Rapid Rehabilitation

By James A. Swanson and Joe Windau

A design-build contract helped complete a typically 18-month bridge rehabilitation in only 47 days.

The Pickaway County State Route 22 bridge over the Scioto River, about 30 miles south of Columbus, OH, required a quick replacement during summer 2003—and a design-build team achieved that goal in just 47 days.

The existing structure was a 45-year-old concrete-slab-on-steel stringer bridge. The 700′-long, six-span bridge had 90′-0″ approach spans and 112′-6″ main spans, consisting of four girders supported by concrete hammer-head piers. The three western spans bridged the main channel of the river while the remaining spans bridged the river flood plain. The deck was 29′-4″ wide, accommodating a two-lane roadway and two, 3′-0″-wide sidewalks. The existing structure was in need of retrofit/replacement because of severe deterioration of the girders, and a wider roadway was desired.

Time Factor

Route 22 is used by more than 9,000 vehicles per day. The bridge could not close to traffic before the end of the school year in June, and had to be reopened no later than the beginning of the fall harvest in August. A replacement structure could not be built adjacent to the existing structure without impacting traffic, since a railroad structure passes over route 22 east of the bridge, and there is significant earthwork west of the bridge. The contract was sold as a fast-track design-build project to minimize the time that the bridge would be closed.

Rehab Plan

The existing riveted steel girders were to be replaced and the structure was to be widened by 10′ on its south side. Hammerhead portions of the existing T-type piers were to be removed and the substructure was to be widened to the south to support the new superstructure. The Ruhlin Construction Company and designer E.L. Robinson Engineering Company developed a steel superstructure and a steel pier-cap design that was awarded the project contract with a bid price of $2.7 million—$500,000 below the next lowest bidder, and $2.3 million below the Engineer's estimate of $5 million.

The final design of the replacement structure consisted of five girders fabricated from high-performance steel, supporting a cast-in-place deck 44′-2″ wide. The girders were designed as simply supported to streamline erection, but were made continuous during construction by pouring integral, concrete diaphragms over the piers. The abutments also were designed as integral, resulting in Ohio's longest bridge without expansion joints.

To accelerate the construction schedule, the design-build team chose metal stay-in-place (SIP) forms. To accommodate the additional 12′-10″ of deck width, the team saw-cut the existing piers below the pier-stem construction joint and replaced this portion with a steel plate girder extending outward to the south side of the structure. The cantilever portion of the replacement piers was supported by groups of four piles that were driven and capped with concrete. The steel piers were galvanized to reduce maintenance since they would be submerged during periods of high water.

The design-build team chose to abandon the trestle concept in favor of operating a crane from the bridge and in the flood plain. This meant accepting the risk associated with lost time due to potential flooding, but it would save time and money. To meet contract documents, a trestle actually was constructed, but it consisted of light steel sections used as piles supporting a pair of light beam sections. The trestle spanned the entire length of the bridge on the north side, as required in the contract, but served as a construction walkway instead of an equipment platform. The design-build team removed saw-cut sections of the existing bridge deck and used them in the flood plane to provide a suitable foundation for the crane. The plain did flood during the construction for 10 days, but did not greatly affect the schedule.

Construction

Pre-Closure Work: The design-build team was concerned about the possibility of hitting the existing foundation of the structure while driving the support piles for the cantilever end of the steel replacement piers. To ensure that this would not lengthen the closed period of the bridge, piles near piers 3, 4, and 5 were driven before the bridge was closed. No difficulties were encountered except that the pile

The structure was widened by 10′ on the south side. The additional width was supported by new piles in groups of four.

hammer broke down during this phase of construction. However, a separate difficulty resulting from the driving of new piles in the main channel of the river arose: Required permits from the Army Corps of Engineering could not be sought until after the contract was awarded, and the lead time involved in this process nearly resulted in construction delays.

Demolition: The bridge was closed to traffic at midnight on June 16, 2003, and demolition of the existing structure began shortly after. The concrete deck was saw-cut into manageable sections that were removed by track hoes and loaders. The demolition started in the middle of the bridge and proceeded towards the abutments. Sections of the existing deck were placed in the flood plain on the north side of the bridge and were used to provide a stable base from which the cranes could safely operate. The existing girders were removed and workers began to saw-cut the tops of the concrete piers. As the tops of the piers were removed, the cut surfaces were prepared and the steel replacement piers were installed and grouted.

Girder Installation: As the pier retrofits were completed working from east to west, the girders were delivered and installed. The girders were designed as simply supported and were made continuous by pouring integral diaphragms over the piers. While some material savings could have been realized by using continuous girders, it was felt that time savings overshadowed the material savings.

Deck Installation: After the girders were placed, prefabricated form supports were installed. The supports, known as "ladders," consisted of pairs of parallel angles connected by bar stock so that they could straddle the top flanges of the girders and support the ends of the stay-in-place forms. The design-build team stated that the prefabricated ladders saved substantial time and worked well with new construction because the girder profiles were known in advance. However, in rehab work with existing girders, the contractor must wait until the existing deck is removed to obtain the in-situ profile of the girders.

After the deck reinforcing was installed and the screed was assembled, the deck was poured, working from west to east. Two concrete pumpers were used—one at the west abutment and one on the east bank on the river in the flood plain—to prevent delays during the pour. The east-approach slab was poured at the same time as the deck but ODOT restrictions and the late arrival of the girders prohibited the pouring of the west approach slab until after the deck was complete. Engineers from the ODOT design office felt that achieving the proper profile for the approach slabs would be impossible without working off of the finished deck.

The parapets were placed using a slip-form machine about seven days after the deck completion. The north parapet is located at the edge of the deck while the south parapet separates the roadway from the pedestrian walkway. A chain-link fence serves as the outside border for the walkway.

On the Road Again

The project was a successful example of how fast-track, design-build contracting methods can be combined with innovative products and materials to dramatically reduce closure times for bridges that are under reconstruction. The bridge was reopened to traffic 10 days earlier than required and the design-build team earned $500,000 in incentives. While this outcome resulted in additional cost for ODOT as compared to conventional construction, the savings passed onto the residents of Pickaway County—both in time and real dollars—almost certainly overshadow this cost.

The bridge won the Associated General Contractors of America, AON Build America Merit Award in 2004.

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