Station Street Bridge Repair

By Robert Lansdown and Aamer Syed

The City of Kankakee is located approximately 60 miles south of Chicago, IL. Incorporated in 1865, the city has a proud history of agriculture and commerce and an exciting future as the service, industrial, cultural, and governmental hub of Kankakee County. Closely tied to the city's growth and future plans for expansion has been the improvement of infrastructure throughout Kankakee. Many recent and major reconstruction projects in Kankakee, including the rehabilitation of the Station Street Bridge, were completed under Illinois FIRST, a public works program.

The Station Street Bridge, constructed in 1924, spans the Kankakee River and connects the east and west sides of the City of Kankakee. This structure is on the Illinois Historic Bridge List and is eligible for the National Register of Historic Places. It is 379 ft (115.5 m) long and has five concrete, open spandrel arch spans. It was originally designed to carry 1920s-era vehicles and a streetcar track operated by the Kankakee Electric Railway Company, but now carries nearly 7000 vehicles daily across the Kankakee River. The historic status of the deteriorating bridge limited the options for rehabilitation to replacement of the bridge in-kind or extensive repairs to the substructure and superstructure.

The bridge deck and spandrel columns were replaced in 1978, but the arches received little attention at that time. An additional 20 years of exposure severely deteriorated the arches, resulting in extensive reinforcing steel corrosion and concrete spalling. A decision was made to come up with a complete repair plan.

Severe corrosion of bridge arches

Evaluation

The majority of the testing budget was reserved for the bridge deck and included an infrared thermographic survey and chloride analysis. Evaluation of the arches was limited to a visual inspection via sounding to determine the extent of the corrosion. The sounding confirmed widespread spalling over the majority of the arch structure. The underwater substructure was thoroughly inspected by an underwater diving company.

Repair System Selection

The historic nature of the Station Street Bridge inspired the design team to study creative and innovative alternatives for its rehabilitation. Several alternatives were studied:

- **Replacing the entire bridge**. The complete replacement of the bridge would have required a long coordination period with the Illinois State Historic Preservation Office and was estimated to be $6 million, twice the available budget. The city did not have funds to replace the entire structure and did not want to lose a historic resource that adds aesthetic value to the neighborhood.
- **Repairing the deck and replacing the arches**. The repair or replacement to the substructure needed to be economical as well as constructible and aesthetically pleasing. The complete replacement of the arches would have been a long-lasting, attractive looking solution rather than a patchwork of spot repairs of the deteriorated concrete. Constructing new arches, however, would have also required a causeway to be built in the Kankakee River, a costly construction technique and environmentally harmful to endangered mussels living in the river.
- **Repairing the deck and arches**. With the available budget and environmental concerns in mind, the design team researched new techniques to repair the arches. Working closely with the City and the Illinois Department of Transportation (IDOT), the engineers recommended that repairs to the arches be made by conventional formed concrete and shotcrete methods. These repairs were to be followed by wrapping the arches

with a glass fiber-reinforced polymer (GFRP) composite. The material selected for this project was an E-glass reinforcing fabric. This innovative repair method improves the structural integrity of the arches by confining the concrete, providing protection from the weather and preventing future spalling. Also important is that this repair method preserves the bridge's historical appearance, is constructible without disturbing the mussels, and gives the city a virtually maintenance-free structure for the next 20 to 25 years. The fiber-reinforced polymer composite wrapping has been used in the State of Illinois to strengthen existing columns in seismic areas, but, to the design team's knowledge, had not been previously used to strengthen a spandrel arch bridge.

Site Preparation

As with any project, the safety of the workers and community was paramount. The contractor implemented a detailed health and safety plan before the start of the project, which included supplying more than the required number of life preservers and water rescue equipment. Appropriate safety information, such as important phone numbers and the route to the hospital, was posted on site. In addition, the city's police and fire departments were notified of the project activities at the start of construction so that they could better respond in an emergency.

The most time-consuming obstacle to overcome before the start of the project was the erection of the scaffolding. Due to the unique arch design of the bridge, suspended scaffolding was used, which offered many challenges. The scaffolding was rigged from the outer two arches and was limited to three spans for the first phase to allow for boat access and the passage of river debris. If too much of the arch cross section were removed during demolition, the arch could fail under the dead load created by the scaffolding. The 300 psi (2.1 MPa) strength requirement of the scaffolding meant a heavier design, which added to the structural concerns. A detailed construction sequence was prepared in the design phase to facilitate the work on the arch structure. In addition, recurring high water levels in the river threatened the wash out the scaffolding, coming within inches of the bottom boards more than once.

Demolition and Preparation

Demolition and preparation methods used traditional techniques that included:

- Sounding and marking the areas of repair via hammer testing;
- Sawcutting the perimeter to achieve a minimum 1/2 in. (13 mm) depth;
- Chipping with pneumatic hammers to a sound concrete substrate;

Scaffolding being erected

Arches being prepared for repair

- Sandblasting all corroded steel reinforcement to achieve a "white metal" finish; and
- Application of an anti-corrosion coating to all prepared reinforcing steel.

Material Selection and Application Methods

Due to the large amount of underside arch repairs, limited accessibility, and tight schedule, a traditional poured-in-place method was not possible for the underside repairs. High-performance shotcrete was chosen as the preferred repair material for the majority of the arches to allow for fast, efficient placement of the repair material. The

mixture design called for a prepackaged silica-fume-enhanced material containing fibers, with a wet-applied technique. Topside arch repairs used a rapid-set, poured-in-place mortar. These materials and application techniques eliminated the need for the typical 28-day cure time prior to the installation of the GFRP system and provided durable repairs to the arches.

On-Site Quality Control

Job control testing included adhesion tests of the installed GFRP system to verify the minimum bond strength of 200 psi (1.38 MPa). Testing was conducted on each arch segment after a minimum 3-day cure and all tests easily exceeded the 200 psi (1.38 MPa) requirement.

Environmental Considerations

As part of the project, an Environmental Survey Request was submitted to IDOT. The result of the survey was the discovery of endangered mussels in the Kankakee River in the vicinity of the bridge. If the contractor was allowed to build a causeway or do any in-stream work, the mussels would have to be relocated to another area of the river. Relocation of the mussels, a costly and time-consuming process, would have significantly delayed the project, compromising the funding. The solution to the problem was to prevent in-stream work by the contractor and to protect the mussels from debris, accomplished by simply writing a special provision requiring the contractor to hang netting to catch falling debris.

Glass fiber-reinforced polymer being measured for placement

Endangered mussels

Repair Project's Impact on Community Relations

This project had historic and environmental issues that were addressed and solved during the design process. The project demonstrates the successful use of fiber-reinforced polymer composite wrapping on concrete arches in Illinois.

The structural integrity of the Station Street Bridge was the primary focus of this project, but its socio-cultural and economic impact on the surrounding community was always considered in the design. The effects of the end product of the project on the community as well as the impacts of construction were always in mind as solutions to the design challenges were developed. A public meeting was held prior to the letting of the project to discuss and address concerns of the neighboring community.

Lighting and safety were important project issues. The existing lighting on the bridge was an IDOT standard pole placed on the bridge as part of the 1978 superstructure repairs. It was located on the sidewalk in the clear zone. As part of this project, historical period lighting was designed. It was located on the back of the parapets, out of the clear zone. Special cantilever pedestals were designed for the new lighting to improve driver and pedestrian safety. This required portions of the existing parapet to be removed and new concrete to be cast. The lighting for this project ties into the City of Kankakee's master lighting plan and allows for future expansion of the period lighting throughout the surrounding neighborhood.

Bridge aesthetics was also an important issue that was addressed during and after construction. The Kankakee River is a great recreational resource for boaters and fishermen and draws people from throughout the region. Activities include power boating, canoeing, fishing, and other water-based recreation. Thousands of people use the river on an annual basis, drawn by events like the American Power Boating Association OBC Nationals (35,000 visitors) and the Kankakee Valley Fishing Derby, the largest in the Midwest. The implemented solution maintained the historic character of the bridge, somewhat of a landmark along the river, while not restricting the recreational activities.

The Station Street Bridge is also adjacent to a public park with a multi-use path running along the river, past three local businesses and a residential neighborhood. After the arches were wrapped, they were coated to protect the composites, giving the repaired concrete a like-new appearance. To improve the appearance of the bridge from all sides, the existing concrete that was not wrapped with glass fiber composites was painted to match the substructure. The final appearance of the bridge is uniform and looks like an entirely new structure.

The use of composite wrapping reduced the duration of construction by at least a year and minimized negative impact on the local businesses.

Challenges under Adverse Conditions

Bridge construction activities typically involve work in the river or stream. Due to the presence of a species of endangered mussels, the project was designed to be constructed without work in the river. This created challenges for moving materials around the project site to where they were needed. In addition, high water during the spring created additional challenges for workers as they attempted to keep the aggressive schedule. Due to their commitment to get the job done, the project was completed ahead of schedule.

The innovative arch repair method provided a cost-effective and economic solution. The original project design also called for repairing and wrapping only the two exterior arches, which were significantly more deteriorated than the center arch. The low bid for the project, $1.6 million, was much lower than the engineers' estimate of $2.5 million and allowed the wrapping of the center arch to be included in the project. With the addition of the center arch, the project total came to $1.9 million and was completed within the 300 calendar-day time frame. The skillful use of modern technology was instrumental in delivering a value-engineered project on time.

Station Street Bridge after repairs

Station Street Bridge

Owner
City of Kankakee
Kankakee, IL

Project Engineer/Designer
Clark-Dietz Engineering
Chicago, IL

Repair Contractor
National Stone Works
Riverside, IL

Materials Suppliers/Manufacturers
Sika Corporation
Lyndhurst, NJ

Robert Lansdown *is a Sales Representative for the Sika Corporation. He has 22 years of experience in the construction field, which includes 17 years of experience in concrete restoration. He received his bachelor's degree in civil engineering from Murray State University in 1989 and his MBA from the University of Kentucky in 1995. Lansdown's experience includes applications in epoxies, sealants, and coatings along with all types of concrete repair methods.*

Aamer Syed *is the Product Marketing Manager—Repair Systems for Sika Corporation. Syed received his BS in mechanical engineering in 1995 from NED University of Engineering and Technology, Karachi, Pakistan. He completed his MS Management Program at Stevens Institute of Technology, Hoboken, NJ, in 2003. His work experience includes representing Hilti Corporation for 4 years. He joined Sika Corporation in 1998 as a Test Engineer. His current responsibilities include product management of Sika's cement-based materials, including repair mortars, grouts, and two-component epoxy resin materials. Syed is a member of ICRI and a member of the Repair Materials and Methods Committee.*