Rehabilitating the Arlington Memorial Bridge: Restoring a Monument

by Shane R. Beabes and Steve A. Matty, AECOM

More than just a bridge crossing the Potomac River, the Arlington Memorial Bridge holds a unique place in the fabric of Washington, D.C. A historic structure and integral part of the regional transportation network, the 2216-ft-long, 94-ft-wide bridge is a monument to reunification after the Civil War and carries more than 65,000 vehicles daily, linking northern Virginia to Washington, D.C. After years of service, major rehabilitation work was required to maintain this notable bridge, which sits among some of the most recognizable national landmarks.

Revitalizing the 87-year-old crossing posed a challenge as unique as the bridge itself. The National Park Service (NPS) and the Federal Highway Administration (FHWA), which jointly administer and maintain the bridge, established a 1000-day schedule to complete the project—the first major reconstruction for the bridge and one of the largest projects in NPS history. The goal was to restore the structural integrity of the bridge and preserve its historical character and context while minimizing disruption to the traveling public.

Carefully considered decisions, including materials selection, construction techniques, and innovative technologies, enabled the project team to meet the requirements of FHWA and NPS and reopen all lanes of the bridge on December 4, 2020.

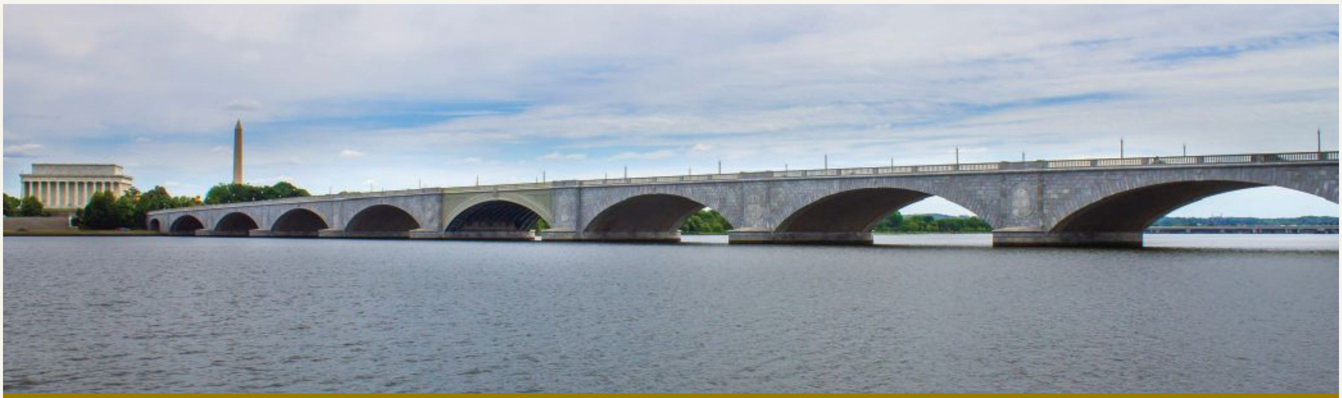
Bridge Overview

The existing bridge is a complex structure, consisting of 10 reinforced concrete arch approach spans and a center double-leaf steel bascule span over the navigable channel. The approach spans are composed of a concrete deck intermittently supported on transverse concrete cross walls on top of the concrete arch rib. The deck and cross walls also tie into the reinforced concrete spandrel walls adorned with granite fascia that close in the span. The bridge also includes four abutments and six concrete piers, each of which contains concrete frames and transverse cross beams designed to support the roadway deck. The frames are supported on the abutments and pier footings that ultimately transfer the loads down to bedrock. During the reconstruction process, most elements of the bridge required some form of intervention: rehabilitation, reconstruction, or preservation.

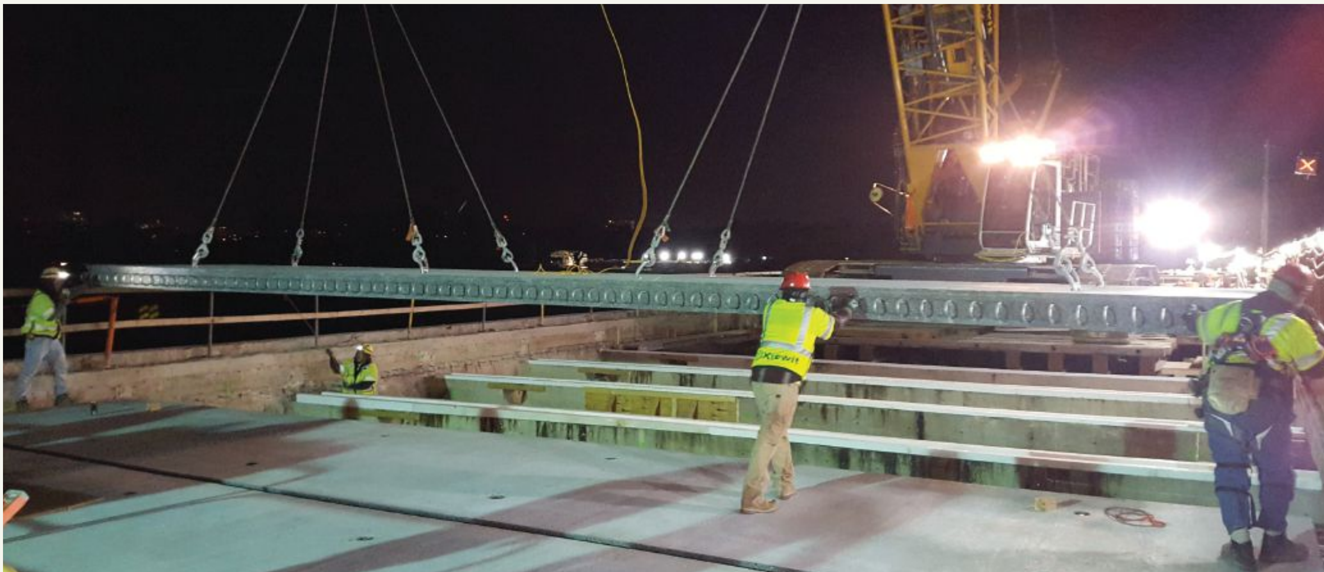
Materials

Precast and Field-Cast Concrete

Whereas the original bridge structure used cast-in-place concrete, which was standard at the time, the team used precast concrete panels to replace the entire deck during the rehabilitation process. Using precast concrete for the new deck expedited the construction process by enabling the existing deck to be removed while the precaster was completing the



The Arlington Memorial Bridge is a monument to reunification after the Civil War and carries more than 65,000 vehicles daily, linking northern Virginia to Washington, D.C. Photo: AECOM.



Precast concrete deck panels were installed at night, when traffic volumes were low. Panels span between the cross walls that are visible in the center of the photo. The bridge was generally closed for only about 15 minutes at a time when a panel was picked and rotated into place. Photo: Pennstress.

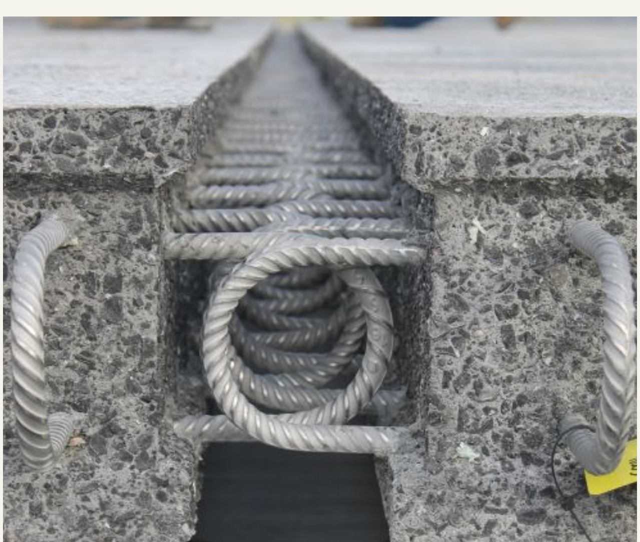
new deck panels off site—a critical factor when considered in the context of the short rehabilitation time frame.

The precast concrete deck panels are 10 in. thick and constructed of 6000-psi high-performance concrete (HPC) with stainless steel reinforcement, providing reduced permeability and greater durability than the original deck, which used 3000-psi concrete and uncoated reinforcing steel. The precast concrete deck panels were set piece by piece to span between the cross walls visible in the nighttime photo above. The deck panels in the approach spans were designed to span longitudinally between the arch cross walls, whereas the deck panels in the new fixed center span were designed to span transversely between the longitudinal steel girders. A 2-in. latex-modified concrete overlay was placed on top of the precast concrete deck panels to provide additional protection for the precast concrete deck and a smooth riding surface.

HPC with 28-day compressive strengths ranging from 4500 to 6000 psi was used for the two 14-ft-wide shared-use sidewalks, approach slabs, cross walls, precast concrete beams, pier caps, columns, and precast concrete deck panels.

Ultra-High-Performance Concrete

The selection of ultra-high-performance concrete (UHPC) and HPC was a critical component of the bridge reconstruction because these materials provided the strength and durability required to meet the project's needs.



The stainless steel hairpin reinforcing bars extending from the precast concrete deck panels overlapped, creating a highly reinforced joint that was filled with ultra-high-performance concrete (UHPC). The exposed aggregate finish on the edges of the panels promoted bond with the UHPC. Photo: AECOM.

Ultra-high-performance concrete is a high-strength, dense concrete that incorporates random steel fibers and reduces permeability to water, chlorides, and other deleterious materials. It provided a minimum 28-day compressive strength of 21,000 psi for this project. Photo: AECOM.

As panels were set into place, the hairpin reinforcing bars extending from the panels overlapped, creating a highly reinforced joint between deck panels and with the cross walls or girders. This joint was then filled with UHPC, a high-strength, dense concrete that incorporates random steel fibers and reduces permeability to water, chlorides, and other deleterious materials. The UHPC on this project had a minimum 28-day compressive strength of 21,000 psi and a minimum 4-day compressive strength of 15,000 psi, which enabled the deck to meet the performance requirements.

Accelerated Bridge Construction and Traffic Management

To sequence the overall construction to minimize construction impacts to the traveling public, the team used accelerated bridge construction methods with six construction stages for the project. Two major construction stages temporarily reduced the six 10-ft-wide travel lanes to three 9-ft-wide lanes with a reversible center lane; this arrangement allowed the team to close half of the bridge at one time while the other half remained open. The process started on the bridge's south side with traffic maintained on the north side. Traffic was then switched to the south side for substantial completion of the remaining work. During construction, one of the two 14-ft-wide shared-use paths remained in service at all times.

Delivering the precast concrete deck panels at night, when traffic volumes were low, reduced congestion and delays. Even at night, the bridge was generally closed for only brief intervals (about 15 minutes) when a panel was picked and rotated into place. The precast concrete panels were designed to extend from the spandrel wall to the middle of the bridge cross section, creating a longitudinal closure joint the full length of the bridge. This joint was also filled with UHPC after the panels were set.

Innovation: Cathodic Protection System

Whereas the deck, concrete frames, and selected cross walls needed to be replaced, testing revealed that the original concrete arch ribs and most of the transverse cross walls were structurally sound. Experts on the design team developed a cathodic protection system to preserve and extend the service life of the remaining preexisting concrete elements. This system uses sacrificial galvanic anodes embedded into the concrete to protect the surrounding steel reinforcement from further corrosion.

Conclusion

Rehabilitating a bridge is rarely simple; rehabilitating a historic landmark is even more complex. The revitalization of the Arlington Memorial Bridge, with all of its complexities and historical significance, is a testament to the use of innovative techniques, thoughtful material selection, and carefully considered coordination among the NPS, the FHWA, and the Kiewit-AECOM team from beginning to end. The completion of the bridge rehabilitation not only ensures mobility across the region but also fortifies a monument to sacrifice and valor that will remain a symbol of our collective history for generations to come.

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Two major construction stages temporarily reduced the six 10-ft-wide travel lanes to three 9-ft-wide lanes with a reversible center lane, allowing for closure of half of the bridge while the other half remained open. One of the two 14-ft-wide shared-use paths remained in service at all times. Photo: AECOM.