VETERANS MEMORIAL BRIDGE

THE VITAL LINK FOR TWO CITIES

Segmental bridge makes statement in Maine

by Christopher P. Taylor, T.Y. Lin International

The original Veterans Memorial Bridge (VMB), which was built in 1954, is an important link connecting the cities of Portland and South Portland, Maine, and spans the Fore River. While the existing bridge is still safe for use, the Maine Department of Transportation recognized that the old structure had met its life expectancy and made replacing the bridge a top priority.

An alternative technical concept for a new bridge alignment was developed by the team of Reed & Reed and bridge designer T.Y. Lin International. The new bridge is being built upstream and at a slightly different angle from the older structure. This offers several significant advantages:

- Overlap with the existing bridge was eliminated, greatly reducing impact to the 22,000 vehicles using the bridge each day.
- Work over and adjacent to the active railroad was minimized.
- The overall bridge length was reduced by nearly 800 ft.
- The level of service of the intersections at the north end of the bridge will be improved.
- The new location and alignment will result in a more popular and efficient entry point to the city.

Superstructure

The new segmental precast concrete bridge has a required 100-year service life and is a more visibly compelling structure for the cities it connects. It is designed to enhance the aesthetic experience and reduce the number of spans needed while providing Portland and South Portland with a signature bridge for this important transportation link. The VMB superstructure consists of twin seven-span continuous, variable-depth, single cell, trapezoidal box girders built using the balanced cantilever method. Typical span lengths are 250 ft each and end spans are 185 and 175 ft. The 1610-ft-long bridge is continuous from abutment to abutment; expansion joints are only required at each end. The superstructure is post-tensioned in both the longitudinal and transverse directions.

The roadway is designed for two lanes of traffic in each direction with an additional 12-ft-wide, multi-use pathway. The superstructure is made up of two parallel precast concrete boxes built using the balanced cantilever method of construction and joined by a cast-in-place (CIP) concrete longitudinal closure strip. The 361 segments vary in depth from 8 ft 1 in. at midspan typical to 11 ft 1 in. at the piers. Segment length is 8 ft to 10 ft, with pier segments of 5 ft. The bridge is on a constant 1.33% longitudinal grade.

Most of the alignment is straight with the north end having a 680-ft radius curve. The width of the north end also widens to accommodate a left turn lane. Here the width of each box top flange increases from 39 ft 9 in. to 45 ft 9 in.

The new bridge is being built on new alignment upstream at a slight angle to the existing bridge. Photo: T.Y. Lin International.

profile

VETERANS MEMORIAL BRIDGE / PORTLAND-SOUTH PORTLAND, MAINE

BRIDGE DESIGN ENGINEER: T.Y. Lin International, Falmouth, Maine

GEOTECHNICAL ENGINEER: GZA Geoenvironmental Inc., Portland, Maine

PRIME CONTRACTOR: Reed & Reed Inc., Woolwich, Maine

PRECASTER: Unistress Corporation, Pittsfield, Mass., a PCI-certified producer

POST-TENSIONING CONTRACTOR: DYWIDAG-Systems International USA Inc., Bolingbrook, Ill.

CAST-IN-PLACE CONCRETE SUPPLIER: Dragon Products Company, Portland, Maine

Three overlooks are provided along the multi-use pathway. Photo: Unistress Corporation.

At three points along the bridge, the 12-ft-wide pedestrian and bicycle path widens into scenic outlooks over the Fore River, providing excellent views toward Casco Bay and Portland Harbor.

The curved concrete walls that divide the path from the motorway will be topped with curved metal poles that appear to wave in a sinuous pattern. The overlooks are accomplished by extending the box girder overhang by 8 ft on one side to 16 ft 3 in.

Substructure

Independent piers support each box girder. The piers are rectangular, single-shaft, cast-in-place columns. The tops of the columns flare out to meet and blend into the superstructure. The columns are pile supported with buried pile caps. Only the shafts of the columns project above the river bottom, creating an elegant appearance with minimal permanent impact to the aquatic resource. The 22-in.-diameter steel pipe piles were driven through approximately 100 ft of marine clay to bedrock.

Construction

During the bidding phase of this design-build project, the team determined that the segmental precast concrete option would provide the best value based on aesthetic and durability aspects. On this relatively small project, segmental precast concrete construction was made competitive by basing the design on reusing existing formwork, saving both time and money. The segments were precast and the four-strand transverse tendons were stressed and grouted prior to being trucked 240 miles to the project site. The transverse tendons consisted of 0.6-in-diameter strands and were spaced at 2 ft centers. At the bridge site, the segments were loaded onto a barge for delivery to the cantilever tips where they were erected by barge-mounted cranes.

The pier segments, weighing up to 76 tons, were supported on disk bearings, temporarily fixed during erection. Temporary shoring towers were installed below the second pair of typical segments to resist the overturning moments. Top slab cantilever post-tensioning tendons are typically nineteen 0.6-in.-diameter strands and the bottom slab continuity tendons are fourteen 0.6-in.-diameter strands.

Community Involvement

Because the bridge is a signature structure, significant public involvement was included throughout the project. A series of public workshops was held in the spring of 2010 for the community to provide input on elements of the bridge that were important to the various stakeholder groups, including pedestrians, bicyclists, veterans groups, and area residents. The bicycle and pedestrian paths connect to an existing parkway trail system. Memorials will also be placed on both sides to honor Maine's U.S. Service and Merchant Marine veterans.

Segments cantilever out from Pier 6 at the north end of the bridge. Photo: Reed & Reed Inc.

In the yard, segments were shuttled with a straddle lift. Photo: Reed & Reed Inc.

MAINE DEPARTMENT OF TRANSPORTATION, OWNER

BEARING SUPPLIER: The D.S. Brown Company, North Baltimore, Ohio

PRECAST SEGMENT FORMWORK: EFCO Corporation, Marlboro, N.J.

BRIDGE DESCRIPTION: Twin 1610-ft-long post-tensioned, precast segmental box girder superstructures supported on cast-in-place (CIP) piers, founded on 100-ft-long, 22-in.-diameter steel pipe piles. Segments vary in depth from 8 ft 1 in to 11 ft 1 in. Twin structures are joined with a CIP closure strip for an overall bridge width varying between 82 ft 6 in. and 94 ft 6 in.

BRIDGE CONSTRUCTION COST: Bridge cost $44.2 million ($325/ft^2); total project cost $63.1 million

The new segmental precast concrete bridge has a required 100-year service life.

100-Year Service Life

The Veterans Memorial Bridge is located over salt water in a harsh, cold-weather environment. This made life-cycle cost and longevity important considerations in the project request for proposal. A number of features were incorporated to ensure long-term durability and corrosion protection and to minimize maintenance costs.

The specified compressive strength for the superstructure concrete was 7000 psi. The concrete contains 20% fly ash by weight of cementitious materials to decrease permeability to below 1000 coulombs at 120 days per AASHTO T 277 and contains 5.5 gal/yd^3 of calcium nitrite corrosion inhibitor.

The superstructure is post-tensioned in both the longitudinal and transverse directions. The deck is designed for a minimum of 250 psi longitudinal compression under permanent loads and zero longitudinal tension under live load. These strict criteria exceed the AASHTO LRFD Bridge Design Specification requirements and reduce the likelihood of cracking. The post-tensioning tendons are protected within grout-filled, polyethylene ducts, virtually eliminating the possibility of chloride attack. All substructure elements exposed to salt water also utilize calcium nitrite corrosion inhibitor at 5.5 gal/yd^3 and have 4 in. of concrete cover to the main reinforcement.

Corrosion resistant ASTM A1035 reinforcement is used in cast-in-place concrete portions of the superstructure. The deck is further protected by a high-performance waterproofing membrane and a 3-in.-thick bituminous wearing surface consisting of modified asphalt. No intermediate deck joints are used.

Segments were carried to temporary docks and loaded on barges to be delivered to the cantilever tips. Photo: Reed & Reed Inc.

Once the two structures were erected, a cast-in-place closure strip joined the two halves, creating a continuous deck surface. Photo: Reed & Reed Inc.

The project was awarded in February 2010 with design starting immediately and segment shop drawing production, in close coordination, starting shortly thereafter. Casting of the segments began in August 2010, and erection was completed in November 2011. The contractor is currently working on paving, barriers, and other finishing touches. The new landmark bridge is scheduled to open to traffic this July. Demolition of the old bridge is scheduled for completion by December 2012.

Christopher P. Taylor is a senior bridge engineer at T.Y. Lin International.

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