

PROJECT

Accelerated Bridge Construction of Two Bridges in Delaware

by Nicholas Dean, Delaware Department of Transportation

The Bridge 1-488N&S project involved the replacement of two bridges over Blackbird Creek along US 13 in northern Delaware. US 13 is a four-lane divided highway, classified as a minor arterial, with a 2050–projected average annual daily traffic (AADT) of 13,500 vehicles in each direction. Bridge 1-488S, which ranked first on Delaware’s list of deficient bridges, was a 42-ft-long concrete arch bridge built in 1920. Bridge 1-488N was a 40-ft-long concrete rigid frame built in 1933. Bridge 1-488S was both structurally and hydraulically deficient. The concrete arch had significant spalling, cracks, and corrosion of exposed bar reinforcement. Bridges 1-488N&S both experienced scour issues related to the stream constriction created by their undersized span lengths. Due to their short timber piles, the bridges were considered scour critical. In addition to their structural and hydraulic deficiencies, both bridges were located at the bottom of a severe vertical sag curve. The roadway profile at the location of these bridges was substandard for stopping sight distance, leading to a high accident rate for vehicles trying to merge onto US 13.

Early in the design phase, several structure types were evaluated, including precast concrete buried arch

structure, NEXT beams, and standard precast concrete economical fabrication girders with a cast-in-place (CIP) deck. Ultimately, because of the accelerated nature of construction, and the need to raise the profile of US 13 approximately 8 ft 6 in., the Delaware Department of Transportation (DelDOT) decided to replace the bridges with decked bulb-tee beams resting on stub abutments supported by prestressed concrete piles. For years, DelDOT has demonstrated

its commitment to implementing new and innovative bridge replacement techniques that decrease construction times, improve commuter and work zone safety, and minimize user costs. Given the high AADT and public exposure at this location, DelDOT opted to employ accelerated bridge construction (ABC) techniques to replace both bridges during a 45-day closure of US 13. The new bridges are composed entirely of precast concrete elements: decked



A precast concrete abutment segment is set into place over piles. Note the shiplap joint where two segments will be joined. All Photos: Delaware Department of Transportation.

profile

BRIDGES 1-488N&S / BLACKBIRD, DELAWARE

BRIDGE DESIGN ENGINEER: Delaware Department of Transportation Bridge Design, Dover, Del.

PRIME CONTRACTOR: Richard E. Pierson Construction Co. Inc., Pilesgrove, N.J.

CONCRETE SUPPLIERS: Cor-Tuf UHPC, Manassas, Va.; Heritage Concrete, Cheswold, Del.

PRECASTER: Precast Systems Inc., Allentown, N.J.—a PCI-certified producer

OTHER MATERIAL SUPPLIERS: Foamed glass aggregate: Aero Aggregates of North America LLC, Eddystone, Pa.



A 125-ft-long prestressed concrete decked bulb-tee beam with end diaphragms is set into place. Two cranes were needed to maneuver each 105-ton beam into its final position.

bulb-tee beams; stub abutments; prestressed concrete piles; approach, sleeper, and moment slabs; and T-walls. To accommodate the significantly accelerated construction timeline, the project team selected foamed glass aggregate (FGA) as a backfill. Additionally, the team chose ultra-high-performance concrete (UHPC) to transversely connect adjacent beams and approach slab segments.

Construction began with a full road closure of northbound US 13 on September 8, 2025. One week later, on September 15, southbound US 13 was fully closed. On October 20, 2025, after 44 days, northbound US 13 was opened to traffic. The next day, after 37 days of closure, the southbound direction was opened to traffic. By comparison, if standard construction techniques were used, bridge replacements of a similar size to Bridges 1-488N&S would require approximately a year to complete.

Precast Concrete Piles

Soil conditions at the project site were well suited for the use of precast, prestressed concrete piles. A single row of eight 16 in. x 16 in., 50-ft-long piles was used to support the abutments on each side of the bridge. Because of the precast concrete abutments, tighter tolerances were required on the piles to ensure proper fit-up. To

accommodate tolerances and achieve proper pile spacing, the contractor erected a robust steel template that could be disassembled and used on future projects. All 32 piles were driven to a depth between 27 and 31 ft into a dense sand layer and achieved a bearing capacity of more than 700 kip per pile. The pile driving took roughly one 10-hour shift per abutment to complete and was finished over the course of four days. Ensuring adequate capacity and proper placement of the precast, prestressed concrete piles was vital to the overall success of the project and

allowed for the rapid erection of the precast concrete abutment sections.

Precast Concrete Abutments

Typical practice on previous DelDOT projects was to cast bridge abutments in place. That practice requires a large amount of time to place and tie reinforcing bars, build formwork, place the concrete, and allow the concrete to cure.

The substructures for Bridges 1-488N&S consist of two 55-ft-long, variable-height precast concrete stub abutments. The abutments were cast to accommodate the 2% cross slope of the roadway. Two separate sections were cast for each abutment with an overlapping (shiplap) joint in the center of the assembled abutment. The team decided to cast the abutment in smaller sections rather than one large piece to minimize the weight of the elements. Minimizing the weight and size of the abutment sections alleviated concerns about transportation and placement. Each precast concrete abutment section weighed roughly 40 tons.

A 1-ft 6-in.-thick precast concrete approach slab segment is placed. The approach slab segments were later connected with ultra-high-performance concrete closure pours.



DELAWARE DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Two 120-ft-long precast concrete decked bulb-tee beam bridges

STRUCTURAL COMPONENTS: Sixteen 66-in.-deep decked bulb-tee beams; thirty-two 16-in.-square precast, prestressed concrete piles; eight precast concrete abutment segments; four precast concrete sleeper slabs; sixteen precast concrete approach slab segments; fourteen precast concrete moment slab segments; one hundred fifty-four precast concrete T-wall segments

BRIDGE CONSTRUCTION COST: \$12.1 million



Bridges 1-488N and 1-488S were replaced in 43 calendar days and 37 calendar days, respectively.

The precast concrete abutments were built with eight 30-in.-diameter full-depth voids to allow placement over the corresponding precast concrete piles. The voids, which were created by casting corrugated metal pipes into the abutments, were essential for proper connection between the piles and abutment sections. The 30-in.-diameter voids were designed to be oversized to account for the possibility that the piles would be improperly located or driven out of plumb. Extra care was exercised by the contractor to properly place the abutment sections over tops of the piles.

Each abutment was set in roughly an hour over four days. Once the abutment sections were set, the sections were doweled together and grouted to create a single composite unit. The 3-ft 4-in.-long dowels are no. 10 bars that are embedded 12 in. into the bottom abutment segment and 2 ft 3 in. into the top segment.

To connect the precast concrete piles with the abutments, a closure pour around the piles within the voids was cast. Because of the short duration of the construction project, it was important for the contractor to be able to load the abutments as quickly as possible. To facilitate this process, Type I 4500-psi concrete (DelDOT Class A) with a 2% high-early-strength admixture was used. DelDOT specifications for loading concrete substructures require that the concrete reach a minimum of 50% of the 28-day compressive strength. By using this mixture, the contractor was able to erect the decked bulb-tee beams four days after performing the closure pour. Successful installation of the precast concrete abutments set the tone for the installation of the precast concrete T-wall system and placement of the beams.

Precast Concrete T-Wall System

With the abutments in place, the contractor was able to begin placing the precast concrete T-wall segments and establish the limits of the proposed embankments. The decision to use the T-wall system was made to limit the impacts of the embankment side slopes on adjacent utilities and wetlands.

Efficient placement of these wall elements started with proper grading of the subbase and achieving the proper elevation for each wall. The front face panels of the T-wall rest on a precast concrete leveling pad, with the stem being supported on a layer of coarse aggregate. The walls are 10 ft



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The faces of the precast concrete T-wall panels rest on a precast concrete leveling pad, with the stem being supported on a layer of foamed glass aggregate (FGA). FGA was selected for all backfill operations because of its low unit weight and other attributes.

high and are composed of 154 precast concrete elements stacked two units high. This project marks Delaware's first use of this wall type. Installation of the 540 ft length of proprietary wall took approximately eight days to complete.

Precast Concrete Decked Bulb-Tee Beams

The superstructures of Bridges 1-488N&S consist of eight 125-ft-long, 5-ft 6-in.-deep, 6-ft-wide prestressed, precast concrete decked bulb-tee beams. Using longer beams and significantly extending the spans of the bridges provided a cost-effective solution that helped limit the duration and quantity of the backfill work needed to raise the profile of the bridges approximately 8 ft. 6 in. Additionally, the use of the decked bulb-tee beams eliminated the need for drawn-out placement of the CIP deck.

Each of the precast concrete decked bulb-tee beams weighs roughly 105 tons. Given the size of these elements, placement of the beams required multiple steps using two cranes. Because a single crane was not large enough to place the beams in their final position, the contractor opted to build a temporary support system at midspan in the channel. On the south side of the channel, the contractor staged a 500-ton crane to pick the beams off the trailer and walk the beams out to the temporary support. The beams were landed on the support, and the crane's pick points were adjusted. A second crane, located on the north side of the channel, was attached to the



Moment slab segments were cast with the sleeper slabs to accommodate the transition from bridge barrier to guardrail.

beams, and together, the two cranes maneuvered each beam into its final position. This approach was efficient and well planned by the contractor, with each beam lift requiring skill and precision to ensure precise installation.

Placement of the beams took two days per bridge. With the precast concrete beams in place, the UHPC connections could be placed, and the remaining precast concrete elements could be installed. (For more information on the use of UHPC on this project, see the Concrete Bridge Technology article on page 26.)

Precast Concrete Sleeper Slabs and Approach Slabs

The use of fully precast concrete sleeper slabs and approach slabs as part of the

bridge replacement project marks a first for DelDOT. The use of sleeper slabs and approach slabs helps alleviate the issue of settlement behind the bridge and improves rideability. Additionally, the interface between these two elements is located where bridge movement is designed to occur. Moving the joints off the bridge helps extend the life of the bearings.

The sleeper slabs are 51 ft 6 in. wide and were cast as a single precast concrete element. In accordance with DelDOT's *Bridge Design Manual*,¹ moment slab segments were cast with the sleeper slabs to accommodate the transition from bridge barrier to guardrail. The sleeper slabs were the most complex element from a prefabrication standpoint. Each



AESTHETICS COMMENTARY

by Frederick Gottemoeller

In the last issue of *ASPIRE*® (Spring 2026), we considered the successful application of innovative precast concrete elements to the Sonoma–Marin Area Rail Transit (SMART) bridge in San Rafael, Calif., which created an attractive background bridge. In this issue, we are reflecting on the successful application of innovative precast concrete elements to accelerate the construction of US 13 over Blackbird Creek in Delaware, which has also created attractive background bridges.

The common feature of these bridges is that the visible precast concrete elements are themselves simple and go together in a visually simple and straightforward manner. (Of course, in practice, the requirements of ultra-high-performance concrete design are far from simple.)

The bulb-tee beams of the US 13 over Blackbird Creek bridges are slim and have an attractive horizontal shadow line, which makes them appear

even thinner, and they rest neatly on the simple shapes of the precast concrete stub abutments. All the other precast concrete elements are hidden within the pavement or embankment.

Background bridges are not meant to attract attention, but they can still be features of urban or rural scenes. The use of attractive precast concrete elements offers a great aesthetic advantage, as it always results in the creation of an attractive bridge. Local residents and visitors alike are the beneficiaries of the care that went into the bridge design.



The 51-ft 6-in.-wide sleeper slabs were cast as a single precast concrete element and were connected using ultra-high-performance concrete closure joints.

approach slab consists of four 30-ft-long, 12-ft 10-in.-wide, 1-ft 6-in.-thick segments. Precast concrete barriers were cast with the exterior approach slab segments. Grading and placement of the precast concrete sleeper slabs and approach slab segments took place over the course of four days for each element type. The approach slab segments were then connected with UHPC.

Precast Concrete Moment Slabs

Because of the need to tighten the embankment limits, guardrail could not be used within the limits of the T-walls. Guardrail would have required much wider limits to accommodate the deflection zone needed behind the rail system. Each moment slab section is 24 ft 6 in. long and accommodates a precast concrete two-strand tube rail barrier system. In total, 14 moment slab segments were placed over three days.

Foamed Glass Aggregate

Given the large amount of backfill required to adequately raise the vertical profile of US 13, DelDOT needed to use a material that could safely and efficiently accommodate the expedited construction schedule. The work required to raise the profile approximately 8 ft 6 in. above the existing grade required roughly 17,000 yd³ of backfill. Because the backfill work was a critical path for opening the roadways on schedule, DelDOT opted to use Foamed Glass Aggregate (FGA) to facilitate the work. FGA is produced from 100% recycled

glass. Its permeability, high friction angle, and low unit weight made it an ideal backfill material for the Bridge 1-488N&S project. The free-draining characteristics of FGA mean that it can be placed in almost any weather condition, except in ponding water. The contractor was able to continue placing the material during rain events, which kept the project moving forward. The high friction angle and low unit weight improved stability of the slopes outside of the T-walls, reduced lateral earth pressure on the wall, and decreased the load on the existing soils. With typical backfill materials, settlement of both the existing soil and the proposed embankment are major concerns. However, because FGA is about 85% lighter than typical backfills with a dry unit weight of approximately 15 lb/ft³, these concerns could be alleviated. Installation and geotextile wrapping of the FGA took place over 14 days and occurred concurrently with the installation of the bridge elements and UHPC.

Conclusion

The replacement of Bridge 1-488N and Bridge 1-488S in 43 calendar days and 37 calendar days, respectively, was deemed a monumental success, and DelDOT expects these new bridges to have a 100-year service life. In many ABC applications, it is common to trade a shorter construction duration for an increased replacement cost. However, given the complexities of normal construction in this location, the ABC replacement of Bridges 1-488N&S slightly lowered costs, while the road

still reopened in a fraction of the time that would have been required for a conventional project.

The project provided valuable insight and experience and demonstrates that DelDOT's commitment to the use of ABC methods has helped stabilize and sometimes diminish costs as better details are developed, ABC practices become more mainstream, and contractors gain more experience. Although ABC techniques in Delaware can be further improved, the success of this project shows the merit of using such techniques, especially for high-volume roadways. Given the high-profile nature of this project, DelDOT closely monitored the progress of construction. Some of the major lessons learned from the replacement of Bridges 1-488N&S include the following:

- Proper detailing of precast concrete elements is essential. When errors in the construction of bridge elements occur, in-field changes to precast concrete components cannot be easily accommodated without cost and scheduling impacts.
- While Delaware is at the forefront with ABC techniques, DelDOT recognizes the benefits of seeking assistance from other states and federal agencies. While developing details and specifications during the design phase, the design team reached out to multiple states. This outreach allowed DelDOT to learn about previously implemented techniques and improve on them in this project.
- An open line of communication with the precast concrete producer and contractor is important. The fabricator and the contractor for Bridges 1-488N&S were able to provide valued input on what did and did not work well, as well as possible changes that could be incorporated into future projects.

Reference

1. Delaware Department of Transportation (DelDOT). 2024. *Delaware Department of Transportation Bridge Design Manual*. Dover, DE: DelDOT. https://bridgedesignmanual.deldot.gov/index.php/Main_Page.