Balanced-cantilever construction for the Bayonne Bridge approaches.

The structure is designed for an additional 100 years of service life after the opening of the reconstructed facility. All reinforcement in the deck or anchored in the deck is stainless steel.

Precast concrete segmental construction is effectively being used for the balanced-cantilever superstructure as well as for the substructure piers and pier caps. Hollow precast concrete segments were used at all 24 of the two-column pier locations, as well as the post-tensioned precast concrete pier-cap segments. Precast concrete segmental construction was used for all 52 spans of the New York and New Jersey approach superstructures. All designs were in accordance with the *AASHTO LRFD Bridge Design Specifications*, 6th edition.

Approach Design and Construction

The design of the hollow precast concrete columns and arched precast concrete pier caps included aesthetics and architectural face treatments to complement the existing architecture of the original 1931 Bayonne Bridge approach piers. Where the substructures support the typical 36-ft-wide roadway, a combined Type 1 two-column pier is used. In the areas adjacent to the abutments on each end of the bridge, where the acceleration and deceleration lanes add an additional 12 ft to the roadway template, side-by-side Type 2 single-column piers are used (see the CBT article in this issue for more information on the piers).

The superstructure is being cast and erected as twin single-cell box girders with variable width to accommodate acceleration and deceleration lanes. The northbound roadway accommodates a 12-ft-wide shared-use path, while the southbound roadway is designed to accommodate future light-rail transit.

All precast concrete segments are being cast in Cape Charles, Va. Precast concrete elements are barged 300 miles on the ocean to Bayonne, N.J., where they are off-loaded and stored until needed for erection. Superstructure segments are either 10- or 14-ft-deep, and the maximum haul weight is 112 tons.

Key Design Parameters and Principal Quantities	
Superstructure concrete strength	10 ksi
Substructure concrete strength	8.5 ksi
Superstructure concrete volume	44,900 yd^3
Substructure concrete volume	15,600 yd^3
Superstructure theoretical (average) thickness	2.33 ft
Superstructure reinforcing bar density[2]	192 lb/yd^3
Superstructure post-tensioning (longitudinal)	5.1 lb/ft^2
Superstructure post-tensioning (transverse)	1.0 lb/ft^2
Substructure reinforcing bar density	160 lb/yd^3
Substructure post-tensioning steel density	70 lb/yd^3

[1] Theoretical average thickness is the volume of superstructure concrete divided by the total deck area. It is a helpful parameter for conceptual estimation of concrete quantities as it varies with the average span length for a given project.

[2] Approximately 70% of the reinforcement was stainless steel, and the remaining 30% was epoxy coated.

Balanced-cantilever construction of the superstructure is performed with the use of overhead self-launching gantries. Superstructure erection is performed at night with the existing bridge closed to traffic, while the permanent post-tensioning is installed and stressed during daytime hours.

Construction Status

On February 20, 2017, two lanes of northbound traffic were transferred onto the new upper roadway. Demolition of the existing suspended-arch floor system has commenced, with June as the target removal completion date. Larger container vessels will then be able to access the port facilities. Removal of the existing approach structure is now under way.

The first task for the southbound approach is the installation of the drilled shafts, followed by construction of the footings. Fabrication of the precast concrete segments for the southbound substructure is essentially complete and casting of the superstructure elements was approximately 65% complete as of April. It is anticipated that construction of the southbound structure will be completed in 2019.

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AESTHETICS COMMENTARY
by Frederick Gottemoeller

Talk about a challenge: significantly altering one of the iconic bridges of the twentieth century, designed by one of the century's master builders, Othmar Amman, and doing that while the bridge is in continuous use! I don't know how the design team slept at night. But they certainly rose to the challenge.

Let's start with the decision to use precast concrete segmental construction for the approach spans. It significantly changes the look of the bridge in comparison to the steel-plate girder spans of the original, but the longer spans and fewer piers open up views through the structure that didn't exist before, and create opportunities for new ground-level activities that will benefit all of those people who live or work near the bridge. Plus, the more massive concrete superstructure absorbs road noise, an underappreciated benefit of concrete segmental construction that will improve the local environment aesthetically as well as physically.

Then there are the new approach piers. The taller and wider piers are more prominent elements in the scene than were the original piers, but visual continuity with the original piers is established by borrowing their arched pier caps and the horizontal grooves of their columns.

I. M. Pei, the architect who redesigned the Louvre, stated the challenge of altering famous structures this way: "How do we make history live, and still point the way to the future?" The designers of the Bayonne Bridge reconstruction have shown how.

EDITOR'S NOTE

Another article about the Bayonne Bridge project is included in this issue on page 28.