

PROJECT

Auction Road Bridge Replacement

by Daniel A. Rogers, RETTEW Associates Inc.

Recreating an Historic Treasure

Lancaster County gave specific instructions . . . to develop a context-sensitive design that captures the architectural, historical, and structural features of the existing bridge.

Big Chickies No. 2 Bridge—more commonly known as Auction Road Bridge—is located between Rapho and Penn Townships over Chickies Creek in historic Lancaster County, Pa. It was designed in 1916 by prominent Lancaster County engineer Frank Shaw and put into service in 1922. The unique 58-ft-long, single-span, tied through-arch concrete bridge is believed to be one of only four of its kind in the commonwealth. Shaw modeled the bridge after the patented rainbow arch bridge design of James H. Marsh, only slightly changing the design by adding diagonal truss chords. Research indicates only a dozen or so of Marsh's bridges remain in the entire country.

Pennsylvania has a rich heritage of historic bridges. With 200 covered bridges, it boasts more covered bridges than any other state in the country. Lancaster County is home to 29 of Pennsylvania's covered bridges—second only to Parke County, Ind., for the most

covered bridges of any county in the United States. Lancaster County has done a tremendous job of maintaining their covered bridges and, in an effort to preserve them, has been reluctant to put steel or prestressed concrete beams under the timber bridges. While Auction Road Bridge is not a covered bridge, the county adopted the same philosophy for this structure's replacement, requiring that the new bridge structurally mimic the original 1916 bridge.

In 2005, Lancaster County gave specific instructions early in the project to develop a context-sensitive design that captures the architectural, historical, and structural features of the National Register-eligible bridge. Context-sensitive design for this structure meant incorporating the same architectural and historical details of the original tied through-arch bridge. Similar to their covered bridge restorations, the county also opposed a design incorporating steel or prestressed concrete beams

A contributor to the project's success was effective coordination among the designer, the contractor, and the precaster.

The completed Auction Road Bridge over Chickies Creek features two lanes of traffic, sufficient sight distance, and current safety features. Photos: RETTEW.

profile

AUCTION ROAD BRIDGE / PENN AND RAPHO TOWNSHIPS, LANCASTER COUNTY, PENNSYLVANIA

BRIDGE DESIGN ENGINEER: RETTEW Associates Inc., Lancaster, Pa.

AWARDS: 2008-2009 Award for Outstanding New Short Span Bridge, Association for Bridge Construction and Design, Susquehanna Chapter; 25th Annual Road and Bridge Safety Improvement Award; 2010 Diamond Award Certificate, American Council of Engineering Companies of Pennsylvania; PCI 2009 Design Award for Best Bridge (Co-winner for Spans Less than 75 Ft)

under the deck. Like the original, they required that the reinforced concrete arch and deck for the replacement structure function as load carrying structural members.

Design and Details

Auction Road Bridge needed to be replaced for several reasons. First and foremost, the structural concrete arch and deck exhibited severe deterioration, with cracked concrete members and exposed reinforcement. As a result of the structural deterioration, the bridge load rating was reduced to only 5 tons. The weight restriction was significant because Auction Road serves as a main thoroughfare for the Manheim Auto Auction—the largest auto auction in the United States and located within only a mile from the bridge.

In addition to the structural deterioration and weight restriction, the existing structure did not have a safety curb or barrier to protect against vehicular collision damage to the structural arch members. The original bridge was also limited to one lane with very steep approaches, which resulted in poor sight distances. Finally, the approach roadways frequently flooded.

Considering Form and Function

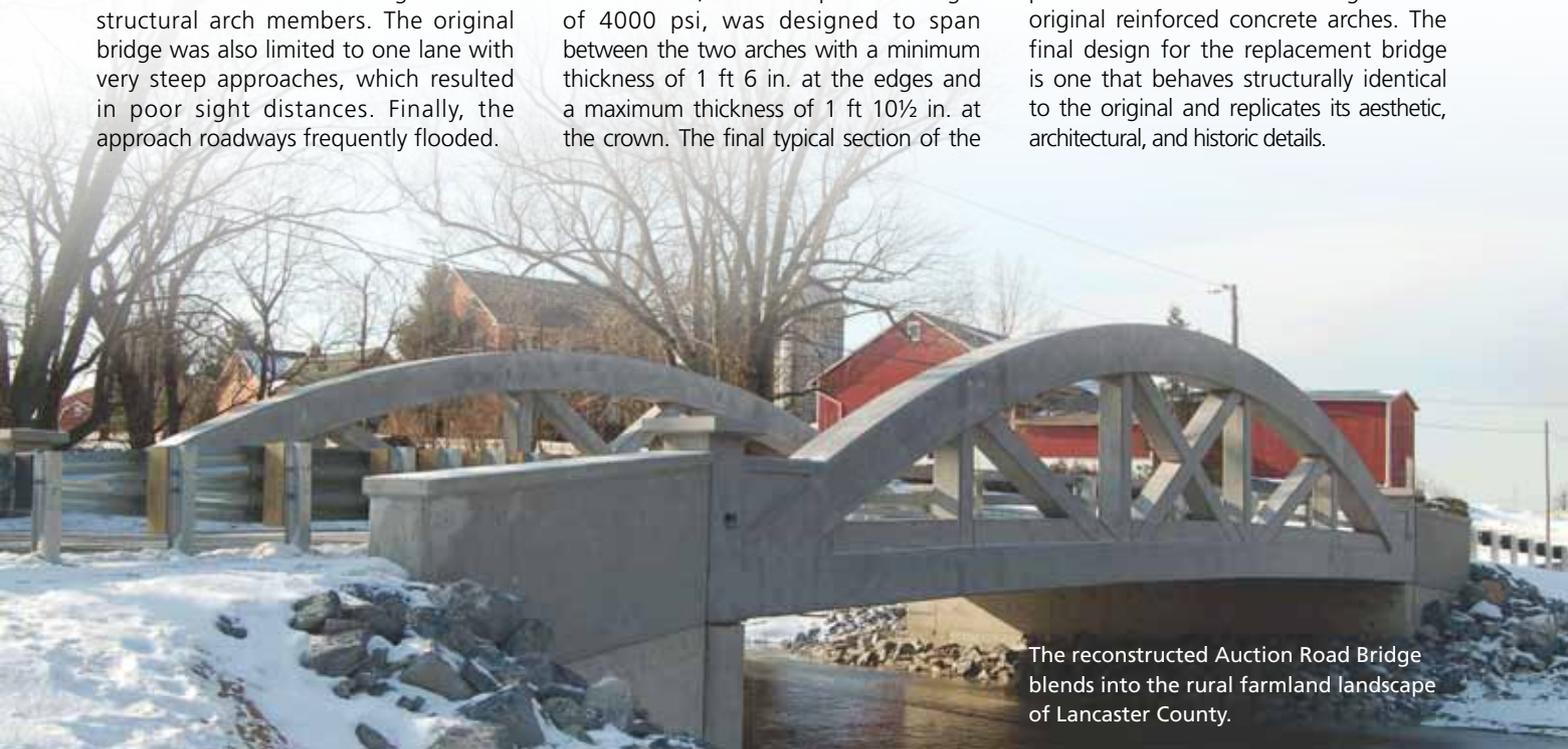
To address the poor sight distances, narrow cartway, and flooding problems, the profile grade was lowered by almost 2 ft at the approaches and the bridge expanded from a 58-ft-long span to a 70-ft span to maintain the required waterway opening. It was also widened from one lane to two 10-ft-wide lanes and two 4-ft-wide shoulders. Improving the steep roadway approaches greatly improved sight distance, and adding PA Type 10M bridge barrier and approach guiderail greatly improved safety. The guiderail meets current Pennsylvania Department of Transportation (PennDOT) standards and protects the arches' main structural members from vehicular collisions.

Finally, to achieve the county's goal of having a context-sensitive structure, the concrete arches were designed as precast concrete members with a compressive strength of 8000 psi. A cast-in-place concrete deck, with a compressive strength of 4000 psi, was designed to span between the two arches with a minimum thickness of 1 ft 6 in. at the edges and a maximum thickness of 1 ft 10½ in. at the crown. The final typical section of the

Key Details of the Precast Arches

- Maximum height of 11 ft 7 ½ in.
- Top Chord: 1 ft 8 in. x 2 ft 0 in.
- Bottom Chord: 1 ft 8 in. x 2 ft 7 in.
- Vertical and Diagonals: 1 ft 0 in. x 1 ft 1 in.
- Weight: 47 tons/arch
- Reinforcement: 25,000 lb including temporary post-tensioning strands
- Post-tensioning used only for lifting and transportation; released after final erection
- Form tolerances set to 1/16 in. maximum using survey control equipment
- Modified concrete mix design with reduced large aggregate size to ensure concrete consolidation

bridge resulted in an out-to-out width of 34 ft 4 in. with two 1-ft 8-in-wide precast concrete arches. Although the arches spanned an additional 12 ft, it was possible to use the same number of panels and the same vertical height as the original reinforced concrete arches. The final design for the replacement bridge is one that behaves structurally identical to the original and replicates its aesthetic, architectural, and historic details.



The reconstructed Auction Road Bridge blends into the rural farmland landscape of Lancaster County.

SINGLE-SPAN, PRECAST CONCRETE TIED THROUGH-ARCH BRIDGE / LANCASTER COUNTY, PA., OWNER

PRECAST SPECIALTY ENGINEER: Pennoni Associates Inc., State College, Pa.

PRIME CONTRACTOR: Kinsley Construction, York, Pa.

PRECASTER: Newcrete Products, Collegeville, Pa., a PCI-certified producer

BRIDGE DESCRIPTION: A 70-ft-span precast concrete tied through-arch bridge with cast-in-place concrete deck

BRIDGE CONSTRUCTION COST: \$966,000

The replacement bridge behaves structurally identical to the original and replicates its details.

Challenges

Numerous challenges needed to be addressed throughout the life of the project. First and foremost, meeting the project requirements meant it was necessary to ensure the final product was constructible and could be built within budget. From the beginning, discussions with contractors investigated erecting and pouring the cast-in-place deck and with fabricators to discuss issues such as formwork of the arches, reinforcing (clearances, bar bends, development lengths, etc.), and transporting the arches.

From a design perspective, a bridge of this nature required a unique approach. The arch and deck were modeled in STAAD and final design completed with spreadsheets that followed load and resistance factor design and PennDOT design requirements.

While each part of the design was important, two were critical. First, because of the continuous loading of the deck, the bottom chord was designed for both tension and flexure. Second, the connection of the deck to the arch was designed to properly account for both shear and torsion.

Finally, gaining approval for the final structure before moving on to construction was challenging. The Pennsylvania Historical and Museum Commission (PHMC) was involved from the very beginning of the project to ensure that the replacement structure matched the historical attributes of the original bridge. Since the design was context sensitive, obtaining PHMC's approval fared easier than originally anticipated. PHMC did, however, require inclusion of some of the nonstructural details, such as the unique architectural end treatments. A detailed historical recordation had already been completed for the existing bridge, but the owner and designer agreed to develop a website to detail the existing bridge and display photographs of the new bridge construction and completion.

Construction and Fabrication

In April 2008, the construction contract was awarded for a winning bid of \$966,000. The county gave notice to proceed in May 2008 with a construction schedule of approximately 7 months.

Newcrete Products fabricated the two precast concrete arches in their Roaring Spring, Pa. plant while site work was ongoing and the abutments constructed. The precast specialty engineer provided services to Newcrete and coordinated with Newcrete and RETTEW Associates to address concerns and make several minor modifications to simplify fabrication and transportation of the arches. Modifications included adding post-tensioning to aid in lifting and transporting the arches, adjusting clearances and development lengths to work within the tight tolerances of the arch formwork, and adding mechanical couplers for the transverse deck bars protruding from the bottom chord of the arches.

On October 22, 2008, the arches were delivered to the site. The contractor worked overnight to erect them and

set the deck formwork in place. The arches were set in place using a 500-ton crane and the deck formwork was hung directly from the bottom chord to avoid working in the creek water. By December 2008, Auction Road Bridge reopened to traffic.

Much of the credit for the success of this unique bridge goes to Lancaster County. Their desire to preserve the heritage of yet another historic bridge was impetus for designing a context-sensitive structure that so beautifully complements its rural surroundings. Another contributor to the project's success was effective coordination among the designer, the contractor, and the precaster. As a result of these three firms working together, Lancaster County now has a new bridge that will serve the community—both in form and function—for as many years as Frank Shaw's original 1916 structure.

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The original structure built in 1922 had one lane and limited sight distance. The original end treatment is replicated in the new bridge.

