PROJECT

Welcome to Ocean City, Via Route 52 Visitors Center Bridge

Curved, post-tensioned, spline bridge welcomes visitors

by Joseph J. Romano, Michael Baker Jr. Inc.; Joseph E. Salvadori, DYWIDAG-Systems International USA Inc.; and Daniel P. Zeller, Route 52 Constructors

A view of the new Route 52 Visitors Center Bridge. Photo: Route 52 Constructors.

The Route 52 Visitors Center Bridge (VCB) on Garrets Island had to provide an inviting and welcoming appearance to all stopping by the newly constructed Ocean City's Visitors Center. This bridge was part of a larger $400 million project replacing the Route 52 Causeway bridges and the roadway section between Somers Point and Ocean City, N.J. Overall, this is one of the New Jersey Department of Transportation's (NJDOT's) largest projects and is a critical link because of its designation as the emergency evacuation route for Ocean City.

The VCB was designed to replace an existing bridge at the newly constructed visitors center. Early in the bridge study, it was determined that aesthetics were going to play a significant role in the selection of the bridge type. In the end, two alternates were suggested for this bridge, a horizontally curved, steel plate girder and curved post-tensioned concrete spline bridge. After seeking input from the community, the curved, post-tensioned concrete spline bridge was selected. One of the more aesthetically pleasing details of the bridge are the large wings that extend over 20 ft from both sides of the bridge.

Superstructure Details

Measuring just under 400 ft in length, VCB consists of four spans (92, 107, 107, and 92 ft) constructed on a 449 ft radius with a 2% vertical grade in superelevation. The connection between the superstructure and three intermediate piers is integral with bearings and expansion joints used only at the two abutments. VCB's superstructure is 70 ft wide with a sidewalk on each side leaving a width of 50 ft for vehicular traffic. The superstructure is 4 ft 6 in. deep.

Considering the minimal depth and solid nature of this structure, post-tensioning was selected as the main reinforcing system for the superstructure. The VCB superstructure contains 17 longitudinal tendons, each with twenty-seven

profile

ROUTE 52 VISITORS CENTER BRIDGE / OCEAN CITY, NEW JERSEY

BRIDGE DESIGN ENGINEER: Michael Baker Jr. Inc., Hamilton, N.J.

PRIME CONTRACTOR: Route 52 Constructors: A Joint Venture of G.A. & F.C. Wagman Inc. and R.E. Pierson Construction Co. Inc., York, Pa.

CONCRETE SUPPLIER: Clayton Concrete, Block and Sand, Lakewood, N.J.

PRECASTER: Precast concrete piles by Bayshore Concrete Products Corp., Cape Charles, Va., a PCI-certified producer

POST-TENSIONING CONTRACTOR: DYWIDAG-Systems International USA Inc., Toughkenamon, Pa.

0.6-in.-diameter strands in the main section with an additional six tendons with nine 0.6-in.-diameter strands in the winged sections running the length of the structure. The path of the tendons is parabolic in the vertical plane and curved in the horizontal plane. In the transverse direction, the bridge contains 256 tendons, each with four 0.6-in.-diameter strands, which were spaced radially at approximately 1 ft 9 in. on center at the center line of the curve.

For strength and durability, a 5500 psi compressive strength normal weight concrete containing a corrosion inhibitor was utilized in the superstructure. The contractor was given three options for corrosion protection of the reinforcing steel: epoxy coating, stainless steel cladding, or galvanized reinforcement. The contractor chose epoxy coating. An additional design requirement that did not permit any tension in the superstructure, along with biaxial post-tensioning, a ⅜-in.-thick deck slurry overlay, and a 1¼-in.-thick integral wearing surface ensures a durable structure that will easily meet the 75-year required service life.

Two pump trucks were used to fill the Route 52 Visitors Center Bridge cross section as quickly as possible to avoid any cold joints. Photo: Route 52 Constructors.

Design

Design of the superstructure was based on the 4th edition *AASHTO LRFD Bridge Design Specifications* (2007) as modified by the *NJDOT Design Manual for Bridges and Structures*. The CEB-FIB 3rd Edition 1978 code was used to model the time-dependent behavior of concrete for creep and shrinkage.

Both two-dimensional and three-dimensional modeling were used. The first model involved the longitudinal analysis of the main solid box section. This time-dependent model constructed the VCB step-by-step and analyzed the structure for its entire design life to ensure that the superstructure remained in compression. Not only were dead and live load combinations considered in this design model, but also uniform-temperature and temperature-gradient load cases were analyzed. The model also accounted for the stiffness of the substructure and its impact on the superstructure design.

With the large overhanging wings, special design methods were utilized in the transverse analysis. A three-dimensional, finite-element model utilizing plate elements, to account for the plate bending and plane stresses (that is, membrane actions, in-plane action), was developed. The plates were considered planar elements with constant thickness, quadrilateral in shape, and modeled with isotropic material properties. For simplicity, the VCB deck wing was modeled from the interface of the wing transition and assumed fixed at this location (outside of the taper where the wing was 2 ft thick). A linear-static analysis was run with this model, resulting in the design forces and stresses that were considered in the transverse post-tensioning design.

Earthquake design considerations were also incorporated into this structure. A multi-mode spectral analysis was performed in accordance with the latest AASHTO requirements. A site-specific response acceleration spectrum was

The path of the tendons in the Route 52 Visitors Center Bridge was parabolic in the vertical plane and curved in the horizontal plane. Photo: Route 52 Constructors.

The Route 52 Visitors Center Bridge superstructure was post-tensioned longitudinally and transversely. Photo: Route 52 Constructors.

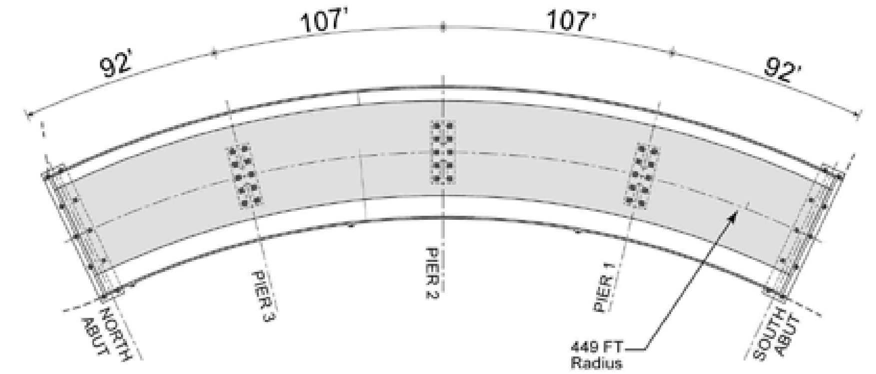
NEW JERSEY DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Four-span (92, 107, 107, and 92 ft) cast-in-place, post-tensioned concrete spline structure 400 ft long and 70 ft wide

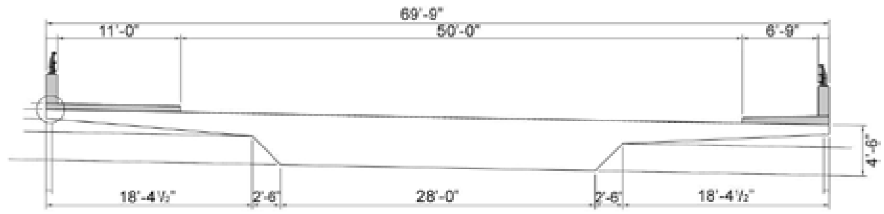
STRUCTURAL COMPONENTS: Precast, prestressed concrete piles and cast-in-place abutments, piers, and superstructure

BRIDGE CONSTRUCTION COST: $6.6 million

Concrete for the midspan regions of the Route 52 Visitors Center Bridge was placed independently of that over the piers by using transverse bulkheads. Photo: Route 52 Constructors.



A plan-view drawing of the Route 52 Visitors Center Bridge. Drawings: Janssen & Spanns Engineering Inc.



A drawing of a typical section of the Route 52 Visitors Center Bridge. Drawings: Janssen & Spanns Engineering Inc.

constructed and used for the evaluation of the bridge. VCB was classified as an essential bridge in Seismic Design Category B. The loads generated in this analysis were used in the connection design at the piers as well as in the design of the VCB substructure and foundation. Seismic restraint blocks with armoring were provided at the end abutments.

Foundations

Square precast concrete piles were utilized in the foundations supporting the intermediate piers and end abutments. Twenty-four-inch square piles containing sixteen 0.5-in.-diameter, epoxy coated, 7-wire, 270 ksi prestressing strands were used at the abutments to a depth of approximately 80 ft. At the intermediate piers, 30-in. square piles containing thirty-six 0.5-in.-diameter, epoxy coated, 7-wire, 270 ksi prestressing strands were used to a depth of approximately 75 ft. The concrete utilized in the piles contained calcium nitrate corrosion inhibitor as required in NJDOT's standard specifications.

The piles at the abutments supported a 5-ft-thick, cast-in-place concrete footing and a 5-ft 9-in.-thick abutment wall, approximately 17 ft in height. Ground reinforcing strips were attached to the back wall to minimize the overturning tendency from the active soil loads.

Piles at the VCB piers support a 5-ft-thick, cast-in-place concrete footing and two non-rectilinear columns approximately 20 ft in height. Protruding reinforcement from the columns extends into the superstructure to accommodate the integral connection. All exposed surfaces of the piers and abutments were stained to provide continuity and consistency to the aesthetic theme and coated with an anti-graffiti treatment.

Construction

The construction of VCB provided several challenges requiring innovative solutions. The soil conditions presented unique settlement concerns for both substructure and superstructure construction. A falsework system was erected to support the cast-in-place construction portion of the superstructure, but this too became a point of concern as the falsework reacted to differential settlement.

Inconsistent soil conditions, combined with vastly contrasting bridge cross sections, created some concern with the potential for structural cracking produced by differential settlement of the shoring foundation prior to post-tensioning.

To better distribute the weight of the structure over the entire footprint of the shoring, the shoring tower aluminum support beams were spliced together in the field to make continuous 80-ft-long beams under the formwork. Finally, the concrete placing sequence was separated into negative and positive moment sections of the bridge for added assurance even though the entire bridge was supported on falsework. These proactive measures proved successful.

In an effort to mitigate additional load on the falsework, the strand packs and specialized strand installation equipment for the transverse post tensioning tendons were installed from a flatbed positioned parallel to the east side of the bridge.

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Joseph J. Romano is the structures department manager for the Michael Baker Jr. Inc. office in Hamilton, N.J.; Joseph E. Salvadori is northeast regional manager for the post-tensioning business unit of DYWIDAG-Systems International USA Inc.; and Daniel P. Zeller is field engineer for Route 52 Constructors.

For additional photographs or information on this or other projects, visit www.aspirebridge.org and open Current Issue.

EDITOR'S NOTE

A more in-depth discussion of the proactive VCB construction methods used for this bridge is available at the ASPIRE™ website, www.aspirebridge.org. Click on Magazine.