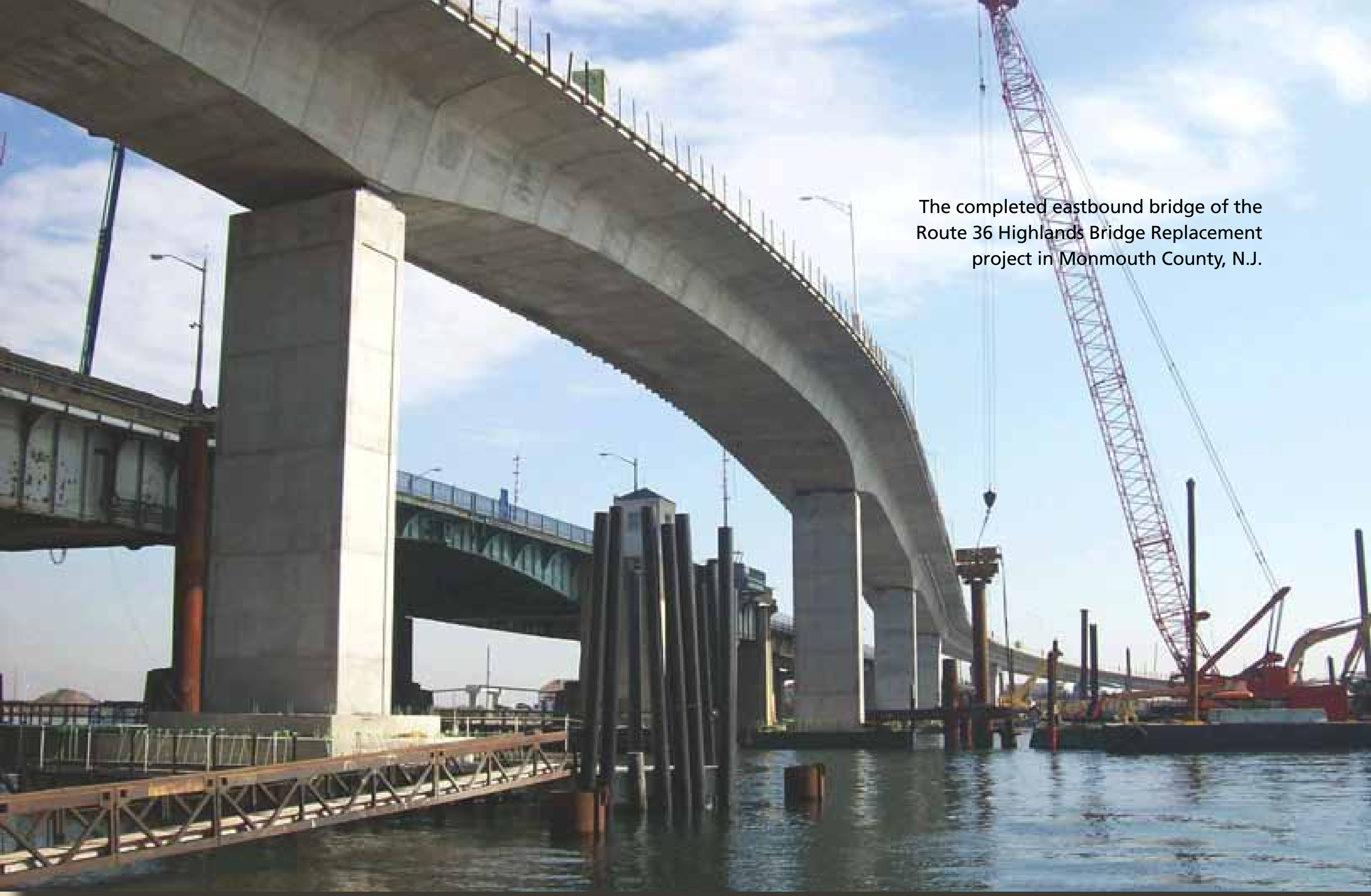
## *Aesthetics Considerations*

When completed, the project will include architectural features that reflect the historic setting and character of the existing bridge, including two monuments located at the bridge abutments. As defined by the New Jersey Department of Transportation, these features include:

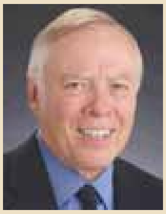
- Decorative fish tiles replicated from the existing bridge to be located on the pylons and light pole pilasters
- Five-bar open steel rectangular railing to enhance the openness of the bridge and provide unobstructed views of the Atlantic Ocean.
- Rustications and reveals in the pier columns and formliner finishes on the waterline footings.

---

*Dominic E. Salsa is project engineer for J.H. Reid General Contractor in South Plainfield, N.J., and Joseph E. Salvadori is Northeast regional manager for the post-tensioning business unit of Dywidag Systems International–USA Inc. in Pompton Lakes, N.J.*



The completed eastbound bridge of the Route 36 Highlands Bridge Replacement project in Monmouth County, N.J.



# AESTHETICS COMMENTARY

by Frederick Gottemoeller

Waterfront communities faced with replacing an existing drawbridge by a fixed, high-level bridge often overestimate the visual impact of the additional height and underestimate the visual benefit of removing the existing low-level bridge. Because of the long spans made possible by post-tensioned segmental concrete construction, people will be able to see right through the Route 36 Bridge and enjoy near and distant views. At the same time, the removal of the low-level drawbridge and its forest of piers will open up water-level views that haven't been seen since its construction. The whole bay will be visually reunited.

The horizontal and vertical geometry of a bridge is often obscured by topography or buildings, and its visual impact unseen. In fact, the geometry describes a ribbon in space with interacting curves that can make the ribbon itself attractive, or not. In a long viaduct, especially over water, the potential aesthetic power of the geometry becomes obvious. The curves required to get the Route 36 Bridge up and over the channel give the structure an attractive flowing, undulating appearance. They show signs of having been refined to do exactly that. The segmental box exactly follows these curves, reinforcing their impact.

The segmental box brings still more to the table. Because the box is both trapezoidal and haunched, the soffits of the boxes vary in width, making the intersections of the box sides and soffits three-dimensional curves in space. These curves visually interact with the curved horizontal and vertical alignments of the bridge, creating wavelike forms that, with their reflections in the water, frame the views beyond. Given the visual quality and complexity of the superstructure, the designer has sensibly kept the piers simple, so that the superstructure remains the star of the show.

All of this may seem abstract, but people recognize the effect. I've shown photos of similar bridges at community meetings and had people spontaneously applaud. And the great thing is that it is all accomplished with the lines and shapes of the structure itself; nothing needed to be added or pasted on.

Balanced cantilever construction of the eastbound bridge as viewed from the eastern shore.

Shown here is a 19 strand wedge plate after lock-off at the anchorage of a vertical pier tendon. Special wedges were provided that gripped the strand through the epoxy coating. Use of these wedges promoted field labor savings and maintained an uncompromised epoxy coating rather than stripping epoxy from the strand ends for wedge bite.