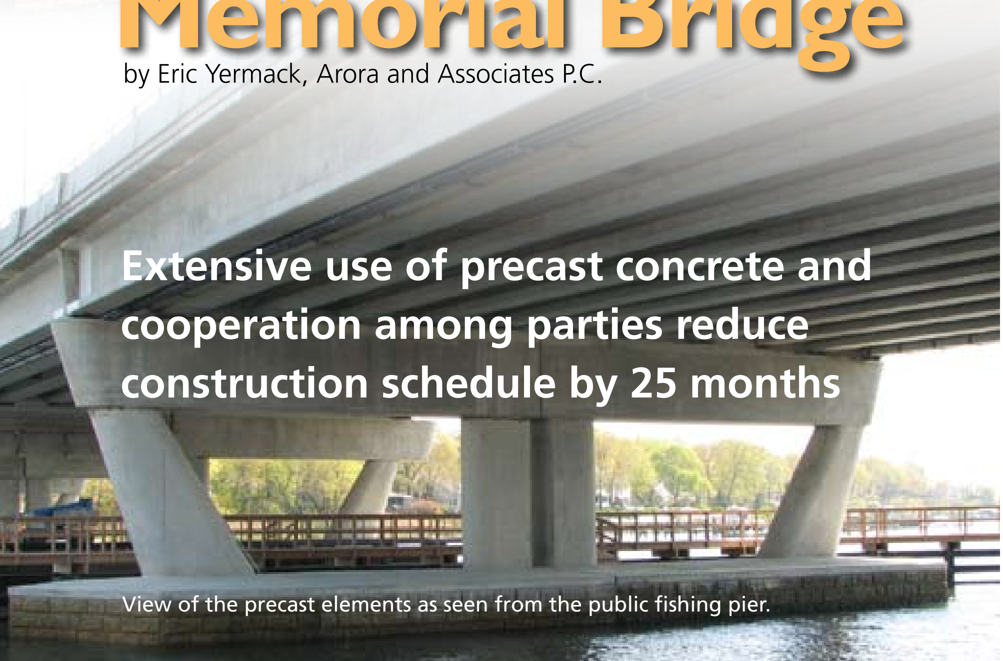
Elevation of the completed Route 70 over Manasquan River Bridge.
All Photos: Arora and Associates P.C.

One of the September 11 Memorial Bridge monuments.

September 11 Memorial Bridge

by Eric Yermack, Arora and Associates P.C.



Extensive use of precast concrete and cooperation among parties reduce construction schedule by 25 months

View of the precast elements as seen from the public fishing pier.

With the replacement of the Route 70 over Manasquan River Bridge, the New Jersey Department of Transportation (NJDOT) planned to create a gateway structure to Monmouth and Ocean Counties in the coastal region of the state. The NJDOT also sought to provide a memorial structure for the 170 local residents who died in the September 11, 2001, terrorist attacks. In September 2004, the bridge was formally dedicated as the "September 11 Memorial Bridge."

The $53 million project replaced a structurally deficient and functionally obsolete single-leaf, bascule bridge constructed in 1936 with a pair of modern, high-level, fixed precast concrete bridges. Each 724-ft-long structure has two, three-span continuous superstructure units (119 ft, 120.25 ft, and 120.25 ft long) comprised of bulb-tee girders at 8-ft center-to-center spacing. The superstructures are supported on two abutments and five architecturally treated in-water piers with pile foundations. To accommodate the needs of marine traffic, the bridge underclearance was increased to 25 ft and the navigation channel was widened from 50 ft to 75 ft.

profile

ROUTE 70 OVER MANASQUAN RIVER, SEPTEMBER 11 MEMORIAL BRIDGE / OCEAN AND MONMOUTH COUNTIES, NEW JERSEY

BRIDGE DESIGN ENGINEER: Arora and Associates P.C., Lawrenceville, N.J.

BRIDGE ARCHITECT: H2L2 Architects/Planners LLP, New York, N.Y.

PRIME CONTRACTOR: George Harms Construction Co. Inc., Howell, N.J.

CONCRETE SUPPLIER: Ralph Clayton & Sons, Lakewood, N.J.

PRECASTERS: Pier Cofferdams, Columns, Cap Beams and Bulb-Tee Girders: Northeast Prestressed Products LLC, Cressona, Pa., (formerly Schuylkill Products Inc.) a PCI-certified producer

AWARDS: *Best Bridge With Spans Between 75 and 150 Feet, 2009 Precast/Prestressed Concrete Institute Design Awards; 2009 Grand Award, American Concrete Institute, New Jersey Chapter; 2009 Project of the Year, American Society of Highway Engineers, North-Central & Southern New Jersey Sections (Projects over $5 million)*

NJDOT then challenged the design team to utilize precast concrete to simplify the architectural concept and minimize the duration of in-water construction.

In addition to completing the NJDOT master plan for the widening of the Route 70 corridor, the project also included the following: a fiber-reinforced polymer bridge fender system, an Americans with Disabilities Act compliant public fishing pier, retaining walls, noise walls, bulkheads, ramps, traffic signals, storm water management structures, highway lighting, intelligent transportation systems (ITS) improvements, and utility relocations.

The Precast Pier Solution

Architectural recommendations were developed with the architect and the NJDOT Bureau of Landscape and Urban Design. The preferred alternative was to use V-shaped piers, with eased edges, punctured by symmetrical, sloped geometric voids. The NJDOT then challenged the design team to utilize precast concrete to simplify the architectural concept and minimize the duration of in-water construction. The process resulted in an architectural pier design with each pier being supported at the waterline on a simulated masonry faced plinth. Each pier would have a pair of prismatic vertical columns near the centerline of the bridge and inclined tapered columns sloping outward towards the bridge fascias. The pier structural system consisted of precast concrete cofferdam shells, columns, and cap beams connected with post-tensioning. The precast bridge elements used 8000 psi high-performance concrete for added strength and durability. The parapets, sidewalks, retaining walls, and noise walls also received architectural treatments.

The foundations utilized 24-in.-diameter concrete-filled steel pipe piles driven to an average pile tip elevation of -110 ft. Groups of 37 piles were used at the fixed piers, 26 piles were used at the continuity piers, and 32 piles were used at the expansion piers. The contractor drove pilot piles with a template around the perimeter of each pile group so that a temporary system could be installed to support the precast cofferdam sections. The remaining piles were then driven through openings in the floor slab of the cofferdam shell. A vibratory hammer was used to advance the piles the first 60 ft through the upper riverbed muck layer, and an impact hammer was used to drive the piles to the estimated tip elevation. After a 7-day setup period, each test pile was restruck to verify attainment of the minimum 800 kip ultimate resistance. Utilizing the setup characteristics of the sandy subsurface layers allowed the pile capacities to be developed without driving to a lower stratum.

The size of the cofferdam footing for each pier half was standardized at 30 ft wide by 49.5 ft long allowing for efficient precast production. The cofferdam shells offered several advantages over traditional cofferdams. These included: providing driving templates, serving as architecturally detailed formwork, constructing the footings at the waterline, and minimizing disturbance of the riverbed. The contract documents allowed the contractor to select the method of support and introduce joints to facilitate casting, shipping, and erection, which resulted in section lengths varying from 7.2 ft to 14.5 ft. The sections could then be easily hoisted into place from barge platforms and connected with couplers consisting of 1¼-in.-diameter anchor bolts, 4-in.-diameter structural tubing, and 1-in.-diameter threaded rods. The cofferdams were faced with a random cut stone pattern and a clear epoxy waterproofing seal coat giving the appearance of wet granite masonry at the waterline.

The piers were constructed using 16-ft-long hollow precast concrete column units with 9-in.-thick walls and 7-ft-deep by 5-ft-wide hollow prestressed concrete cap beams. These precast components were connected by post-tensioning extending from anchorages in the footings to connection points in the cap beams. The post-tensioning design was based on ½-in.-diameter, ASTM A416, Grade 270, low-relaxation strands. However, to facilitate the erection and post-tensioning in the sloped outer columns, the contractor substituted an equivalent system of 1¾-in.-diameter, epoxy-coated, Grade 150 bars (ASTM A775).

Superstructure Innovations

The bridge was designed to accommodate either Prestressed Concrete

TWIN 724-FT-LONG, SIX-SPAN, PRECAST CONCRETE BULB-TEE GIRDER BRIDGES WITH PRECAST PIERS / NEW JERSEY DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Twin, parallel bridges built in phases to appear as one structure, 724 ft long and 94 ft 8 in. wide, using PCEF 71-in.-deep bulb-tees spaced at 8-ft centers; precast concrete piers with a pair of precast plumb columns and a pair of precast voided, inclined columns; a precast cap beam; precast cofferdam shells; precast sound walls; and MSE walls

NOISE WALLS: Jersey Precast Corp., North Brunswick, N.J., a PCI-certified producer

MSE WALLS: Wyoming Concrete Industries, Camden Wyoming, Del.

BEARINGS AND JOINTS SUPPLIER: The D.S. Brown Company, North Baltimore, Ohio

BRIDGE CONSTRUCTION COST: $28 million as part of a $53 million construction project

(Left Photo) Placing reinforcement in a form for the inclined precast concrete column.

(Right Photo) Inclined, voided, precast concrete column being handled in the casting yard.

Economic Fabrication (PCEF) Bulb-Tee girders or New England Bulb-Tee girders. The contract plans were detailed using the PCEF XB 71 47 section, a 71-in.-deep bulb-tee girder, which was the section ultimately supplied by the contractor. The existing bridge was used as a working platform during Stage 1 to set the girders for the eastbound structure. During Stage 2 the newly constructed eastbound structure was used to set the girders for the westbound structure. Galvanized steel intermediate diaphragms were used to quickly secure the girders at the time of erection.

The bulb-tee girders were designed to be simply supported for dead load and continuous for live load. To improve the performance of the continuity diaphragms, NJDOT requested that a better detail be developed for this project. Borrowing ideas from the Pennsylvania DOT and Illinois DOT, the prestressing strands were extended and bent upwards for continuity and 90 lb roofing felt was introduced on the sides of the girder ends to serve as a bond breaker.

Keys to Accelerated Construction

The construction contract was awarded in December 2005 with a construction start date of February 6, 2006. Since in-water construction operations were prohibited from January 1 through June 30, every effort had to be made to maximize each in-water construction season. Cold weather concrete provisions would pose an added difficulty if the pier construction extended into the winter months. The preconstruction baseline schedule was predicated on the pier construction being impacted by these restrictions, so an extended construction schedule of 56 months was anticipated.

To make a significant improvement on the overall project duration, the contractor had to complete the substructures and superstructure of the first half of the bridge as quickly as possible so that traffic could be shifted onto the new structure and the in-water construction activities could begin at the start of the following in-water construction season.

Working within the Environment

Route 70 is a coastal evacuation route and a heavily traveled regional corridor with a two-way average daily traffic in 2005 of 32,300 vehicles. Therefore, NJDOT required that staged construction be utilized and traffic maintained. Following a partial demolition to remove an auxiliary bridge operator's house, the eastbound bridge structure was constructed approximately 3 ft from the south fascia of the existing bridge. The span arrangement allowed the proposed pier foundations to be constructed adjacent to the existing bridge with minor adjustments to clear existing piles. After construction of a temporary pedestrian walkway and transfer of traffic onto the newly constructed eastbound structure, the existing structure was demolished and the westbound bridge constructed.

Environmental permit considerations were important. To protect fish during migration and spawning runs, an in-water work restriction period was imposed from January 1 to June 30 by the United States Army Corps of Engineers and New Jersey Department of Environmental Protection. It was also desirable to minimize the bridge footprint in the riverbed to avoid excavation of salt laden soils and contaminated riverbed sediments.

To achieve this, the contractor operated on a 6-day workweek and employed multiple crews, which moved from one pier location to the next, performing the same tasks for each pier in sequence. In this way the contractor was able to achieve a production rate of 19 working days per pier on each half of the bridge. The project was substantially complete on September 8, 2008, 25 months ahead of schedule.

Lessons Learned

The Route 70 over Manasquan River Bridge Replacement Project provided a sustainable, signature bridge design that met the project requirements. A precast concrete substructure solution achieved the architectural and environmental goals while contributing to accelerated bridge construction.

Of the many important lessons learned on this project, cooperation between the owner, engineer, and contractor stands out. By providing flexibility and alternate provisions in the contract documents and allowing reasonable substitutions, engineers and owners can empower contractors and fabricators to provide lower cost, high-quality projects constructed at a faster pace.

The project also demonstrated the feasibility of precast pier systems for medium-span, in-water bridges. As engineers and contractors continue to gain experience with precast substructure construction, it is expected that precast substructures will be adopted for more conventional spans and even greater efficiencies will be realized with lower project costs in the future.

Eric Yermack is manager, structural engineering with Arora and Associates P.C., Lawrenceville, N.J.

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

THE ART FORM OF BEAUTIFUL BRIDGES™

TOP **Heritage Bridge** over **Turner Turnpike –** This award-winning project used our state-of-the-art form liners to create the stunning aesthetic treatments. Our detailed high-relief fiberglass liners were used to cast the central shield and wing walls depicting local ledge stone and the emblem from the Oklahoma state flag. Specialty staining in earthen browns, reds, blues and beiges further enhances the local stone affect. Our durable rubber liners were used to cast the repeating woven band and jewel pattern along the parapets and piers. Even with only a 2" relief, this crisp pattern is visible from a great distance.

BOTTOM **U.S. 77 Bridge –** Our high-quality rubber form liners and stamps created stylized prairie grass patterns across the wing walls, piers, parapets, and slopewalls of this newly constructed bridge. In select locations, Oklahoma's state bird, the Scissor-tailed Flycatcher, appears to soar above the grass blades. Even without specialty stain enhancements and only a 2" relief, the intricate details created by our in-house artists make these patterns appear three-dimensional and lifelike.

CREATIVE FORM LINERS, INC.

GIVING AESTHETICS FORM™

www.CreativeFormLiners.com **301-864-3676** info@CreativeFormLiners.com

Placing reinforcement and setting forms for a precast concrete cofferdam.

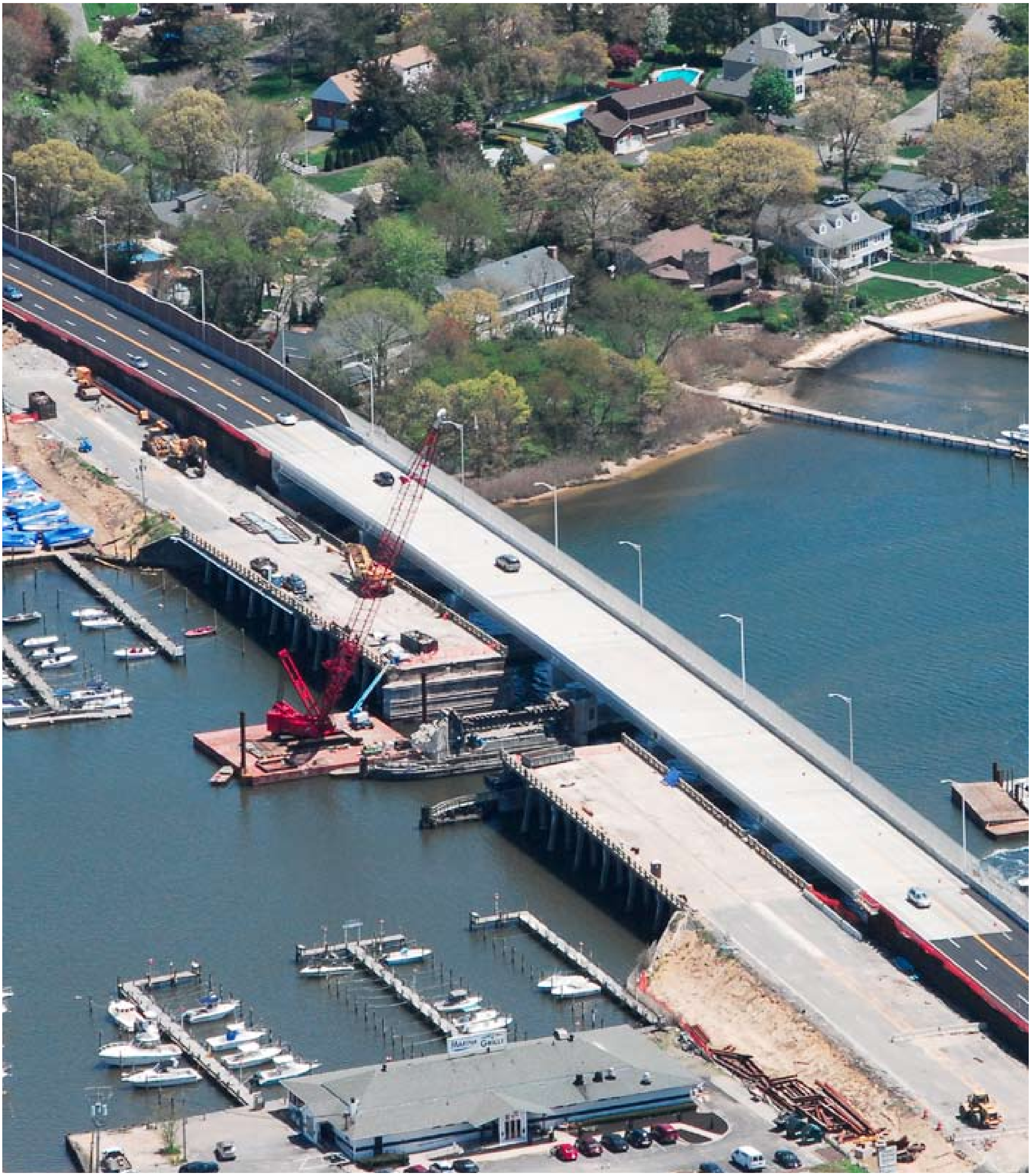
The precast concrete cofferdam shells offered several advantages over traditional cofferdams.

Precast cofferdam section being lowered into place.

All Photos: Arora and Associates P.C.

A precast concrete substructure solution achieved the architectural and environmental goals while contributing to accelerated bridge construction.

Demolition of the existing bridge during Stage 2 construction. Four lanes of traffic were maintained and located on the new eastbound structure.



All Photos: Arora and Associates P.C.

Westbound piers during Stage 2 construction.

All Photos: Arora and Associates P.C.

ROUTE 70 OVER MANASQUAN RIVER, SEPTEMBER 11 MEMORIAL BRIDGE /
OCEAN AND MONMOUTH COUNTIES, NEW JERSEY

The Stage 1 eastbound structure under construction.

View of the precast elements and the underside of the bulb-tee girders.

All Photos: Arora and Associates P.C.