PROJECT

Blue Ridge Parkway over Interstate 26

by Christopher Negley, Federal Highway Administration

In October 2019, construction began to widen 16.9 miles of Interstate 26 (I-26) through Henderson and Buncombe counties in North Carolina to ease traffic congestion near Asheville. This $531 million infrastructure project, led by the North Carolina Department of Transportation (NCDOT), will improve overall roadway capacity and meet future traffic demands by widening the interstate below the Blue Ridge Parkway from 4 to 10 lanes. Because the existing seven-span bridge over I-26 conflicts with the wider interstate, it is being replaced with a precast concrete segmental box-girder bridge with a 275-ft-long main span.

After a precast concrete superstructure segment is transported to the jobsite on its open side, it is placed on a sand bed and rotated to its upright position before erection. All Photos and Figures: Federal Highway Administration.

New Alternatives

The original bridge, built in 1966 with steel I-beams and a cast-in-place concrete deck, carries Blue Ridge Parkway and the Mountains-to-Sea Trail over I-26. The original planning to widen the interstate began in the early 2000s, but a 2003 lawsuit over environmental concerns delayed the project until NCDOT revived it in 2013. In 2015, NCDOT worked with the Eastern Federal Lands Highway Division (EFLHD) of the Federal Highway Administration to complete a National Environmental Policy Act reevaluation. A draft environmental impact statement was approved in 2016. NCDOT proposed replacing this bridge over I-26, with EFLHD taking the lead on proposing new bridge alternatives and designing the new concrete segmental box-girder bridge with in-house staff.

The new Blue Ridge Parkway over I-26 Bridge is a 605-ft-long, three-span, post-tensioned precast concrete segmental box-girder structure constructed using the balanced-cantilever method. The precast concrete superstructure segments carrying the 275-ft-long main span over I-26 vary in depth from 8 to 16 ft. The piers are also composed of post-tensioned precast concrete segments. The oblong pier segments are mostly 8 ft long (one segment is 5 ft 9 in. long). They are 8 ft deep, and widths vary from 17 ft 4.5 in. to 14 ft 8.75 in. for the pier cap. All segments were match cast, and all mild steel reinforcement in

profile

BLUE RIDGE PARKWAY OVER INTERSTATE 26 / ASHEVILLE, NORTH CAROLINA

BRIDGE DESIGN ENGINEER: Federal Highway Administration, Eastern Federal Lands Highway Division, Ashburn, Va.

OTHER CONSULTANTS: Construction Engineer: COWI (Finley Engineering Group Inc.), Tallahassee, Fla.; Engineer of Record: AECOM, Raleigh, N.C.

PRIME CONTRACTOR: Fluor-United Joint Venture, Greenville, S.C.

CONCRETE SUPPLIER: Coastal Precast Systems LLC, Wilmington, N.C. (on-site batch plant)

PRECASTER: Coastal Precast Systems LLC, Wilmington, N.C.—a PCI-certified producer

POST-TENSIONING CONTRACTOR: Structural Technologies/VSL, Columbia, Md.

Rendering of the three-span Blue Ridge Parkway bridge over Interstate 26 with the Blue Ridge Mountains in the background.

View of Interstate 26 through the main-span closure pour opening. The shear keys on the precast concrete segments are visible on the left and right sides of the photo.

the superstructure and piers is epoxy coated. Superstructure segment weights varied from approximately 104 to 183 kips. Pier segment weights varied from approximately 62 to 85 kips, with the pier cap weighing approximately 88 kips.

The typical bridge section carries 10- and 12-ft-wide lanes as well as a new 5-ft-wide sidewalk to transport pedestrians safely across the bridge for the Mountains-to-Sea Trail. The new bridge will carry the Blue Ridge Parkway on a new, improved alignment over I-26 that eliminates a sharp horizontal curve near the bridge. The alignment adjustment allows this segment of the parkway to remain open to the public while the new bridge is constructed. The preliminary abutment grading work on the new alignment began in October 2020.

Innovative Thinking and Creative Delivery

Early in the design phase, EFLHD realized that one of the major challenges in delivering this bridge would be transporting the precast concrete superstructure segments to the site. With the largest segments being 16 ft in height, there would be multiple clearance issues if the segments were transported vertically from a PCI-certified precast concrete facility to the site. The team initially looked for possible batch plant locations for precasting near the proposed bridge. However, an American Segmental Bridge Institute conference in October 2017 that showcased the Sarah Mildred Long Bridge between Portsmouth, N.H., and Kittery, Maine, inspired a new idea to transport each superstructure segment on its side, eliminating the clearance issue. EFLHD presented this idea at the project prebid meeting to address contractor concerns about segment delivery. (The Sarah Mildred Long Bridge was featured in the Spring 2019 issue of *ASPIRE*®.) The contractor's construction engineer implemented a modified version of the idea: instead of a lifting frame, a sand bed was used at the jobsite to rotate the deeper segments to their upright positions in preparation for erection. The segments were analyzed for stresses during the rotation process, with the segment sections fully post-tensioned in the transverse direction before rotation. This innovative method of transporting precast concrete segments allows high-quality precast concrete construction

The Blue Ridge Parkway Bridge before the closure pour of the main span, as seen from Interstate 26. A new alignment of the parkway allows the existing parkway to remain open while the new bridge is constructed.

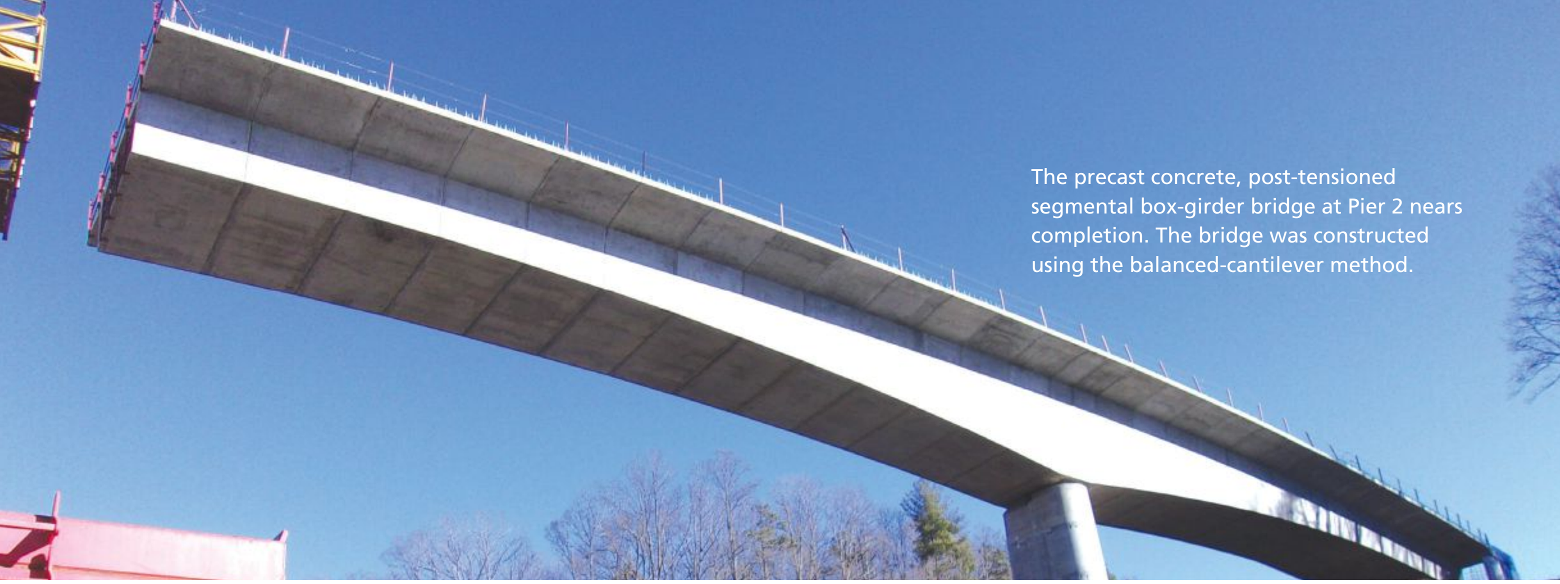
NATIONAL PARK SERVICE, OWNER

OTHER MATERIAL SUPPLIERS: Formwork: EFCO Formwork Solutions, Des Moines, Iowa; erection equipment: lifting frame: Structural Technologies/VSL, Columbia, Md.; post-tensioning: Structural Technologies/VSL, Columbia, Md.; disc bearings: RJ Watson Inc., Alden, N.Y.; modular expansion joints: Mageba USA, New York, N.Y.

BRIDGE DESCRIPTION: 605-ft-long (165-275-165), 36.5-ft-wide, three-span precast concrete, post-tensioned segmental box-girder bridge over Interstate 26 with precast concrete, post-tensioned piers

STRUCTURAL COMPONENTS: 62 precast concrete superstructure segments varying in depth from 8 to 16 ft, with three closure pours, 58 pairs of internal post-tensioning tendons, and four pairs of external post-tensioning tendons, 14 precast concrete pier segments (8 ft tall) with five internal post-tensioning tendons per pier, and cast-in-place spread footing on rock

BRIDGE CONSTRUCTION COST: Approximately \$15.5 million (\$700/ft^2)



The precast concrete, post-tensioned segmental box-girder bridge at Pier 2 nears completion. The bridge was constructed using the balanced-cantilever method.

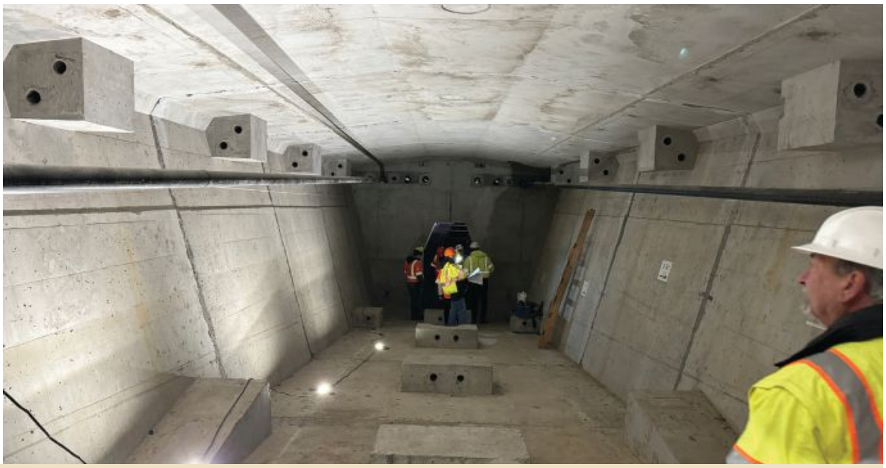
to be considered for deeper sections of longer spans.

NCDOT incorporated the bridge design into their larger design-bid-build project for widening I-26. The bridge was designed by in-house EFLHD bridge design engineers. NCDOT is administering the project, and the National Park Service (NPS) will be the owner of the bridge upon final acceptance. The close relationship between the NPS and EFLHD, based on decades of partnership, played a crucial role in ensuring that the bridge would meet NPS's aesthetic-context sensitivities. Steel formwork was required for the precast concrete pier and superstructure segments to produce smooth, clean lines, and a Natina treatment was used on the galvanized pedestrian rail to produce a rustic weathered look. The abutments were clad with stone masonry that NPS specifically approved for use on the bridge. Lastly, the same stone masonry was used on the custom-designed bridge approach parapet and guard wall.

Design Challenges

The unbalanced spans of 165-275-165 ft over I-26 caused issues with the anticipated 10,000-day, long-term tensile stresses at the soffit of the main span. The main span required eight pairs of bottom-slab, internal continuity tendons, and two pairs of external continuity tendons. Because of the parabolic curve of the superstructure soffit, the addition of internal tendons in the bottom slab resulted in increased tension in the bottom slab near the midspan portion of the 275-ft main span. The external tendons anchored high into the pier-table segments counteracted this tension and added compression back into the joints at midspan. The shorter end spans required four pairs

Interior of Pier 2 cantilever, facing the pier diaphragm.



AESTHETICS **COMMENTARY**

by Frederick Gottemoeller

Interstate 26 (I-26) through northern South Carolina, North Carolina, and eastern Tennessee is one of the most scenic stretches in the Interstate Highway System. In that same area, the Blue Ridge Parkway makes accessible one of the most attractive landscapes on the East Coast. This new bridge, built where the two corridors cross, lives up to the visual quality of its surroundings and the symbolism of its role. The bridge acknowledges the significant expansion of the highway below by spanning it all in a single 275-ft jump. That span's arched soffit creates a visual gateway to the scenic areas beyond. The same arched soffit combines with the reciprocally arched soffits of the side spans to visually reflect the loads on the structure: the bridge is thickest over the piers, where its support forces are concentrated, and thin everywhere else. The setting called for innovation, and the design team provided it, developing methods to make precast concrete segmental box construction possible in this isolated area.

The final necessary step in this endeavor was attention to the finish and details, and the design and construction team provided that, too. Steel formwork for the precast concrete pier and girder segments met the National Park Service's requirements for surface precision, whereas the stone abutment masonry and colored metal for the railings ensured a seamless fit of the new bridge into the aesthetics of the Blue Ridge Parkway. It is unfortunate that travelers on the parkway won't share with the travelers on I-26 the view of the masterpiece that is carrying them across the interstate.

The reinforced-soil retaining wall at the Abutment 2 approach will have native grasses growing on the gabion baskets.

of bottom-slab, internal continuity tendons, and one pair of external tendons. All the internal and external tendons in the superstructure are composed of twelve 0.6-in.-diameter seven-wire ASTM A416,[1] Grade 270, low-relaxation strands. Alternative strand configurations using nineteen 0.6-in.-diameter-strand tendons were evaluated in select locations. However, the benefits of maintaining the same tendon configuration, anchorages, and anchor-block designs at all locations were greater than any benefits gained from using the 19-strand tendons at some locations. For the internal top-slab tendons, one contingency duct that ran the entire length of the cantilever was provided per web. Accommodations for one pair of future external tendons per span, which would allow 22 strands per tendon, were also provided. During construction, the team implemented a contractor-proposed improvement for the external tendons by switching from the embedded bent steel pipes as originally designed to diabolos. (See the Fall 2015 issue of *ASPIRE*® for more details on the benefits of diabolos.)

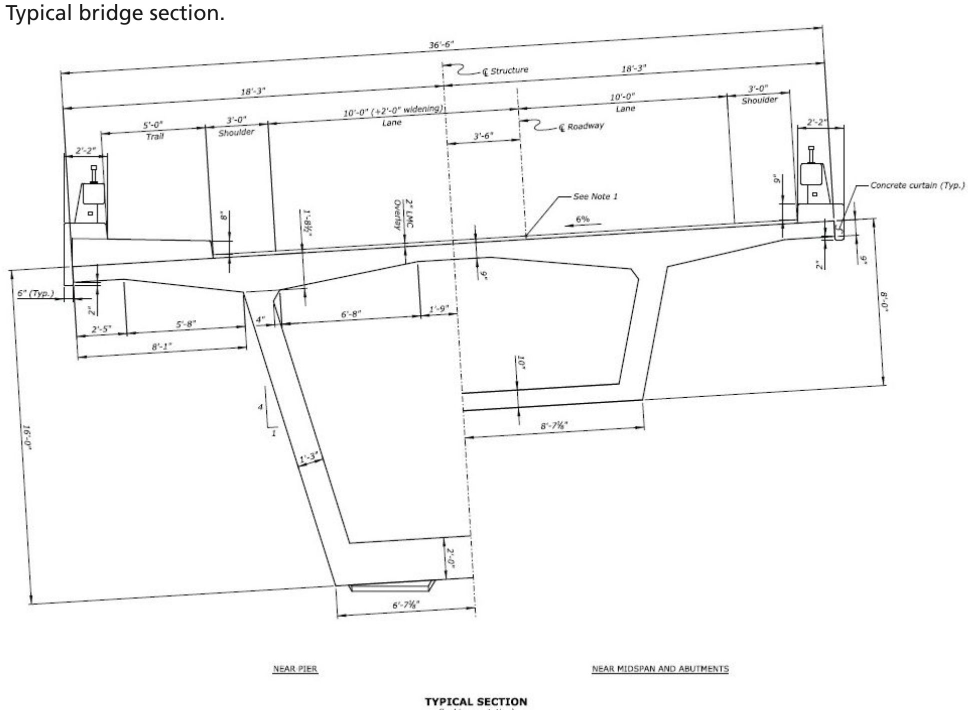
Although the new alignment allowed the Blue Ridge Parkway to remain open during construction of the new bridge, the revised alignment with significant grade changes on the approach road in the mountains of the Blue Ridge Parkway posed its own challenges.

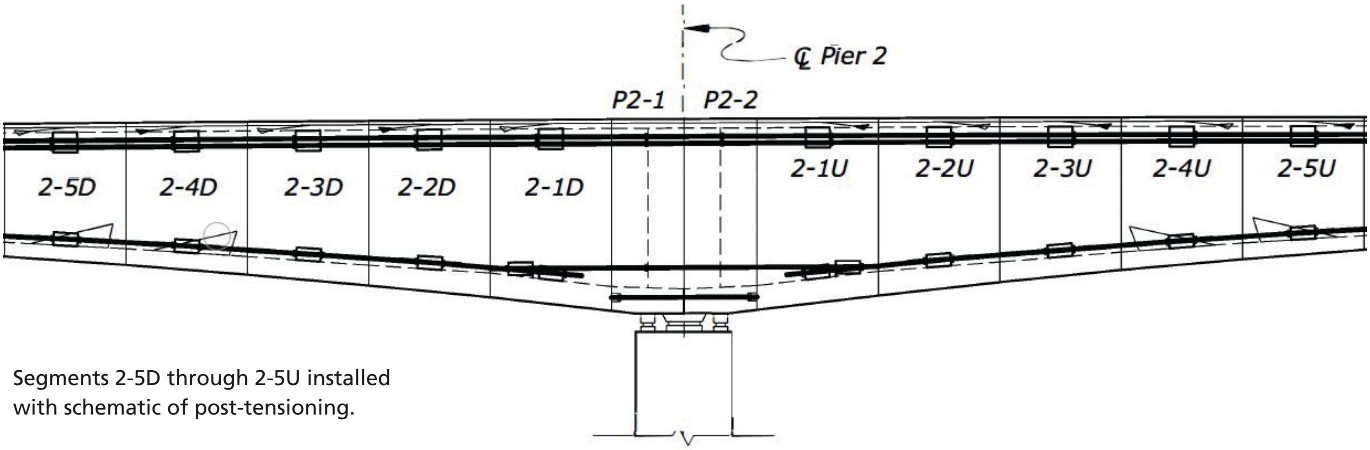
To help NPS meet its mission of preserving "unimpaired the natural and cultural resources of the National Park System for the enjoyment, education, and inspiration of this and future generations,"[2] EFLHD designed a reinforced-soil retaining wall that will eventually have native grasses growing on the gabion baskets.

Construction Challenges

A precast concrete, post-tensioned segmental box-girder bridge is itself a major project, but the I-26 bridge accounted for only about 6% of the total amount for Buncombe County's portion of the project (which involved widening a 7.8-mile stretch known as Section I-4700). Construction of the I-26 bridge had to be coordinated with traffic shifting and the widening of the interstate below. This led to some unintended delays of the I-26 bridge construction, including one in December 2022. During that delay, with superstructure segments 2-5D

Typical bridge section.





Segments 2-5D through 2-5U installed with schematic of post-tensioning.

PARTIALLY ERECTED PIER 2 CANTILEVER

through 2-5U installed, rainwater entered the cantilever. The parabolic shape of the soffit acted as a funnel for water entering the erected cantilever segments. Water then entered ungrouted ducts in the soffit in segments P2-1 and P2-2 through exposed grout tubes. The water subsequently froze inside the ducts, resulting in minor concrete surface spalling inside the segments, which was later repaired. For the repairs, the damaged concrete was removed, the post-tensioning bar duct was grouted, the exposed epoxy coating on the reinforcing bars was repaired, a bonding agent was applied, grout was placed back with a minimum 6-ksi compressive strength, the top of the repair was contoured to drain to the weep hole, and a high-molecular-weight methacrylate sealer was applied on top of the repair.

Conclusion

Except for this minor spalling and the stop-and-go nature of bridge construction, the I-26 bridge project has been moving along smoothly. In mid-May 2024, the contractor completed the final closure pours in the main span over I-26 and near abutment 1. Next, the final continuity and external tendons will be tensioned by the post-tensioning subcontractor, and the bridge rail, sidewalk, and overlay will be completed by the prime contractor. The opening date of the I-26 bridge has yet to be determined, but it is anticipated to occur in late 2024.

References

1. ASTM International. 2018. *Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete*. ASTM A416/A416M-18. West Conshohocken, PA: ASTM International.

2. National Park Service. 2023. "About Us." https://www.nps.gov/aboutus/index.htm.

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