OHIO FULTON ROAD BRIDGE REPLACEMENT

by Gregory Kronstain, Ohio Department of Transportation, John Dietrick, Michael Baker Jr. Inc., and Brendan Finn, Cuyahoga County Engineer's Office

OHIO'S CONCRETE BRIDGES

Sitting at the crossroads of a number of the nation's major east-west and north-south transportation corridors, Ohio is second only to Texas in the size of its bridge inventory. Including all state, county, and local bridges 10 ft or more in length, Ohio's inventory includes over 20,000 concrete bridges. Of these, over 7000 bridges, representing some 20 million ft^2 of bridge deck, are prestressed concrete bridges. For the first time, in 2007 the Ohio Department of Transportation built more new concrete bridges than steel bridges. Previous issues of *ASPIRE*™ have featured the Pomeroy-Mason Bridge; Veteran's Glass City Skyway, Toledo; the High-Main Street Bridge, Hamilton; and the Perry Street Bridge, Napoleon. Among the new concrete bridges emerging in the state are a number of creative and innovative structures like the new Fulton Road Bridge in Cleveland.

For over 70 years, the original Fulton Road Bridge stood within Brookside Park and the Cleveland Metroparks Zoo, carrying a significant volume of traffic 100 ft above the zoo, the park, Big Creek, and two active railroad lines. Replacement of this concrete open-spandrel deck arch bridge, which was constructed in 1932, had become imperative because of the severely deteriorated condition of the bridge, which resulted from extensive use of deicing chemicals in northeast Ohio's severe climate.

profile

FULTON ROAD BRIDGE REPLACEMENT / CLEVELAND, OHIO

ENGINEER: Michael Baker Jr. Inc., Cleveland, Ohio

CONSTRUCTION MANAGER: Ohio Department of Transportation

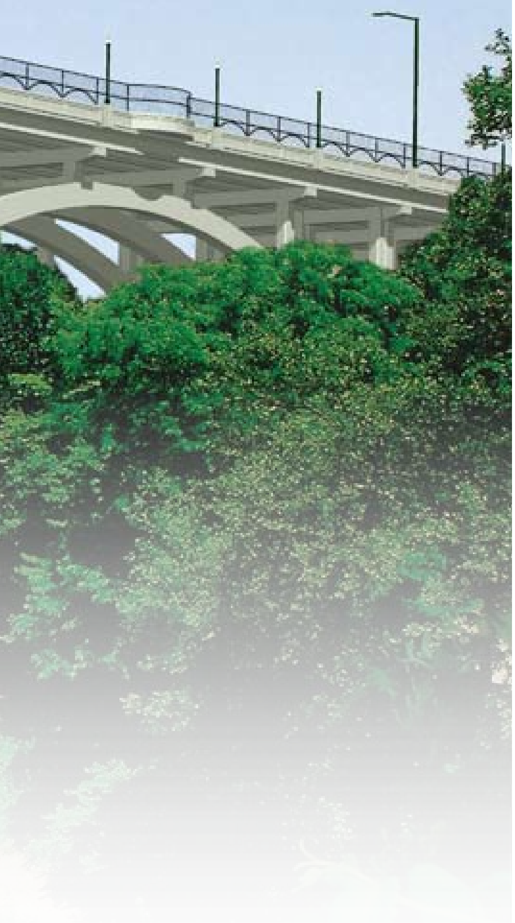
CONTRACTOR: Kokosing Construction Company Inc., Fredericktown, Ohio

CONSTRUCTION ENGINEER: Janssen and Spaans Engineering Inc., Indianapolis, Ind.

POST-TENSIONING SUPPLIER: Dywidag-Systems International USA Inc., Bolingbrook, Ill.

PRECAST ARCH SUPPLIER: Carr Concrete Corporation, Waverly, W.Va., a PCI-certified producer

A rendering showing the Fulton Road Bridge traversing the Big Creek Valley and a walkway at the Cleveland Metroparks Zoo. Illustration: Michael Baker Jr. Inc.



Design considerations represented excellent opportunities for the owner and stakeholders to create a more sustainable, durable, and low-maintenance replacement structure.

With its unique location inside the Cleveland Metroparks Zoo, which is attended by over a million visitors annually, the bridge had long been a highly visible structure and an important symbol to the community. It was also one of the few of its type and era still in use in Ohio. For these reasons, a bridge alternative study was performed to evaluate replacement bridge types, focusing on maintaining the unique aesthetic character and cultural significance of the original structure and minimizing negative impacts to the zoo.

After evaluating a number of conceptual and preliminary bridge replacement types and incorporating public input, a precast concrete arch alternative, with six 210-ft-long spans to resemble the original structure, was selected and advanced to final design. Construction of this unique new structure is currently ongoing with an anticipated completion in late 2009.

Structure Type Selection

The conceptual design phase followed a number of previous efforts to address concerns with the deterioration of the bridge. These concerns are of particular importance in light of the significant pedestrian traffic that passes beneath the structure. The conceptual design effort also encompassed a number of environmental, cultural, and historic issues associated with the replacement of the structure.

Because of the nature of the extensive deterioration in the original structure, rehabilitation was judged to not be a practical alternative. In recognition of the strong sentiment and personal attachment to the original arch bridge by the local populace, it was also decided during development of alternatives that the new bridge be "arch-like" in appearance. Additionally, to limit the impact to the zoo and Brookside Park, and to minimize right-of-way acquisition, it was deemed important to maintain piers at the existing pier locations.

These geometric parameters, established early in the conceptual design, provided a context for the development of bridge replacement alternatives and put practical limitations on feasible replacement types. With the goal in mind of replacing the Fulton Road Bridge with another structure "arch-like" in appearance, the design team initially developed 12 different alternatives for the bridge replacement. Each of these alternatives fit the criteria of being "arch-like" in appearance, even though several were not true arch structures.

The designers worked collaboratively with the Cuyahoga County Engineer's Office (CCEO), City of Cleveland, Ohio Department of Transportation (ODOT), Cleveland Metroparks, the Federal Highway Administration (FHWA), other key stakeholders and the public to systematically evaluate and refine structure type alternatives based on agreed-upon evaluation criteria. Among the criteria judged to be of importance on this project were aesthetics, public input, long-term durability, anticipated maintenance requirements, and construction impact.

The final alternative selected for construction was a precast, post-tensioned concrete arch bridge with 210-ft-long main arch spans similar to the existing structure. This alternative employs the use of modern materials and construction methods with

PRECAST, PRESTRESSED CONCRETE I-GIRDER BRIDGE SUPPORTED ON SIX PRECAST CONCRETE ARCH SPANS / CUYAHOGA COUNTY, OHIO, OWNER

PRECAST BEAM SUPPLIER: Prestressed Services Industries LLC, Grove City, Ohio, a PCI-certified producer

BRIDGE DESCRIPTION: 35-span continuous, 1583-ft-long bridge with AASHTO Type III girders supported on five approach spans and six 210-ft-long precast concrete, post-tensioned arch spans with cast-in-place concrete piers, spandrel columns, and transverse cap beams

COST: \$45.9 million; Structure Cost: \$293/ft^2

All photos: Ohio Department of Transportation.

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four spandrel columns in each span, giving a more open and contemporary appearance than the original bridge.

The arch ribs of the original structure were cast in place, which necessitated extensive formwork supported from the ground. For the new structure, in consideration of the desire to maintain operations in the zoo at all times, it was proposed to use precast arch rib segments fabricated in approximately 60-ft-long, 70-ton pieces. A top-down approach to the arch construction was proposed to minimize the negative impact to the railroads and allow for continuous operation of the zoo during construction.

The introduction of post-tensioning in the precast arch ribs also represented an opportunity to enhance the long-term durability of the structure. Along with the ability to provide a structure with no expansion joints between abutments, as described below, these design considerations represented excellent opportunities for the owner and stakeholders to create a more sustainable, durable, and low-maintenance replacement structure.

Bridge Design

Right-of-way easements existed for the existing bridge footings only, with the bridge superstructure occupying an aerial easement. Most of the remaining land beneath the bridge is owned by the Cleveland Metroparks Zoo, Brookside Reservation, and the Norfolk Southern and CSX railroads. Thus, the main arch spans were designed to match the original six 210-ft-long arch spans.

The arch spans have a parabolic profile and a 41 ft 8 in. rise. They consist of three precast concrete sections, comprised of two identical end segments and one crown segment. The tall piers supporting the arches lead to greater arch design moments than if the arches were founded directly on rock. These increased moments are resisted using post-tensioning. The individual segments contain two post-tensioning tendons to resist eccentric design moments and the completed arch span is connected with four concentric post-tensioning tendons. While design of the segmental concrete arches included analysis tools that evaluate staged construction and time-dependent creep and shrinkage forces, important design aspects were gleaned from historical design references, including Conde McCullough, the great American designer of many continuous concrete deck arch bridges.

The original bridge had expansion joints between each arch span and drainage conduits located inside the pier columns. Years of deicing salts caused significant deterioration of the structural concrete, contributing to the bridge's demise. The CCEO desired a low maintenance, durable structure for economic considerations and to minimize future impact to the zoo. Additionally, the owners desired a superstructure that would facilitate part-width deck replacement for future rehabilitation. These desires resulted in a 1583-ft-long bridge with no expansion joints between abutments. The addition of a crest vertical curve and bicycle lanes created the ability to eliminate all scuppers and downspouts from the bridge. Removal of drainage facilities from the bridge also limited right-of-way needs from the zoo and reduced direct runoff to Big Creek.

To accomplish this, a prestressed concrete I-beam superstructure was designed to "float" on top of six 210-ft-long arch spans with a spandrel column spacing of 42 ft. Nine AASHTO Type III beams support an 81-ft-wide deck, with four 12-ft-wide traffic lanes, two 5-ft-wide bicycle lanes, and two 10-ft-wide sidewalks.

Including the six main arch spans and five approach spans, the beams will be continuous across 35 spans. A combination of elastomeric and PTFE sliding bearings are necessary to accommodate the thermal movements. The beams will be composite with the

A Metroparks Zoo walkway crosses beneath the location of an arch span.

deck and will be connected transversely with continuity diaphragms. The beams were designed to account for deflection of the arches under live loads in addition to long-term creep and shrinkage effects. Thus, the design of the individual 42-ft-long beam spans between spandrel columns were superimposed with the design of a continuous 210-ft-long beam spanning each arch span, with the spandrel columns acting as flexible supports for the continuous span. The outcome was the need for additional prestressing strands near midspan of the arches, additional reinforcement in the deck over the arch span piers, and a longer length of extended strands at the continuity diaphragms.

Construction

The project went to bid in late August 2006 and had an original duration of almost 3 years. The contract was awarded to Kokosing Construction Company Inc. from Fredericktown, Ohio, with a low bid of $45,859,138. The project includes the construction of a new zoo entrance that was required to be completed and placed into use prior to demolition of the old structure, a mechanically stabilized earth wall at the north abutment, a shared-use path with soldier pile/concrete panel retaining walls, and minimal roadway work on the approaches.

Construction operations began in early October 2006 with preparations for the demolition. The contractor elected to use explosives to demolish the six main arch spans. One of the spans was over both the Norfolk Southern and CSX railroads, where access was difficult and "track time" was limited. A big challenge was coordinating work with both railroads simultaneously. The railroads were able to provide only a 48-hour window to remove the tracks, implode the structure, haul out the debris, and re-install the tracks.

Two other existing main arch spans cut through the Cleveland Metroparks Zoo, where zoo access would be impeded. The access path closure times were limited and traditional mechanical demolition techniques were neither desirable to the zoo authorities nor in the best interest of the animals.

Another of the main spans crossed over both the Big Creek and an old historic three-hinged arch bridge that required protection throughout the construction work. The contractor chose to construct a temporary bridge over the top of the historic bridge to serve as both protection during demolition and access across the creek and into the zoo.

Foundations for the structure consist both of footings on large drilled shafts and spread footings on hard shale. The footings, pier bases, and pier thrust blocks are all cast-in-place concrete. Due to the complexity of the thrust block construction (dense configuration of reinforcement, post-tensioning ducts, and mass concrete cooling tubes), the contractor chose to use self-consolidating concrete (SCC) for these placements.

Each arch line consists of three precast arch segments, as described above, that have a 1 ft 6 in. concrete closure placement between each segment. The end segments are erected first, with one end supported on a temporary steel tower and the other end bolted to a temporary support bracket attached to the cast-in-place concrete thrust block arm. The crown segments are later set utilizing a strong-back connection at one end and a temporary bolted connection at the other. After the closures are cast, the post-tensioning is performed, tying the segments together.

Precast concrete arch struts are installed between arch lines by bolting them to the face of the arches. Closure placements are required to encase the steel bracket connections and give the arch strut a uniform appearance.

Work has recently begun on the cast-in-place concrete spandrel columns and frames. The columns will extend up from the top of the arch lines, framing into transverse column caps. The column caps will support the prestressed concrete I-beams that in turn will support the deck.

Bridge construction is expected to be completed by the end of 2009. In the meantime, the local residents and all of the participating agencies are looking forward to the completion of this project and the enjoyment the new structure will provide to the citizens of Cleveland and to patrons of the zoo for decades to come. Once reopened, the bridge will again be a key connection across the Big Creek Valley, improving traffic operations on Fulton Road and allowing greater pedestrian and bicycle access across the valley and into the park below.

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For more information on this or other projects, visit www.aspirebridge.org.

Reinforcement in the footing on 6-ft-diameter drilled shafts. Photo: Ohio Department of Transportation.

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Thrust blocks located within the Cleveland Metroparks zoo. Photo: Ohio Department of Transportation.