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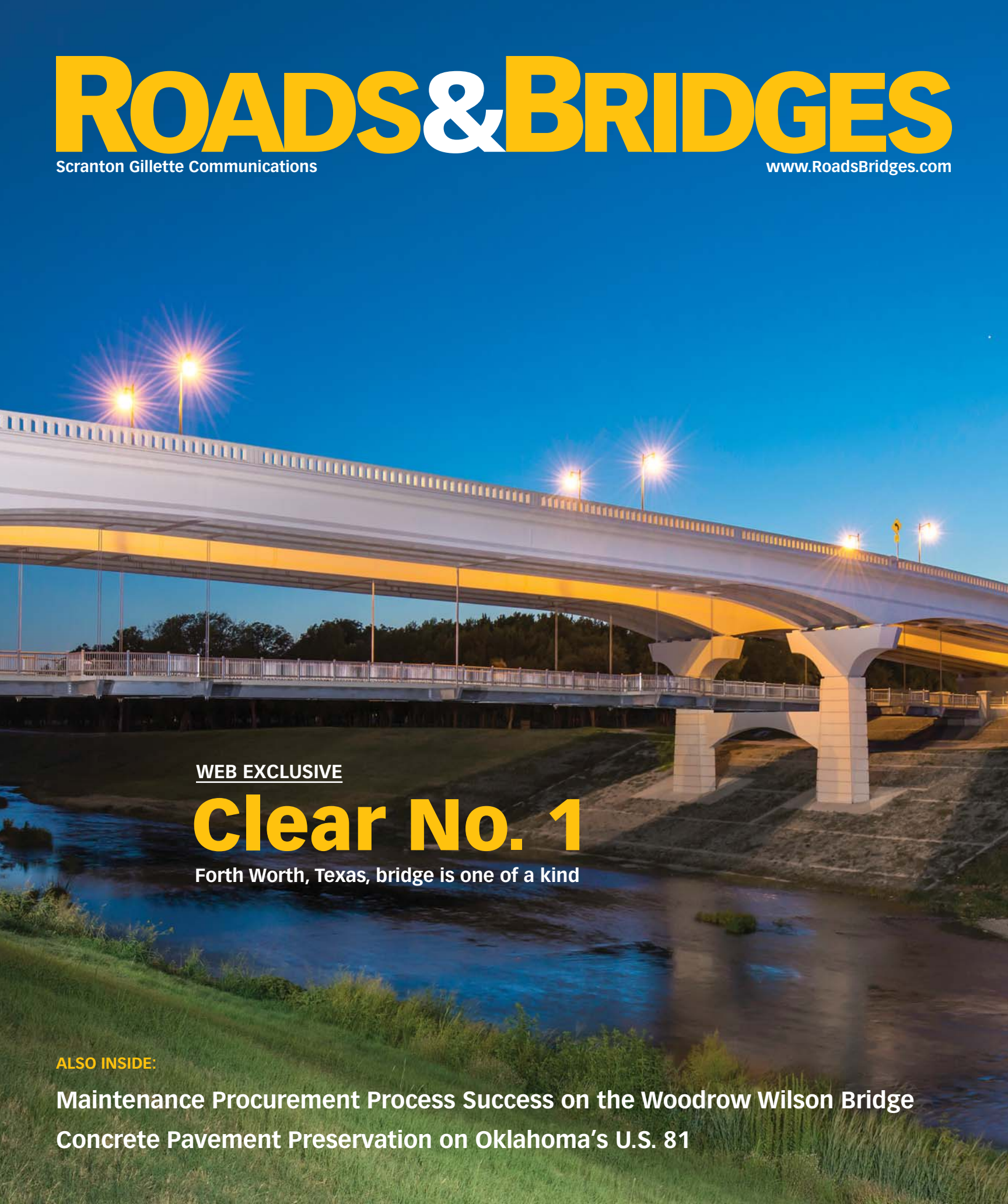


WEB EXCLUSIVE

Clear No. 1

Forth Worth, Texas, bridge is one of a kind

ALSO INSIDE:

Maintenance Procurement Process Success on the Woodrow Wilson Bridge

Concrete Pavement Preservation on Oklahoma's U.S. 81

A bridge between agencies

Virginia's Woodrow Wilson Bridge exemplifies maintenance procurement process success

By Adrian Burde, Ken McEntire and Clinton Simpson
Contributing Authors

Since 1996, the Virginia Department of Transportation (VDOT) has been using the performance-based maintenance contracting method to deliver routine maintenance services.

This process differs from the traditional way of contracting in which the work method is not specified; instead, the agency allows the contractor to decide on the best maintenance plan for meeting or exceeding certain minimum performance requirements.

In 2005, VDOT started the Turnkey Asset Maintenance Services (TAMS) program to widely apply performance-based maintenance contracting to the Virginia interstate system and selected primary roads. The network was divided into 13 contracts. One contract in particular, the Woodrow Wilson Bridge (WWB) TAMS contract, is considered an example of outstanding maintenance outcomes and positive collaboration between the owner agencies and the maintenance contractor. The WWB project extends from the Eisenhower connector on I-495 (Virginia) to the interchange with Maryland's S.R. 414. The total project is 134 lane-miles, including the drawbridge, main line and ramps.

In 2015, VDOT and the Maryland State Highway Administration (MSHA), the WWB owner agencies, commissioned a study to identify best practices and lessons learned applicable to other performance-based maintenance contracts. The study included several on-site visits, unstructured interviews with key managers and project staff, and an online self-administered survey to reach a larger group of stakeholders to collect their personal insights into issues related to the implementation and operations activities.

The study team focused on the procurement process first. Due to the complexity of the project and the importance of the connection from a national security standpoint, the agencies agreed that a low-bid process was not the most adequate approach for procuring the maintenance and operation services and selected a competitive sealed proposal, or Request for Proposal, process instead. The negotiation method, built into the procurement process, allowed the agencies and the contractor to discuss and agree on the performance requirements and define the acceptable levels of service.

The WWB performance requirements were based partly on the National Bridge Inspection Standard (NBIS) and partly on existing TAMS contract templates. Several departments involved in the project participated in the reviewing process to provide their particular views and comments about the service requirements included in the solicitation package. Both agencies agreed on setting higher performance standards for the bridge connection than those adopted on the rest of the Virginia interstate system.

The contract was administered by a VDOT representative who managed all the contractual communications. Both agencies received a work plan on a daily basis, indicating the location of all the active maintenance activities. Agency inspectors and monitors managed any maintenance issues in the field and escalated them to the contract administrator representative should the problem remain unresolved. The contract administrator representative also got involved in all high-level concerns. The participants of the study described the communication process as "friendly, open and honest."

Study participants agreed that the leadership style adopted by the project managers from both agencies and the contractor firm significantly contributed to the success of the project by fostering a collaborative environment, maintaining open communication at all levels, and making fair and reasonable interpretations of the scope of work. Study participants also indicated that the contractor's project manager was crucial in promoting this type of leadership. He was described as a reasonable manager with good negotiation skills and always willing to sit down to discuss project issues.

The study evidence suggests that the maintenance contractor has been meeting or exceeding both agencies' expectations on a regular basis. All participants agreed that the Woodrow Wilson Bridge TAMS contract was and continues to be a successful project. The main factors that contributed to the success were the presence of knowledgeable staff and the willingness of upper management to succeed. Frequent and positive interactions among the members of the project augmented by the willingness of the contractor to include agencies' recommendations into the planning process facilitated the development of trust and enabled a collaborative environment.

The owner agencies found the contractor to be responsive and in possession of the right group of people in charge of the daily maintenance and operations activities. The owners' perception of having adequate resources committed to the project was traced to the negotiation method that took place during the procurement process where both parties had a hand in the strategic approach and project design and were vested in the success of the project. Additionally, the managerial style adopted by both agencies and contractor representative facilitated the exchange of ideas, a situation that proved to be critical at the time of resolving challenging situations.

In an attempt to validate the results of the study, the study team turned to other similar performance-based maintenance contracting methods in the U.S. to identify any commonalities. The Florida and South Carolina departments of transportation are managing similar bridge asset performance-based maintenance contracts which include primarily bridge structure assets with some additional ancillary assets associated with the

Reasons for success

The owner agencies consider the Woodrow Wilson Bridge project to be a successful project because of the following outcomes:

Contractor has consistently exceeded the performance targets: VDOT measures the maintenance contractor's performance based on the condition of the assets, which is inferred from inspections conducted at random locations by trained inspectors. The records indicate that between 2012 and 2015 the WWB contractor consistently exceeded the performance targets and passed all the performance evaluations.

Project security is in good standing: In 2014, both owner agencies, in conjunction with the facility operator and other local agencies, participated in the enhanced critical infrastructure protection visit. During the out-brief session, security advisors commended the management team for maintaining good communication during openings and adopting a pre-emptive approach to critical failures, including emergencies on the bridge.

Project outcomes are meeting the public's expectations: To the general public the conditions within the WWB boundaries noticeably look better.

Both owner agencies agreed on setting higher performance standards for the Woodrow Wilson Bridge than those adopted on the rest of the Virginia interstate system.

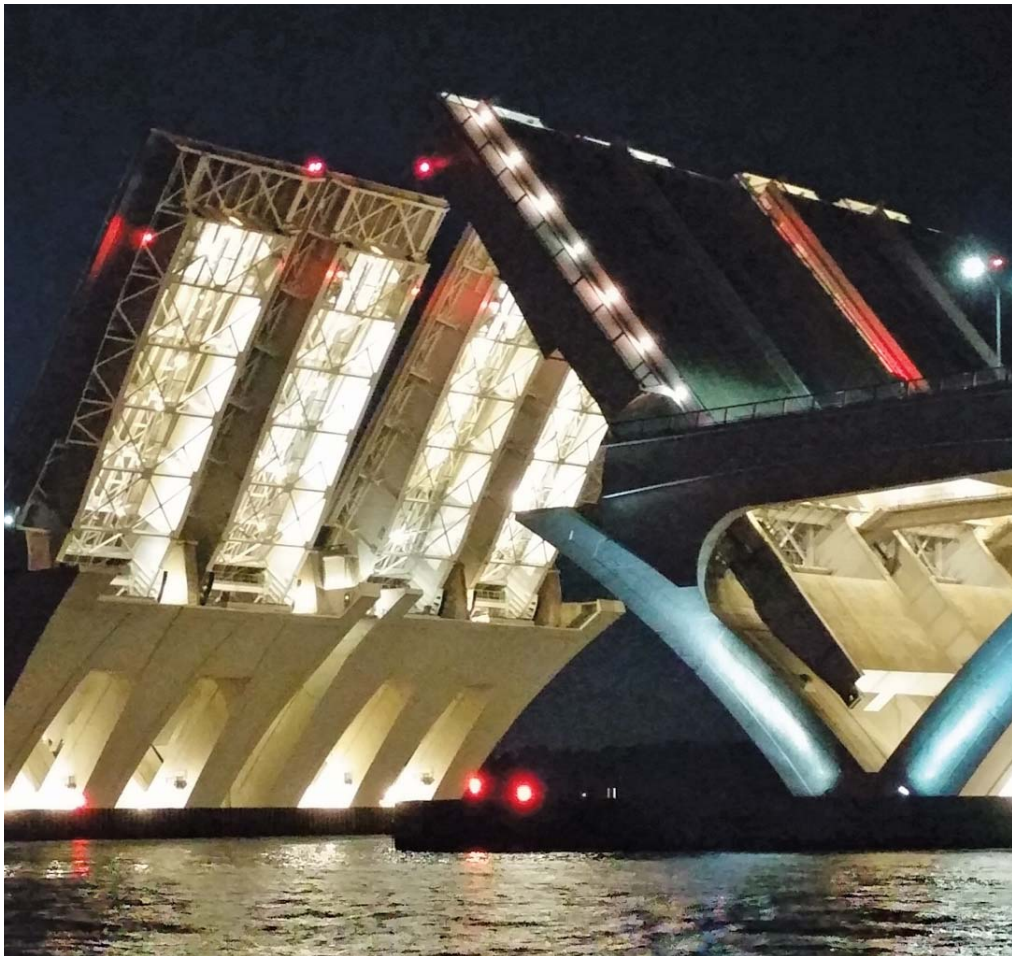
bridges and other roadway assets within close proximity to the bridges. Both contacted agency representatives indicated that their performance-based bridge contracts were considered successful examples within their agencies, and they identified the contractor's performance and project management as factors in their respective projects' success.

Moreover, both interviewees indicated that the qualifications of the project managers tend to be higher in this type of contract because more complex bridge structures, such as drawbridge or cable-stayed bridges, require strong professional and technical skills, and added that one benefit from having highly qualified project managers is that it facilitates communication between the contractor and the owner agency to mutually agree on the maintenance strategy. They also highlighted the fact that the performance indicators were easily recognizable and agreed upon since deficiencies were identified through the NBIS inspection process.

At the end of each interview, the participants were asked to elaborate on areas of concern and challenges to the future of the project. From the owner's perspective, the main concern was experiencing a change to the current managerial style, such as the contractor becoming less responsive. Also, participants from both agencies indicated that adopting a low-bid approach instead of a competitive sealed proposal process on future procurement processes may hinder the agency's ability to successfully negotiate the terms of the contract. All participants pointed to changes in the traffic pattern and aging assets as future challenges to the delivery of maintenance and operation services. To all, continuing the partnership and maintaining the collaborative environment seems to be the logical approach to addressing these future challenges. The owner agencies would like to have more control over certain activities, such as snow and ice removal, but overall they are satisfied with the contractor's technical performance. **R&B**

Burde is a consultant with Leidos Inc. McEntire is a consultant with Asset Management Associates LLC. Simpson is a state program manager for maintenance contract management with the Virginia Department of Transportation's Maintenance division.

For more information about this topic, check out the Bridges Channel at www.roadsbridges.com



Lessons learned

A summary of lessons learned from the Woodrow Wilson Bridge project:

Define clear performance standards and expectations. Agencies should clearly define performance standards that are easily recognized by objective analysis to minimize disagreements during the execution of the project.

Select a procurement process that permits the agency to negotiate the proposed level of resources and scope of work. The level of commitment of a participant with the success of the project is somewhat associated with his/her confidence in the amount and quality of resources committed to the project.

Be aware of the managerial style on the performance of the project team. Promoting open communication and inclusion were essential for developing a collaborative environment to sustain the success of the project.

Select a project manager with the ability to reconcile governmental, transportation agency, and for-profit organizations' needs and expectations. Being able to understand the expectations of all the team members and make compromises in the decision-making process is a desirable quality of the project manager in charge of planning the work.

Bring and retain highly qualified personnel. Connections with complex facilities such as drawbridges or cable-stayed bridges tend to attract more highly qualified personnel.

Be sure to innovate. Innovation is a driving force at the core of the performance-based maintenance contracting approach.

Odd is back to normal

Repairs resurrect Okla.'s U.S. 81

By John Roberts
Contributing Author

U.S. 81 is one of the many U.S.-numbered highways established in 1926 by the U.S. Bureau of Public Roads.

The Bureau, in conjunction with the American Association of State Highway Officials (AASHO), developed the numbering system in order to bring organization and oversight to the U.S. road network.

Before U.S. routes were designated, the main method of marking roads throughout the country was via auto trails designated by auto-trail associations. Then, in 1925, AASHO recommended that the Joint Board on Interstate Highways form a national numbering system to organize the roadways.

In the numbered highway system, north-to-south highways are generally odd-numbered, with lowest numbers in the east (the area of the 13 founding states) and highest numbers in the west. Similarly, east-to-west highways are even-numbered, with the lowest numbers found in the north, where roads were first improved, and highest numbers in the south.

Most of the roadways in the new highway system were not newly constructed, but existed as part of the original trail network that had evolved spontaneously across the countryside. The segment of U.S. 81 located in the state of Oklahoma corresponds to the old Chisholm Trail used for cattle drives from Texas to railheads in Kansas in the 1860s and 1870s. The challenge has been to keep U.S. 81 in good repair. Recently it was determined that the 3.7 miles of U.S. 81 running through Chickasha, Okla., was in need of some well-deserved repair. Chickasha is one of the major Oklahoma towns along U.S. 81.

The Chickasha section of U.S. 81 is a two-lane roadway that is more than 40 years old and travels through an urban-type setting. The goal of the recent repair project was to complete all necessary work on the affected stretch of road while minimizing inconvenience to the traveling public. The project required full-depth patching, dowel-bar retrofit (DBR), diamond grinding, curb/gutter replacement, sidewalk replacement, pedestrian ramp construction and new turn-lane construction.

The Oklahoma Department of Transportation (ODOT) chose to use concrete pavement

preservation (CPP) techniques, which are used to rehabilitate deteriorated roadways by targeting and repairing areas of distress in otherwise sound concrete pavements. CPP only targets deteriorated areas, saving time and cost when compared to other treatment options. Additionally, the Chickasha area is heavily trafficked, so a complete reconstruction was not appealing to ODOT due to the large number of businesses that would be burdened during construction.

Rundown of repairs

Interstate Improvement Inc., based in Faribault, Minn., began constructing full-depth repairs last fall. Full-depth repairs were necessary in the areas where pavement distresses extended through the entire depth of pavement. "Interstate Improvement repaired about 17,500 sq yd of the approximate 100,000 sq yd of the roadway in the Chickasha area," said Sam Gramling, president and chief operations officer of Interstate Improvement.

"Additionally, we constructed two new turn lanes, as well as pedestrian ramps and sidewalks at eight intersections," said Gramling.

DBR was used to repair faulted joints on U.S. 81. By using DBR, the traffic load is shared between adjoining slabs. This prevents differential vertical movement at the joints and cracks, thereby eliminating the formation of faults or step-offs. These faults cause the rough ride and "wheel slap" that is noticed when traveling on a concrete roadway that has lost its ability to transfer load from one panel to the next.

When properly constructed, DBR lasts in excess of 15 to 20 years. Projects can be completed during off-peak hours with short single-lane closures. DBR is a cost-effective repair technique, since it is only applied to the faulted lane; other repair alternatives, such as a structural overlay, would be required on all lanes and shoulders, significantly increasing costs. When utilizing the overlay option, guide rails, overhead signs and bridges may need to be raised, additionally increasing overall project costs.

To perform DBR, slots were cut in the pavement across a joint or crack. The slots were then cleaned, the dowel bars placed, and the slots backfilled with fast-setting, high-strength concrete. At the Chickasha repair project, every transverse joint that wasn't repaired with a full-depth patch received DBR. Interstate constructed a total of 21,600 DBRs as part of this project.

Cross-stitching was used to reinforce low-severity longitudinal cracks where full-depth patching was not deemed necessary. Cross-stitching uses deformed tie bars epoxied or grouted into holes drilled at opposing angles across a longitudinal crack or unreinforced longitudinal joint. Cross-stitching is a repair technique for longitudinal cracks and joints that are in reasonably good condition. The purpose of this procedure is to maintain aggregate interlock, provide added reinforcement and strength, and prevent the crack or longitudinal joint from vertical and horizontal movement.

To perform cross-stitching, deformed tie bars are inserted into holes drilled across a crack at angles of 35° to 45°, depending upon the slab thickness. A 0.75-in.-diam. bar is sufficient to hold the joint tightly together to enhance aggregate interlock. The bars are spaced 24 to 36 in. from center to center and alternate from each side of the crack. The tighter spacing should be used for heavily trafficked roadways.

In total, Interstate Improvement installed 226 cross stitches as part of this project.

Upon completion of the repairs, ODOT chose to employ conventional diamond grinding as the final surface texture. ODOT has successfully utilized this procedure on numerous projects to remove joint faulting, improve ride quality and create a smooth, uniform pavement profile.

Diamond grinding an existing pavement often leaves a surface as good as a new pavement. In reducing the roughness of the pavement surface, the dynamic loading from heavy wheel loads is decreased, resulting in lower stresses and longer life for the pavement.

A diamond-ground surface has other benefits in addition to a smooth ride. Grinding reduces road noise and enhances surface macrotexture and skid resistance. The procedure uses closely spaced diamond saw blades that gently abrade away the top surface of the concrete. On average, the diamond-cutting media will contact the pavement surface nearly 27 million times per sq yd. This accounts for the gentle removal action of the surface, and distinguishes diamond grinding from more aggressive carbide milling operations. The level surface is achieved by running the blade assembly at a predetermined level across the pavement surface. The uncut layer

Full-depth repairs were made to approximately 17,500 sq yd of roadway in the Chickasha, Okla., area.

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On average, the diamond-cutting method will contact the pavement surface nearly 27 million times per sq yd.

between each saw cut breaks off, leaving a level surface (at a macroscopic level) with a longitudinal, line-type texture. The result is a pavement that is smooth, safe, quiet and pleasing to ride on.

Interstate Improvement continuously diamond-ground all 100,000 sq yd of pavement, after which the joints and cracks were re-sealed to minimize the infiltration of surface water and incompressible material into the joint system. With less water entering the joint, subgrade softening is reduced, and the pumping and erosion of sub-base fines will be slowed. In total, approximately 120,000 linear ft of joints and cracks were cleaned and resealed.

Curb and gutter repair, as well as sidewalk repair, were completed by the same crew tasked with the concrete patching. In order to be time-efficient, the crew accomplished the additional repairs while waiting to achieve opening strength on the roadway repairs—making use of what would otherwise have been downtime.

Additionally, the contract required some new construction, including two new turn lanes, pedestrian ramps and sidewalks at eight intersections.

Deciding to do both

CPP is a series of engineered techniques developed during the last 40 years to manage the rate of pavement deterioration in concrete streets, highways and airports. It is a non-overlay option used to repair areas of distress in concrete pavement without changing its grade. This preventive procedure restores the pavement to a condition close to or better than the original and reduces the need for major and more costly repairs later. More important, CPP addresses the causes of pavement distress, minimizing further deterioration. In contrast, covering the distress with a non-structural overlay does not correct the cause of the distress, allowing it to manifest again, usually as a larger, more expensive problem.

Under the U.S. 81 contract in Oklahoma, crews also made curb and gutter repairs, as well as sidewalk repairs. New construction including two new turn lanes, pedestrian ramps and sidewalks at eight intersections also was required under the new contract.

The benefits of using CPP on this project were numerous. While concrete pavements can darken over time as a result of pollutants, reducing their original reflectivity, CPP with diamond grinding restores and lightens the pavement surface. Additionally, the diamond grinding enhances surface friction for greater traction and safety. The results are a smooth and safe surface that reduces road noise and transitions imperceptibly to adjacent pavements.

The CPP techniques were performed during off-peak hours with brief lane closures and without encroaching into adjacent lanes. Applying CPP in one lane did not require application on the adjacent lanes. Since CPP doesn't change the existing pavement elevation, it didn't reduce curb reveal or the reservoir capacity of gutters. Most manhole covers, drainage inlets, guide rails and overhead fixtures did not require adjustment. Adjacent cross streets and driveways were unaffected by CPP, eliminating costly and time-consuming tie-in issues associated with overlay treatments.

Portland cement pavement can be rehabbed up to three times using CPP without a loss of structural or load-carrying capacity. CPP repairs are known to last for decades when constructed with the proper materials and durable aggregates.

This $3.3 million project began in the fall of 2014. There were some subsequent delays due to record amounts of rainfall received in Oklahoma in the spring of 2015, but final joint sealing and permanent pavement markings were completed and the project was finished in the summer.

"The Oklahoma DOT made the wise decision to invest in both repairing the concrete roadway and performing preventive maintenance at the same time," said Gramling. "Full-depth patching fixes areas that are in need of immediate repair, whereas dowel-bar retrofits, diamond-grinding and joint-sealing will provide motorists with a smooth, safe and quiet roadway for many years to come." R&B

Roberts is the executive director of the International Grooving & Grinding Association.

Fork it over

Unique design is the right one to span Fort Worth river

By John Dewar, P.E., S.E.
Contributing Author

Challenged by competing demands of limited budget, stringent flood-control requirements, urban pedestrian trail connectivity and bridge aesthetics, the Clearfork Main Street Bridge employed a concrete spliced girder system (only the second in Texas and the first in 28 years) with a unique steel pedestrian bridge suspended below.

Since the 1960s, the city of Fort Worth, in partnership with many other organizations, has pursued a vision of the Trinity River as an urban asset, working to develop natural, commercial, residential and recreational opportunities along the banks of the Clear and West Forks of the river as they come together in Fort Worth. At the same time, the city has pursued a strategy of planned development in its southwest quadrant, along the Clear Fork. Regional planning has long included development of the newly opened Chisholm Trail Parkway connecting downtown Fort Worth to the neighboring city of Cleburne, and concurrent private development of the adjacent 270-acre Clearfork mixed-use project.

That planning included a bridge across the Trinity in southwest Fort Worth, linking the Hulen Street corridor with Chisholm Trail Parkway and Bryant-Irvin Road. As the area and the Parkway developed, and as ideas evolved about transportation, flood control, urban environments and the relationship with the river itself, bridge requirements and opportunities expanded. In 2009, when the city began design on the Clearfork Main Street Bridge, features identified as desirable and required included:

- An aesthetically pleasing bridge that would complement the natural beauty of the river;
- Access and amenities for pedestrians and cyclists along the Trinity River trails on both banks;
- Aesthetic enhancements in conjunction with the public art program;
- Compliance with stringent U.S. Army Corps of Engineers (USACE) flood-control

requirements for this important regional floodway; and
- Meeting the limited construction budget.

The design team responded with twin precast concrete spliced girder two-lane vehicular bridges with a steel pedestrian bridge suspended below. There are only two sets of piers on the riverbanks supporting the 550-ft bridge, which lessens environmental impact and allows the structure to meet the stringent USACE requirements for the river and floodplain.

Twin bridges, separated by a distance of 20 ft, were used to allow sunlight to shine through to pedestrians below, thus avoiding a dark, uninviting area that a wider single structure would create. Each of the twin vehicular bridges has three spans totaling 550 ft, with center spans of 220 ft and end spans of 165 ft.

Addressing the concerns

The spliced concrete girder design addressed four primary concerns: flood control, aesthetics, long-term maintenance and budget.

The USACE required that the bridge construction not increase the water surface elevation during flood conditions. Furthermore, no bridge piers were allowed within the levee that ran along the eastern bank of the river, and 15 ft of clearance above the levee was required for the roadway. This raised the overall height and length of the bridge, increasing the cost of the bridge from initial estimates and exacerbating budget concerns.

The USACE requirement that the bridge not increase flood levels by more than 0.25 in. meant that the bridge could have only two sets of columns, which in turn required a center span of 220 ft. While the customary bridge system for this span length would be a steel girder, the estimated cost of a steel girder bridge was $13.9 million, $2 million over the city's budget. Instead, after considering five bridge options, the design team recommended a system relatively new to Texas: a precast concrete spliced girder bridge.

This bridge is composed of five precast, prestressed concrete girder segments, ranging from 96 to 120 ft in length, which were shipped to the site, erected and then spliced together using steel post-tensioning tendons to form one continuous, three-span girder. The five precast concrete segments are field-spliced together using reinforced concrete closure pours. The girder segments were constructed of readily available AASHTO Type VI precast beam shapes, haunched at the columns for additional strength and reduced live-load deflection.

The sequence of segment erection avoided any temporary supports in the river itself.

Spliced girders combine the economy and durability of precast concrete beams with the long-span capabilities and aesthetics of a continuous steel girder. According to National Cooperative Highway Research Program Report 517, "Extending Span Ranges of Precast Prestressed Concrete Girders," there are more than 220 spliced girder bridges across the U.S., but only one other in Texas, built in 1985.

To enhance aesthetics, the transitions from the standard Type VI girder section to the haunched girder section were curved with two different radii, 185 ft and 200 ft. This slight difference also provided balancing

There are only two sets of piers on the riverbanks supporting the 550-ft bridge, which lessens environmental impact.

FACT FINDER

This 550-ft twin precast concrete spliced girder bridge is upheld by only two sets of piers, minimizing environmental impact and falling in line with USACE floodplain strictures.

during beam placement, providing slightly more concrete weight toward the temporary shoring towers.

People below

Typical vehicular bridge sidewalks would have required pedestrians and cyclists to endure a steep and isolated half-mile-long trek in the hot Texas sun just to cross the 250-ft-wide river. As a more direct way to allow pedestrian-trail users to cross the river, the team designed a trail-level pedestrian bridge suspended below the vehicular level. This pedestrian level connects to the two riverbanks at trail level, offering a shorter, shaded trip separate from motor vehicle traffic.

The pedestrian bridge is 12 ft wide and 410 ft long with the low chord clearing the maximum 500-year flood elevation. The pedestrian bridge is supported by 1.25-in.-diam. tension-only hanger rods and at midspan only a set of 4-in.-diam. steel pipe hangers. The steel pipe hangers provide both tensile and compressive resistance to ensure enough torsional rigidity to prevent dangerous wind-excited bridge oscillations. The hanger rods and steel pipes are connected to the bottom of the vehicular bridge girders. At each hanger location, diaphragms connecting adjacent girders are used to distribute the pedestrian bridge loads evenly. High-strength steel rods minimize the hanger size and improve aesthetics.

Both the vehicular and pedestrian bridges are supported by drilled-shaft foundations bearing on limestone bedrock. The east abutment of the pedestrian bridge, however, terminates at an earthen USACE levee, where drilled-shaft foundations are prohibited from use. Instead, a shallow spread footing was used at this location to support the pedestrian bridge abutment. Since the spread footing will settle differentially from the rest of the bridge structure, the pedestrian bridge includes a hinge in the beam framing to accommodate abutment settlement.

Taking advantage of the hanger rod support locations on the pedestrian bridge, the

The twin bridges separated by 20 ft were used to allow sunlight to shine through to pedestrians below, thus avoiding a dark, uninviting area that a wider single structure would create.

The bridge abutments act as a kind of canvas, shielding pedestrians near the multimodal trail connections and tiered seat walls. These areas have already seen use for social events.

team incorporated eight widened overlooks with benches, affording both resting areas and a view of the river and the Fort Worth skyline. The benches were sponsored by private donors, who dedicated each bench with a plaque. These donations completely covered the cost of the benches and raised over $20,000 toward a local nonprofit dedicated to improving the Trinity River in Fort Worth.

The split vehicular twin bridges above allow sunlight to naturally illuminate the pedestrian areas below. At night, the vehicular bridge lighting, mounted to the inside vehicular bridge railing, simultaneously illuminates the pedestrian bridge below, creating a pleasant, indirect glow for pedestrians. This also saved money by eliminating pedestrian bridge lighting.

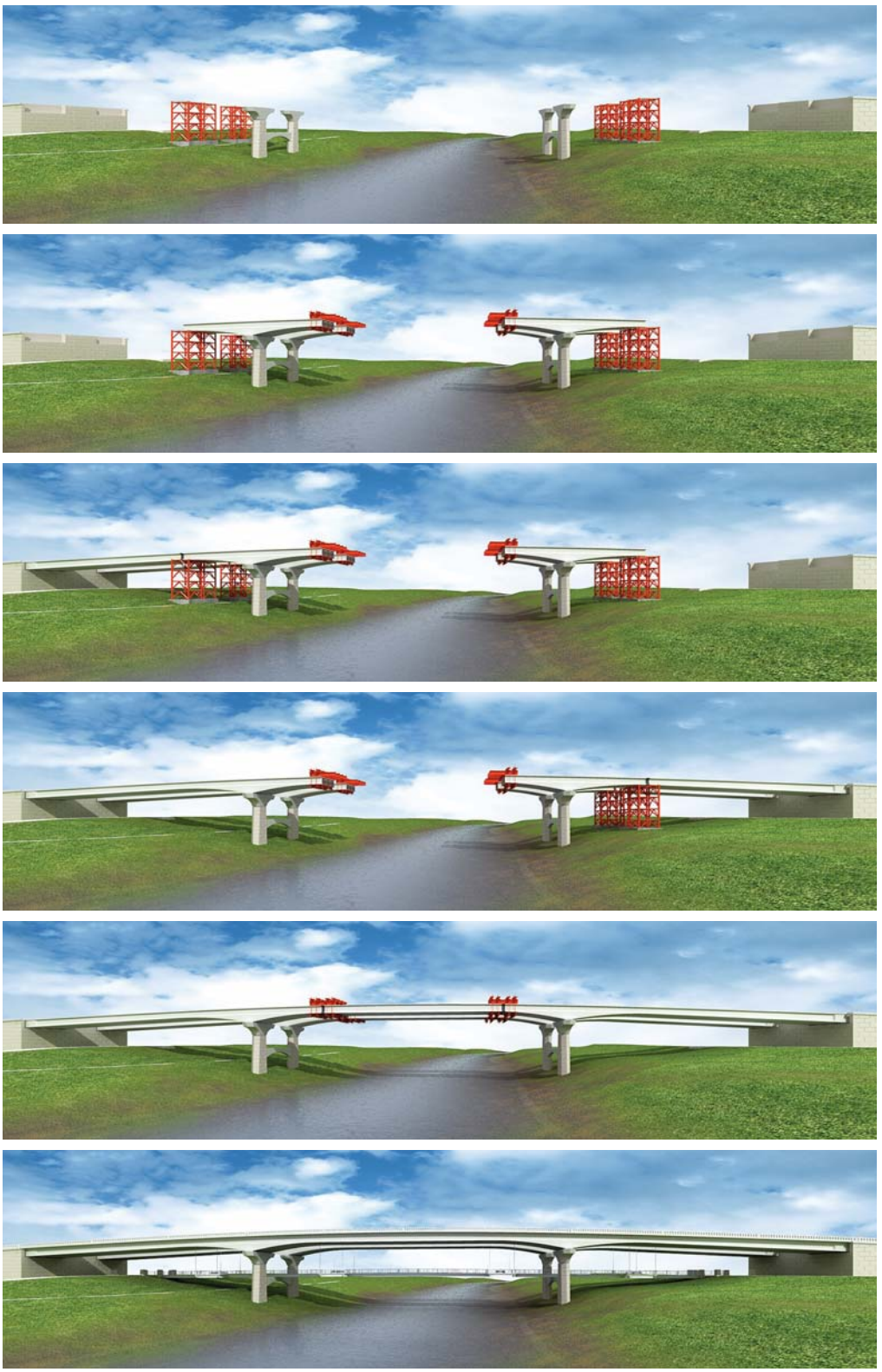
At each end of the pedestrian bridge, near the vehicular bridge abutments, the team designed plaza areas that serve as multimodal trail connections with tiered seat walls offering a shaded rest area for pedestrians and cyclists. The bridge abutments act as a canvas for large-scale public artworks measuring 30 ft wide. These plazas, with their shaded seating and attractive public art, transform what is normally a neglected space to one that is a pedestrian refuge. In fact, these plaza areas have already hosted parties and even been planned for a wedding.

The bridge opened and was under budget at $9.8 million. When Fort Worth Mayor Betsy Price presided at the dedication of the bridge, she said, "The (pedestrian) bridge is 410 ft long and 12 ft wide and was designed by Freese and Nichols for the city of Fort Worth. Isn't it spectacular?"

The Clearfork Main Street Bridge was recently awarded the 2015 Silver Medal Engineering Excellence Award from the American Council of Engineering Cos of Texas. **R&B**

Dewar is vice president of Freese and Nichols, a Texas-based civil engineering firm.

For more information about this topic, check out the Bridges Channel at www.roadsbridges.com.



The five prestressed concrete girder segments were spliced together to form one continuous three-span girder, which minimized the bridge's footprint and kept the levee free, per USACE strictures.