As part of the renovation of the Minisa Bridge in Wichita, Kans., its decorations made of Carthalite concrete, unique to the city, were repaired and restored.

Community residents helping to restore some of the decorative sculptures on the Minisa Bridge.

PARTNERSHIP PAYS OFF

by Don King, King Construction Co.

Updating the 1932 Minisa Bridge along West 13th Street in Wichita, Kansas, involved a variety of unusual challenges. In essence, the bridge was torn away completely in the rehabilitation work, leaving only the sidewalks and ornamental elements on both sides supported by standalone shoring of steel and wood to provide access for children to their school on the other side. The bridge then was reconstructed beginning in January over a major river. The work not only preserved the historic portions of the bridge but opened less than 6 months later, ahead of schedule.

All of the stakeholders, including designers, contractors, city officials, city engineers, public-works employees, historical experts, and local school officials realized that partnering would be a key element of the project if it was to succeed. Engineers at Parsons Brinckerhoff had to recreate the plans for the bridge, as the originals were 76 years old and in bad condition. The designers and city both provided great latitude to make formwork and construction decisions, with their approval, so construction could proceed quickly.

The ornamental elements were rebuilt using a cast-in-place concrete mix that replicated the original material used for the construction, consisting of Carthalite concrete. Carthalite is essentially white portland cement concrete with colored glass aggregates. The material was made by the Cement Stone & Supply Co. in Wichita and was used to create ornamental sculptures, such as buffaloes and Native American images, as well as unique colors for the bridge. The material appears to have only been used in Wichita, where it was incorporated into 13 buildings, a flagpole base, and the Minisa Bridge. The company still operates, but it does not make the Carthalite concrete, requiring a new approach for the repairs.

I-Beams Installed

Structural integrity was first restored to the bridge, using precast, prestressed concrete I-beams. Seven spans of nine girders each were erected, ranging in length from 33 ft to 41 ft. A conventional cast-in-place composite concrete deck was used on the girders. Once the main structure was completed, restoration of the historic concrete wingwalls and piers supporting the balustrades was performed. Under consultation with historic-masonry experts, the historic Carthalite mortars and materials were replicated.

Restoration work consisted of four phases: joint and crack repair, sculpture repair, recasting, and cleaning. Joints and cracks were repointed and injection-patched with less-dense mortar to allow the concrete to "breathe." Then the historic colored mortars were analyzed and recreated. The original castings had featured crushed-glass aggregates, which required incorporating glass made prior to 1950 to obtain pigments stable enough to withstand future weathering. Local citizens donated family treasures, old bottles, and even bought and donated antiques to aid in creating the glass aggregate.

During the removal of the original materials, a wide variety of mortar-patch materials were uncovered that had been applied over the years. These consisted of epoxies, plasticized mortar mixes, silicon and butyl rubber caulk, and other unknown materials. These inappropriate mortar-joint materials caused additional problems and had to be removed by hand to avoid causing further damage.

A calcium hydroxide-based lime mortar was used to replace all existing mortar, providing a strong bond that would remain sufficiently porous to allow rapid water migration. Crew members monitored the joints for approximately 5 hours per application, taking moisture and temperature readings. Each reading indicated a joint noticeably harder than before.

Broken caps on some pillars were patched or recast with the historic-mortar formula. Some areas that had become stained from pollutants resisted typical cleaning methods, so a diluted solution of muriatic acid was applied with a bristle brush, immediately neutralized, and rinsed with water.

The bridge was reopened to traffic in 5½ months, some 32 days early, earning a substantial bonus. After opening, some of the historic preservation work continued and a new bike path was added under the bridge to connect an existing bike path to a new area two blocks away. All of the work was completed on budget and with no lost-time accidents.

Don King is president of King Construction Co., Hesston, Kans.

Precast concrete components, including columns and spandrel walls were carefully fabricated to replicate the look of the original concrete pieces replaced on the historic Spring Street Bridge in Floyd and Clark Counties, Ind.

PRESERVING HISTORY

by Kevin R. Loiselle, Farrar, Garvey & Associates, division of Clark Dietz Inc.

The Spring Street Bridge over Silver Creek in Clark and Floyd Counties, Ind., built in 1926, is eligible for inclusion in the National Register of Historic Places due to its engineering significance. Local officials wanted to ensure it maintained that eligibility while updating it to increase its load capacity to HS 20 and lengthen its service life. The design team at Clark Dietz Inc.'s Farrar, Garvey & Associates division worked with a variety of local and federal officials to preserve the four-span, reinforced concrete, open-spandrel arch bridge.

The proposed improvements included replacing the entire bridge deck, railings, floor beams, and stringers to upgrade the deteriorating components to meet current safety standards. The columns were repaired or replaced, while the arches were repaired.

Coordination began early in the design phase due to the historic nature of the project. Engineers at Farrar, Garvey & Associates coordinated communications with Floyd and Clark Counties, the adjacent towns of New Albany and Clarksville, the Indiana State Historic Preservation office, the Indiana Department of Transportation, and the Federal Highway Administration. They also worked closely with the general contractor, Gohmann Asphalt & Constructors Inc.

This detailed coordination was required to ensure that any removed structural elements were reconstructed to match the existing elements' sizes and shapes. Precast concrete components were used extensively to save construction time and eliminate the need for additional formwork and bracing. It also eliminated any extra construction dead loads applied to the arch ribs.

Precast columns were attached to pedestals on the arch ribs with grouted NMB splice sleeves. These sleeves also were used to tie the floor beams to the tops of the columns. The precast spandrel walls were constructed to the same size and shape as the existing ones, as these were the most visible elements from below the bridge. The spandrel walls were attached to the columns using a Halfen anchor channel cast into the column and a Halfen tee-head bolt cast into the spandrel wall.

Several challenges arose due to the open-spandrel arches and the bridge's location. The 150-ft main span rises 38 ft above the springline and 50 ft above the flowline. That made it difficult to inspect the arches, columns, and underside of the deck. A snooper truck was used to provide access for inspecting and sounding the individual elements.

The loading and unloading sequences had to be carefully analyzed and planned to ensure portions of the arches were not asymmetrically loaded, which could cause a collapse. To eliminate the time and expense of creating supporting falsework during rehabilitation of the columns and deck, construction unloading and loading were evaluated. It was determined that no more than two adjacent sections of the arch could be unloaded at once to keep the arch in compression.

Precast, prestressed concrete deck panels were used to span the floor beams instead of metal-deck forms; thereby, maintaining the appearance of the concrete deck. Using the deck panels provided permanent formwork that did not have to be removed.

The historic railing did not meet current standards because the pilasters located within the rail protruded 4 in. into the driving area. The new railing was modeled from the crash-tested Texas type bridge railing, but it was modified along the exterior face to replicate the appearance of the historic bridge railing.

The rehabilitation work increased the load rating and lengthened the bridge's service life while maintaining its historic character. The goal was to use techniques to maintain the history while increasing load capacity and providing ease of construction. Using precast concrete construction saved time and eliminated the need for additional bracing. That resulted in safer construction and a reduced schedule, which helped minimize costs. The project met the owners' goals and will enhance its community for many decades to come.

Kevin R. Loiselle is senior project manager with the Farrar, Garvey & Associates, division of Clark Dietz Inc., Indianapolis, Ind.

SETTING THE STANDARD

by Nate Scigliano, Nathan Contracting Co. and Will Gold, BASF

When officials at the Pennsylvania Department of Transportation (PennDOT) decided to make repairs to the bridge on State Route 4012 in Northumberland, Pa., they made it more than a stand-alone rehabilitation project. They designated the procedures applied to the repairs to serve as the specifications for future repairs on other bridges. That put more pressure on this project to be completed in ways that maximized savings on time, labor, and material.

The bridge, built in the 1940s, consists of a 48-ft-long span using six reinforced concrete tee beams. By 2008, the bridge was showing signs of corrosion damage and could not support the loads required for modern truck traffic. PennDOT officials worked with researchers at Penn State University and West Virginia University to evaluate the bridge's condition and investigate repair options.

The officials ultimately selected two key products from BASF to be used to restore the bridge and chose Nathan Contracting in Allison Park, Pa., to perform the work. PennDOT set loading criteria and performance standards and arranged for Nathan to work with university researchers to uncover the full extent of the repairs needed to achieve the set goals. Nathan, operating under a subcontracting agreement with Gregori Construction Co. in Sarver, Pa., exposed damaged portions of the bridge to give West Virginia University and PennDOT officials better access to the deteriorated areas.

BASF then provided in-house engineering services to determine how best to address the conditions with the selected products of MBrace Composite Strengthening System and Emaco S-88 CI Concrete Repair Mortar. Nathan and BASF had worked together for more than 10 years on projects and were familiar with each other's approaches. This project required a lot of out-of-the-box thinking to determine the best approach to the conditions to ensure they could be addressed in ways that other bridges could use. BASF provided theoretical design options that Nathan then evaluated for in-field feasibility to maximize constructability.

The strengthening system consists of carbon-fiber sheets that are applied to the surface of the concrete structure to restore or increase its strength without changing the dead load. After the extent of the deterioration in the concrete was determined, each area to be addressed was prepared by sandblasting the surface. Then a two-part epoxy coating was applied with a roller. The MBrace sheets, which have the thickness and texture of denim, were cut to size and applied to the affected area. Another layer of epoxy was then added over the sheets.

The repair mortar was applied to damaged concrete areas and to the cross section of the bridge beams where needed. A special corrosion inhibitor also was included in the mix to provide additional protection.

The carbon-fiber installation took only 3 days to complete and was accomplished with no unusual challenges once the specifics of the plan were worked out. The work allowed the bridge to carry modern HS20 loading with an inventory rating of 1.0. This timely procedure will provide key benefits to many bridges that require repairs and rehabilitation to ensure they continue to offer long service to the public.

Nate Scigliano is president of Nathan Contracting Co. in Allison Park, Pa., and Will Gold is the project's technical service representative at BASF in Evans City, Pa.

Repairs to the bridge on State Route 4012 in Pennsylvania, which used carbon-fiber reinforcement and cementitious repair mortar, will serve as the standard by which other bridges will be repaired in the state.

PERFORMANCE OF
BRIDGE DECK SEALANTS AND CRACK SEALERS

The Minnesota Department of Transportation has released a report defining the state-of-the art regarding the use of bridge deck sealants and crack sealers to extend the life of reinforced concrete bridge decks. Based on information collected from a literature review and survey of 16 state departments of transportation, the best sealant materials and application practices are recommended for use throughout the Midwest.

Deck Sealants
The research on deck sealants suggests that a number of measures can be taken prior to application of the sealers to improve their effectiveness. The initial moisture content of the deck should be as low as possible because a higher moisture content can hinder penetration of the sealer. Also, curing compound should be removed from the deck prior to application of the sealer.

The researchers noted large variability present in the data collected for deck sealants. Many times, observations made in the laboratory could not be reproduced in the field and different laboratory studies yielded conflicting results. Nevertheless, the researchers were able to make some specific observations and recommendations including the following:

- Silane products typically outperform siloxane products.
- Solvent-based products typically outperform water-based products.
- Water-based products are not suitable for reapplication.
- High solid content is typically desirable.
- A solvent-based silane with 40% solids is the commonly produced sealant that best fits the criteria above.
- Sealants should be applied between temperatures of 40 °F and 100 °F.
- A drying period of at least 2 days before application of the sealant should be enforced if the deck is moist from rainfall or washing.

Crack Sealers
Information collected in the literature review and performance survey indicated that epoxy crack sealers tend to have the highest bond strength as well as a good resistance to freezing-thawing. However, high molecular weight methacrylates (HMWM) are much less viscous, which enables them to achieve a larger penetration depth. Because of this property, product selection may need to depend on specific project conditions. If very narrow cracks are present in the bridge deck, depth of penetration may be deemed more important than bond strength indicating that an HMWM product is the best choice. However, if the bridge deck cracks are large, bond strength may become a more important criterion indicating that an epoxy crack sealer is the best choice. Additionally, HMWM products are typically applied in a flood coat and epoxy products are generally applied to individual cracks. This means the extent of cracking on the bridge deck may also be a factor in the decision.

Specific observations and recommendations from the researchers included the following:

- HMWM products typically provide better penetration and are better suited for narrower cracks.
- Epoxy products typically provide higher bond strength.
- Although test results are varied, epoxy sealers tend to demonstrate good resistance to freeze-thaw effects.
- Cracks sealers should be selected with
    1. viscosity less than 500 cP (or 25 cP for HMWM sealers),
    2. tensile strength more than 1160 psi, and
    3. tensile elongation larger than 10%.
- Some form of surface preparation should be used to clean the cracks.
- Crack sealers should be applied between temperatures of 45 °F and 90 °F.
- If possible, crack sealers should be applied between 11:00 p.m. and 7:00 a.m.
- A drying period of 2 to 3 days before application of the sealer should be enforced if the deck is moist from rainfall or washing.

Further Information
The full 268-page report titled *Crack and Concrete Deck Sealant Performance* by the Department of Civil Engineering at the University of Minnesota is available at http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=1754 and click on download pdf.