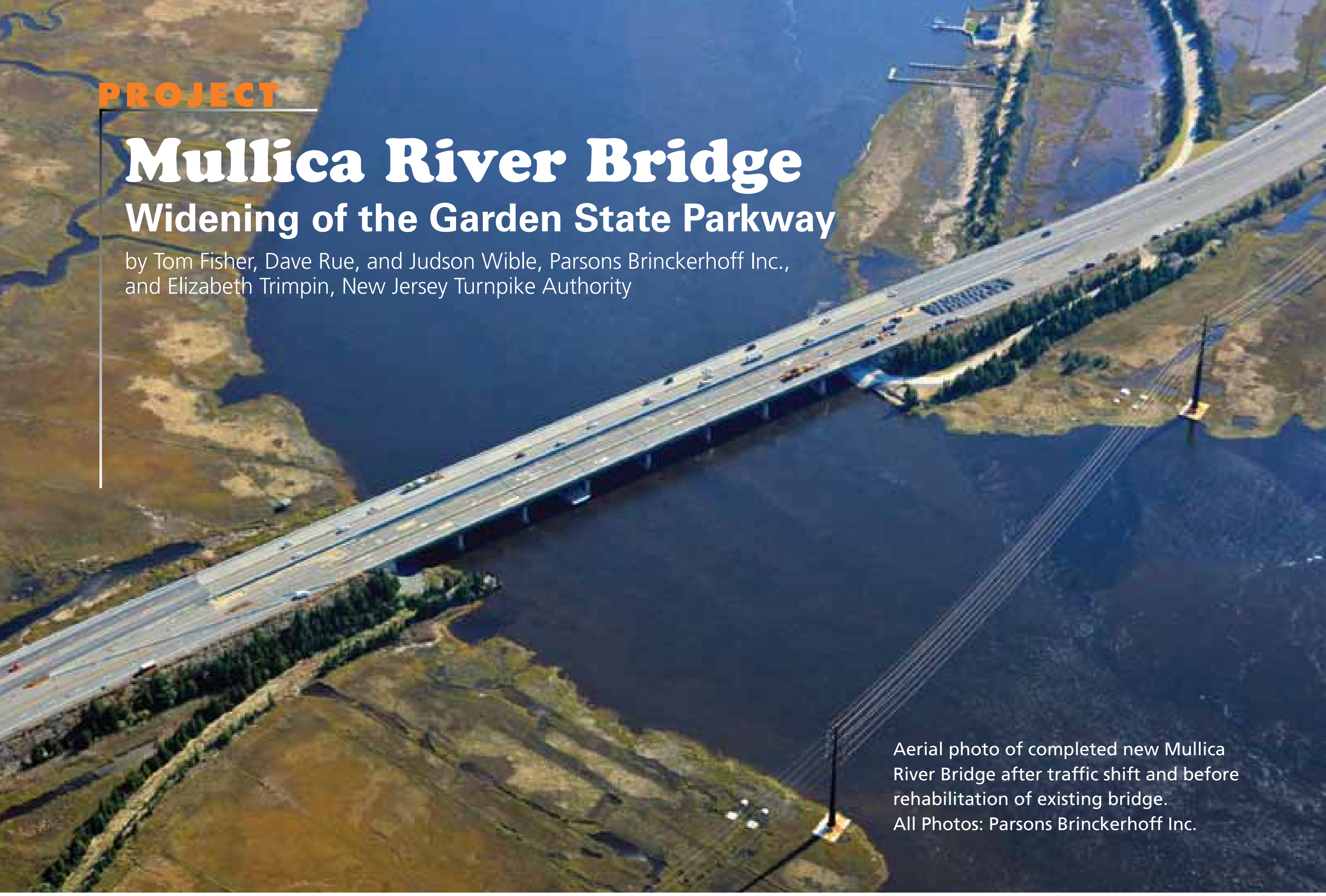
PROJECT

Mullica River Bridge

Widening of the Garden State Parkway

by Tom Fisher, Dave Rue, and Judson Wible, Parsons Brinckerhoff Inc., and Elizabeth Trimpin, New Jersey Turnpike Authority



Aerial photo of completed new Mullica River Bridge after traffic shift and before rehabilitation of existing bridge.
All Photos: Parsons Brinckerhoff Inc.

There's nothing like a 25-mile detour plan to make you realize that the Mullica River Bridge is a critical piece of infrastructure on the Garden State Parkway (GSP). If you're traveling to the Jersey shore (made more popular by the TV show of the same name)—or away from it due to a hurricane—the Mullica River Bridge is the travel crossing located at milepost 49.0 of the GSP.

The New Jersey Turnpike Authority's (NJTA) "Widening of the Garden State Parkway from Interchange 30 to Interchange 80" program consists of planning and design for 50 miles of mainline widening of the GSP from Somers Point, Atlantic County to Toms River, Ocean County, N.J. When completed, the widening program will provide a third travel lane and shoulders for both the northbound and southbound directions.

The widening at the Mullica River crossing will be accomplished with the construction of a new six-span concrete structure to carry northbound traffic, followed by the rehabilitation of the original 1954 eight-span steel structure to carry southbound traffic. The new bridge is designed to handle a four-lane interim traffic pattern, two lanes in each direction, enabling the off-line rehabilitation of the original bridge.

The new structure is 1230 ft long and 56 ft 9 in. wide, providing a final configuration of three 12-ft-wide lanes, a 5-ft-wide inside shoulder, and a 12-ft-wide outside shoulder. The rehabilitated structure is 877 ft 6 in. long, and when finished, will be 61 ft 9 in. wide with three 12-ft-wide lanes, a 10-ft-wide inside shoulder, and a 12-ft-wide outside shoulder. The two tangent parallel bridges are 12 ft apart and the approach embankment is retained by mechanically stabilized

profile

MULLICA RIVER BRIDGE / CITY OF PORT REPUBLIC – ATLANTIC COUNTY AND TOWNSHIP OF BASS RIVER – BURLINGTON COUNTY, NEW JERSEY

BRIDGE DESIGN ENGINEER: Parsons Brinckerhoff Inc., Lawrenceville, N.J.

PRIME CONTRACTOR: Agate Construction Company, Ocean View, N.J.

CONSTRUCTION MANAGER: Parsons Brinckerhoff Inc., Lawrenceville, N.J.

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

CONCRETE SUPPLIER: Penn Jersey Concrete, Egg Harbor Township, N.J.

POST-TENSIONING CONTRACTOR: Freyssinet Inc., Sterling, Va.

earth (MSE) walls to minimize the environmental impacts.

Substructure

The challenges to successful completion of design and construction of the new bridge included environmental restrictions, drilled-shaft design considerations, scour countermeasures, spliced concrete girder design, and constructability issues. Overcoming all of these issues led to opening the new bridge to traffic in April 2011.

With a six-month permit allowance each year for in-water construction, along with other environmental restrictions, the new bridge design had several major construction obstacles to overcome. Construction scheduling and planning accommodated the environmental constraints and conditions for indigenous species including oyster beds, osprey nests, anadromous fish, winter flounder, and terrapin turtles.

With in-water construction restricted to between July 1 and December 31, the need to reduce the extent and duration of in-water work was paramount for all involved. Fewer longer spans were selected in the design phase to reduce the number of piers that needed to be constructed in the water. In addition, the contractor advanced its work within a temporary steel cofferdam, which created a sealed environment that contained any disturbance of the river bed and allowed installation of the demonstration drilled shaft during the restricted time period. Once the demonstration shaft was satisfactorily tested, the foundation for pier 1 was constructed within the sealed cofferdam.

The Mullica River-area soil can be generally categorized as lowland alluvial deposits overlying marine sediments with locations of tidal marsh soils. The soft soils presented a challenge to developing the foundations for the new bridge. As part of the design, 8-ft-diameter drilled shafts were specified in some areas to extend down to an elevation of -230 ft to satisfy scour, vessel collision, and other design considerations. The foundation design and construction represented a significant item in the total project cost.

Pier 1 segment installation.

A demonstration drilled shaft was included in the project to ensure that the contractor's means and methods were appropriate and confirm the required length of the production shafts. Evaluation and analysis of the demonstration shaft with Osterberg Cell rings and cross-hole sonic logging and tomography, resulted in raising the typical elevation for the bottom of the shaft to an elevation of -180 ft. This change in elevation, from the original foundation design, resulted in a savings of nearly $3 million for the NJTA.

Three, 8-ft-diameter drilled shafts were installed per pier. The three-shaft configuration was selected because of redundancy during an extreme loading event typical of a natural disaster, explosion, or vessel impact. The shafts extended to a height of 18.23 ft above mean high water and are anchored directly into the pier caps. A polymer slurry was used to keep the drilled shaft holes from collapsing during construction and self-consolidating concrete was pumped into the bottom to prevent anomalies in the shaft concrete. The pier caps are 58 ft long, 9 ft wide, and 10 ft thick.

Span segment installation with strong-backs.

NEW JERSEY TURNPIKE AUTHORITY / GARDEN STATE PARKWAY, OWNER

BRIDGE DESCRIPTION: 1230-ft-long continuous, spliced, post-tensioned concrete girder bridge with four 220-ft-long spans and two flanking 175-ft-long spans, supported by 8-ft-diameter drilled shafts anchored into 10-ft-high by 9-ft-wide pier caps, with three 180-ft-long drilled shafts per pier

STRUCTURAL COMPONENTS: Fender system, prestressed concrete piles, mechanically stabilized earth walls, drilled shafts, controlled modulus columns, seismic isolation bearings, articulated concrete block mattresses, and modular expansion joints

BRIDGE CONSTRUCTION COST: $52,524,000

AWARDS: 2012 New Jersey-American Concrete Institute 49th Annual N.J. Concrete Awards—Grand Award; 2012 American Council of Engineering Companies (ACEC)—N.J. Honor Award; 2012 ACEC National Recognition Award; and 2012 Professional Engineering Society of Mercer County Project of the Year

Concrete pumping trucks were used in series to install the self-consolidating concrete in the drilled shafts.

MSE retaining wall and articulated concrete block mattresses were used as an access road.

The new bridge abutments, wingwalls, and MSE walls were all subject to scour and required deep foundations. The abutments and wingwalls were installed on prestressed concrete piles, and the MSE walls were constructed on controlled modulus columns. A controlled modulus column (CMC) is a soil improvement method used to stabilize an area of typically poor soil. An auger forcibly displaces soil and grouts a column of concrete into the ground. The Mullica River Bridge has 2129 CMCs on the project. Additionally, articulated concrete block mattresses were installed to provide scour protection for the existing bridge.

Superstructure

Concrete was selected as the material of choice for the new superstructure to eliminate future painting costs associated with steel bridge sustainment in this coastal area. The new bridge is a 1230-ft-long continuous, spliced, post-tensioned concrete girder bridge with four main spans of 220 ft and two end spans of 175 ft. It is currently one of the longest, continuous, post-tensioned spliced girder units in North America. Modular deck joints are provided only at the abutments. The seven lines of AASHTO Type VI Modified post-tensioned concrete composite girders were spaced at 8 ft 6 in. on centers. The Type VI girders are haunched over the piers and support drop-in segments. The girder depth varies from 78 in. deep at midspan to 108 in. deep at the piers with each pier segment weighing 137,500 lb. Specified concrete compressive strength for the beams was 8 ksi.

The sequence of girder erection consisted of:

- erecting pier segments at five piers,
- installing drop-in segments in the four main spans,
- installing drop-in segments in the two end spans, and
- casting closure joints.

Pretensioning was provided in each of the segments to account for anticipated shipping, handling, and erection stresses. Corrugated plastic ducts were embedded in the beam for the post-tensioning tendons. The design specified four tendons each consisting of twelve, 0.6-in.-diameter, seven-wire strands. Two tendons were tensioned after the girders were erected to achieve continuity. The remaining two tendons were tensioned after the concrete deck slab was placed and cured. Temporary moment connections between the haunched girders and the pier cap were created with vertical post-tensioning. This connection transferred the unbalanced moment during placement of the drop-in girder spans on the pier cap. Strongbacks were designed to support the girder loads.

The high-performance concrete (HPC) deck construction for the Mullica River Bridge went smoothly from start to finish. The specifications detailed important requirements such as a 14-day wet cure burlap application along with Rainhart Profilograph ride quality testing. Two-stage post-tensioning provided residual compression in the deck due to the tensioning of two of the four girder tendons after the composite deck had been placed.

A time-step analysis model was used to evaluate the loading during the girder erection and the post-tensioning phases. Careful consideration and evaluation for temporary unbalanced load conditions on the permanent structure, vertical and horizontal deflections, and loads of both the girders and piers were conducted as each component was constructed. The benefit of this methodology was the elimination of the typical shored construction method using temporary support towers for the superstructure (prior to splicing), resulting in considerable construction cost savings.

Summary

This project presented significant environmental challenges and considerations, restrictive construction windows, unique seismic design applications, and is currently on pace to open, with traffic flowing in both directions and over both structures, by December 2013.

Tom Fisher is the project manager, Dave Rue is the structural lead, and Judson Wible is a structural engineer, all at Parsons Brinkerhoff Inc., Lawrenceville, N.J. Elizabeth Trimpin is a project manager, New Jersey Turnpike Authority, Woodbridge, N.J.

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