



Photo Courtesy of FIGG

The new I-91 Brattleboro Bridge in Brattleboro, Vermont, is a three-span, 1,036 ft arching bridge with a 515 ft main span soaring 90 ft above the West River built utilizing segmental balanced cantilever construction. The new concrete segmental bridge (a first in the state) features landmark aesthetics and provides a 150-year service life. This signature bridge, which is the largest bridge in Vermont's history, creates a special gateway into the state.

The new bridge was opened to traffic on September 12, 2017, and replaced twin aging steel bridges that were built in 1958. The new bridge carries four lanes of traffic but has the capacity to carry eight lanes of traffic.

The Design/Build Team (FIGG Bridge Engineers, Inc., and PCL Civil Constructors, Inc.) worked closely with the community and VTrans on the aesthetic and functional design centered around a theme of "Vermont: A Bridge to Nature." This postcard-worthy bridge features viewing platforms for pedestrians, hikers, and visitors at the base of each pier overlooking the West River and mountainous valley.

I-91 Brattleboro Bridge

Category: Long Span and Cable-Stayed Bridges

Innovation of Design and/or Construction

The balanced cantilever method facilitated construction to rise above the site constraints on the ground below and allowed the long spans to be formed in a self-supported manner during construction. This was an important benefit for the unobstructed use of the West River and West River Trail for recreation throughout construction. Using self-advancing formwork (form travelers), segments of the bridge were cast-in-place 16 ft at a time, alternating from one side of the pier to the other, until each cantilever arm reached 257 ft. When the adjacent pier's cantilever was completed using the same process, a small closure segment was cast to connect the two cantilever arms and form the span. For the two cantilevers to meet at a precise mid-air target, surveying and geometry control were a full-time endeavor. Balanced cantilever construction also allowed crews to work throughout the harsh Vermont winter. Cast-in-place concrete segments were cured using the IntelliCure Match curing system which matches the water temperature conditions of the cure box with sensors in the segments so concrete breaks accurately represented what was going on with segment curing.

The quad wall piers are comprised of four concrete columns that each curve outward in two directions symmetrically. This wall pier system provided stability and allowed for the balanced cantilever segmental construction of the bridge superstructure from above without temporary props in the river, preserving the West River and West River Trail.

The design team utilized sophisticated LARSA 3D finite element models with time dependent effects to design the bridge to not only withstand the appropriate standard loadings, but to also account for the time dependent effects on the concrete as it creeps and shrinks throughout the 150-year design life of the bridge.

To support the bridge deck width of 104'-8", a two-cell, three-web trapezoidal box girder was used. A variable depth profile was used for structural efficiency. Another unique feature to the box girder section is the vaulted

bottom soffit that runs the full length of the underside of the bridge. This 20 ft wide, 4 ft deep barrel-like shape serves to add dimension to the soffit that would otherwise be a flat 55 ft width. Continuous mild reinforcement through segment joints and a grouted post-tensioning system create continuity through the cast-in-place segments. Top slab tendons were used during cantilever construction, while bottom slab and external draped tendons provided continuity after span closures. Transverse top slab tendons balanced the deck design. All tendons have multiple layers of corrosion protection including an integral wearing surface, concrete cover, low-permeability concrete, plastic ducts, and high-quality grout.

Rapid Construction

The concrete segmental bridge design allowed means and methods that provided simple solutions to the complex site. Balanced cantilever construction techniques were utilized to build the bridge from above continuously and without interruption throughout the year.

Aesthetics and/or Harmony with Environment

It was important to VTrans and the surrounding communities for the new bridge to serve as an icon and a gateway to Vermont. Its long spans provide openness, and its arching shapes enhance the bridge as a visual gateway.

Travelers along Route 30 experience this distinctive bridge from a side vantage point as they travel under the bridge. They see the vaulted soffit stained with a blue color like the sky. The arching, long span of the superstructure is half as deep as the former bridge and opens up views of the surrounding landscape. A permanent concrete earth-toned tan stain was applied to all sides of the bridge superstructure, matching the surrounding environment. The 60 ft tall piers were cast to a texture like Vermont stone, which creates a dramatic look with different natural colors along the height. The upper "fins" of the piers cradle the superstructure and

Jury Comments

The State of Vermont entered the family of states with segmental bridges in this spectacular example of the I-91 Brattleboro Bridge. The Bridge's 515 ft main span with its cast-in place variable depth span use the advantages of balanced cantilever construction to span the entire waterway. The innovative approach to sustainability with 150-year design life, the use of calcium nitrate, and stainless-steel reinforcement will ensure this bridge will be a destination for generations to come. The signature bridge is inspired by the natural beauty of Vermont and highlights both function and symbol with shape, color and stone. Balanced segmental cantilever construction techniques eliminated the need for temporary works and allowed construction to occur throughout the year.



Photo Courtesy of FIGG

were hand sculpted using shotcrete to match the stone texture below.

Observation platforms at the base of each pier provide access to view the Gallery of the Natural Habitat where visitors can walk between the massive quad walls. The platform space is formed from the top of each footing with a stone texture and a green pattern representing a white pine with 14 branches. This is inspired by the Vermont State Seal which features a white pine with 14 branches because Vermont was the 14th state. Standing on the observation platform and looking up between the stone textured columns of the pier gives the feeling of being in an outdoor cathedral. The bridge is both structure and symbol, both function and sculpture. Educational plaques honor Vermont's natural resources and history.



Cost Competitiveness

This project exemplifies the "Best Value" effectiveness of concrete segmental bridge structures.

This \$60 million project has a bridge square foot cost of approximately \$475/SF. A single bridge configuration was provided in lieu of a twin structure. The single structure configuration eliminated 50% of the major maintenance of traffic shifts and phases, providing savings during construction and reducing Owner costs.

Minimization of Construction Impact on the Traveling Public

The bridge was constructed with minimal impact to the traveling public on Interstate 91 and all traveling under the bridge including vehicles on Route 30 (a major route to ski resorts), kayakers on the beautiful West River, and hikers on the West River Trail. The segmental balanced cantilever construction with quad wall design eliminated temporary piers in the river and allowed for construction to be built from above, minimizing impact to the thoroughfares below. Concrete segmental construction was the most sustainable, environmentally friendly, and mobility maximizing method for this project.

A single bridge configuration, instead of twin bridges, eliminated a major traffic shift and cross-over section, resulting in better mobility for the traveling public during construction. This resulted in greater safety for Interstate 91 users due to shorter construction time and fewer traffic movements. Impacts on Route 30 were halved compared to a twin bridge design due to less hauling equipment, materials, and work overhead.

CREDITS

Owner:
Vermont Agency of Transportation

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(Segmental Review)
VHB

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Contractor:
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Construction Engineering Inspection:
FIGG
Hoyle, Tanner & Associates, Inc.

Form Travelers for Cast-in-Place Segments:
MEXPRESA

Post-Tensioning Materials:
DYWIDAG-Systems International, Inc.

Bearings:
R.J. Watson, Inc.

Expansion Joints:
Watson Bowman Acme

Prepackaged Grout:
EUCCO Cable Grout PTX

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