Scheduling key to major East Coast bridge project

The original Governor Harry W. Nice/Senator Thomas "Mac" Middleton Bridge connecting Dahlgren, Va., and Newburg, Md., was a 1.9 mi (3.1 mi), two-lane bridge over the Potomac River that opened in 1940. The main spans of the bridge featured approach-span deck trusses leading up to an arch through-deck truss over the main channel.

The new Nice/Middleton Bridge that replaces it is 61 ft (19 m) wide and has four 12 ft (3.7 m) wide lanes and a center median to increase traffic capacity, improve safety, and facilitate access for maintenance and wide-load vehicles. The new bridge was dedicated in October 2022.

Coastal Precast Systems of Chesapeake, Va., was brought on to design and build all precast concrete elements on the new bridge.

The new bridge incorporates many innovative precast concrete elements for the Maryland Transportation Authority (MDTA), such as 66 in. (1670 mm) cylinder piles with carbon-fiber prestressing strands, precast concrete drainage troughs beneath modular expansion joints, and precast concrete foundation frames called *bathtubs*, to name a few.

Safe construction activities were important on the project, so many major bridge elements like the girders and bridge support guard segments were identified and designed as precast concrete elements. These elements were cast off-site in a controlled and safe environment, away from traffic, and were transported to the site via barge. Prefabricating major bridge components allowed workers to engage in repetitive work on the ground, a far safer work environment than performing extensive cast-in-place construction at varying heights over water. Minimizing the number of high-risk operations early in the design phase also allowed an avenue to compress schedule and therefore cost.

In addition to the cylinder piles, Coastal Precast produced other components for this project including 36 in. (910 mm) square piles as long as 191 ft (58 m); precast concrete bathtub forms as massive as 191 tons (173 tonnes) used on pier footings; a pier protection system with components as heavy as 223 tons (202 tonnes); 79 and 95 in. (2000 and 2400 mm) prestressed concrete girders that are up to 174 ft long; and miscellaneous items, such as drainage troughs and collars.

John Pridgen, plant manager for Coastal Precast, says that the two most difficult parts of the project were the precast concrete bathtubs and the fender rings. The design plan for these items was for piles to be driven and then the units placed over the piles. "With the pile placement location laid out, it seemed

The new Governor Harry W. Nice/Senator Thomas "Mac" Middleton Bridge over the Potomac River uses precast concrete to replace the steel bridge that opened across the river in 1940. Courtesy of SCM Project Images.

simple enough to design these units to fit," he says. "However, everyone has tolerances, and sometimes Mother Nature does not play nice."

When driving this many large piles this close together in a sandy base, there will be some movement. After casting several of the bathtubs prior to driving the piles, it was discovered that some piles were moving beyond the locations planned in the bathtubs. This altered the production schedule. With the piles moving, Coastal Precast could no longer cast all of the bathtubs with the locations as shown. Coastal Precast worked with the contractor to cast the bathtubs using as-built locations for the piles after they were driven. This meant that the production schedule had to be tightly followed so the bathtubs could be ready when needed without a long lead time to make them in advance.

To help with this, Coastal Precast fabricated the reinforcing bar cages as designed and ready for casting while the pile driving for each unit was being completed. When the as-driven drawings were confirmed, minor changes to the reinforcing bar cage were made as necessary to accommodate any location deviations.

The largest bathtub units were too large to construct as one piece. These units were split in half and seal joints designed to allow these two-piece units to perform as one piece.

The fender rings had their own challenges. The final design included using polystyrene foam voids in the centers of the fender rings to reduce the weight. Even so, the largest of these units came in at more than 223 tons (202 tonnes).

Another fender ring production obstacle was the projecting reinforcing bar. To make a solid ring around the shipping lane, a solid connection between each of these large pieces had to be engineered. Coastal Precast anticipated putting threaded couplers in the ends of each unit to allow threaded bars to be screwed into place after the units were in place; however, this was not deemed to be structurally strong enough because threaded splice bars would be too short.

The final design required more than 70 no. 11 (36M) bars to project from each end of each unit. The reinforcing bar from each neighboring piece had to be within a few inches of the adjacent fender unit while also being close enough to establish a lap but also allow the fender units to be erected without bending the projecting bars. Coastal Precast worked with a local steel fabrication shop to design individual form heads to go on each of the fender ring forms to hold this cluster of projecting bars in place while also allowing the forms to be removed and reused on similar pieces.

Transporting the ring pieces took a flotilla of barges shipping from both Coastal Precast's Cape Charles and Chesapeake plants. "Most of the precast, prestressed pieces on this project were too large to be transported over land," Pridgen says, "but with the deep water access at both of the Coastal Precast plants, along with using their heavy lift cranes, Coastal Precast was able to use the waterway to get these pieces to the jobsite."

—William Atkinson

Tollway uses largest prestressed concrete bridge girders produced in Midwest

Two aging bridges in Chicago, Ill., were reconstructed to accommodate increasing traffic demands, minimize maintenance, and improve safety. The 4800 ft (1460 m) long structures are traveled by 150,000 vehicles daily and serve as an essential regional corridor. Prestressed concrete bridge girders were specified to meet the project's goals of improving safety and reducing ongoing repairs. In particular, project leaders were challenged with replacing the four-lane northbound and southbound structures with larger bridges that accommodate five lanes of traffic and include a flex lane for increased safety. The structures would need to span two major railroads, three waterways, local roads, and commercial properties.

The original bridges were supported by 53 piers. The new structures have 27 spans that are supported by 26 piers. Fewer piers meant less impact on the transportation and commercial activities underneath the bridges.

Prestressed concrete supported the structural and environmental goals of this project. Colossal prestressed girders, measuring up to 187 ft (60 m) long, were used to achieve the design's longer spans. The PCI producer, County Prestress & Precast LLC of Janesville, Wis., (operating as County Materials Corp. at the time of this project) manufactured and delivered 523 prestressed concrete girders for this project, 44 of which measured 187 ft (60 m) long and 90 in. (2290 mm) tall and weighed 240,000 lb (1070 kN). The beams are the largest prestressed concrete bridge girders produced in the region to date.

The construction schedule was meticulously executed in three phases to minimize road closures and reduce traffic congestion. Phase one focused on the northbound structure and began in July 2019 when prestressed girder production began. Production continued through May 2020, and construction crews completed the bridge in October 2020. In January 2021, girder production for the southbound structure began. The southbound bridge was under construction from August 2021 through June 2022. The project concluded in 2023 after demolition and related stormwater management updates commenced.

"As the precaster, our sole responsibility was to produce and deliver the prestressed concrete bridge beams," says Gary Courneya, plant operations manager for County Prestress & Precast. The design was handled by a third-party design/engineering firm. "During the design stage, County Prestress & Precast worked to assure the designer that we had the capabilities to successfully produce and deliver bridge beams of this size and quantity," he says. "We provided multiple plant tours of our manufacturing facility located in Janesville, Wis., to designers, engineers, and the owner [the Illinois Tollway Authority] to showcase both our state-of-the-art indoor manufacturing plant and also our highly skilled team."

County Prestress & Precast LLC of Janesville, Wis., (formerly operating as County Materials Corp. at the time of this project) manufactured and delivered 523 prestressed concrete girders for the Mile-Long Bridge in Chicago, Ill. Courtesy of County Materials Corp.

Production of the precast concrete pieces did pose some challenges. The prestressed concrete bridge beams that were selected for the Mile-Long Bridge were a California Department of Transportation (Caltrans) design. "Not only was the California design new to us, as a producer, but the beams themselves were very large," he says.

To better understand production of the Caltrans beam design, County Prestress & Precast sent a small group of individuals from its Janesville manufacturing plant to visit a California bridge beam producer for an up-close look at Caltrans beam production. This trip proved invaluable to the production team by allowing them to learn many tips and tricks related to Caltrans beam production.

"Prestressed beams of this size presented multiple challenges to a production team," says Courneya. "Many of the production activities had to be performed on elevated work platforms, such as scaffolds and lift baskets. These elevated work platforms safely put production employees at the proper height to perform their work activities."

With beam weights reaching 245,000 lb (1090 kN), careful consideration needed to be taken when moving and handling the beams. Specialized lifting devices were designed and purchased that allowed crane operators eight picking points to safely move the beams from the production area to the storage yard. Each beam required two 70 ton (64 tonne) cranes operating in tandem to lift and move the beams. "The Caltrans beam design is also heavily reinforced to allow for potential seismic activity in the Western region of the United States," Courneya says. "This heavy reinforcement design nearly doubled the amount of rebar that employees had to hand tie in each beam compared with typical Midwest region prestressed beams."

—William Atkinson