Statewide Solutions

Missouri's Safe & Sound Bridge Improvement Project

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Old bridge before construction (left) and new bridge after construction (right), Andrew County Route 98. All photos: MoDOT.

Missouri recently completed a landmark project, the Safe & Sound Bridge Improvement Project—repairing or replacing over 800 of the state's worst bridges in three-and-a-half years. The bulk of this effort involved a single design-build contract for 554 replacement structures. This landmark, state-wide contract is the focus of this article, showcasing the results achieved through innovation, speed, and volume associated with this unique partnership. The remaining 248 bridges were predominantly rehabilitation and deck replacement projects, which were performed with a modified design-bid-build process through the typical Missouri Department of Transportation (MoDOT) construction program.

Showcasing the results achieved through innovation, speed, and volume.

MoDOT envisioned this large state-wide effort to improve the overall condition of their bridge system. The single design-build effort was led by KTU Constructors, a joint venture of Kiewit Western Co., Traylor Brothers Inc., and United Constructors Inc., with HNTB and the LPA Group (a division of Michael Baker Jr. Corp.) as their design team.

The design-build contract format afforded flexibility in the choice of design standards, and in assigning and managing risks that simply wouldn't be available in a traditional design-bid-build procurement. This contract model also allowed for a dynamic process to accommodate schedule flexibility and provide overall economies of scale in prefabricating bridge elements. These factors all contributed to the overall speed of the project.

Planning

The first step in this effort was selecting the bridges to be replaced. Missouri has over 10,000 bridges on the MoDOT system, and 10% were in poor or serious condition. The project budget limited the number of these bridges that could be replaced, and the speed of the project resulted in screening out any complex or environmentally challenging sites. This way a prioritized bridge list was assembled.

Environmental screening and National Environmental Policy Act (NEPA) approval efforts began as soon as the bridge list was identified. This was performed prior to the design-build procurement in order to obtain NEPA clearance ahead of project start. Once the contract was awarded, the majority of environmental constraints were already targeted in the project construction schedule.

Speed was a central theme of the project from the start, as stated in the project goals:

- Deliver good bridges at a great value.
- Minimize public inconvenience through increased construction speed and flexible schedule.
- Complete construction by October 31, 2014.

Procurement

The procurement process started in October 2008 and consisted of a two-step, qualification or short-listing process, followed by confidential meetings with each qualified proposer to discuss its strategies and approach. The final conforming contract was signed in June 2009.

Scheduling and organization were the early challenges, which were achieved by dividing the entire state into regions that corresponded loosely with MoDOT's internal district boundaries. The schedule for each region started with the higher-standard roads and then moved into the collector road system. This proved to be a great help in managing the logistics, as cranes and prefabricated bridge components could more easily access each site, with little potential for encountering access issues due to load-restricted bridges on the existing system.

Execution

Four initial bridges were constructed in the fall of 2009, at the same time a monumental design effort for all remaining bridges was starting. The KTU strategy for execution revolved around standardizing the design process with

Number of Each Type of Bridge Structure Designed as Part of Missouri's Safe & Sound

Structure Type	Number
Adjacent core slabs	196
Adjacent box beams	116
Adjacent core slab/box beams	45
Spread core slabs	80
Spread box beams	41
Spread core slabs/box beams	23
Steel girders	8
NU girder	5
Flat slabs	17
Box culverts	15
Pipe culverts	1
Super-Cors	1
Prestressed slabs	3
Hybrid composite	3
TOTAL	**554**

a focus on prefabricated bridge elements and subcontracting a large number of bridges, grouped in packages within each region. This combination of design standardization and subcontracting led to a rapid design schedule, which was completed within one year. The design standards development and process was a significant challenge, which was met through teamwork and nearly constant communication. Once started, the schedule was relentless, proceeding at a pace of over 10 bridges designed every week. The use of constructability reviews was a centerpiece of this process, where constructors, designers, and owner staff all worked together to review the initial design solution and layout for each individual bridge. Key items which were standardized in the design included the following:

- Limited bridge types
- Standardized design elements
- Beams produced in 10-degree skew increments up to 40 degrees
- Beam lengths in 5-ft increments

The relatively shallow depths of the adjacent beams did not necessitate raising the bridge elevation and causing additional roadway work. Each bridge type included a sequence of pile foundations (both H and pipe piles), placement of a reinforced concrete cap, precast concrete beam setting with grouting and transverse post-tensioning, waterproofing, and, finally, paving an asphalt wearing/leveling surface. This system resulted in consistent construction speed while rebuilding the bridge essentially in place with no reduction in hydraulic performance.

Setting adjacent beams.

Fabrication and Delivery

The next major logistical challenge was the fabrication of precast, prestressed concrete beams. Standardization of the beam types and lengths aided in production scheduling, however the subcontracting schedule quickly became the critical path to producing the needed bridge components in advance of construction crews mobilizing at each site. Timing was critical and scheduling of finished bridge beams was monitored constantly. Not only did the beams have to be ready and pass quality checks, they had to be transported across the entire state on a tight schedule.

Teamwork was essential with suppliers and plant inspectors communicating with designers and constructors to obtain quality. Delivery and logistics were achieved through teamwork with MoDOT's Motor Carrier division. Motor Carrier permit staff and Safe & Sound staff from both MoDOT and KTU exchanged information on route selection, carrier requirements, escorts, curfew restrictions, and the overall permitting process. Close contact with the permitting staff was a key to success, since there were frequent challenges to meet when shipping over 81 miles of precast, prestressed concrete beams to remote locations throughout Missouri.

Construction began in earnest in the 2010 season, when 152 bridges were completed. A benefit of using similar bridge types is that crews got faster as they grew familiar with the process and the bridge types. Quality issues were overcome through diligent tracking and innovative resolution as well as through development of a best-practices manual (BPM). The BPM provided up-to-date guidance to prevent repeat issues and acceptable corrective measures developed throughout the project. This BPM was used consistently at all training sessions and in the field, undergoing multiple revisions to constantly improve quality and consistency.

Prestressed concrete box beam fabrication.

The 2011 construction season was the most productive. All design work was complete and prefabrication stayed ahead of schedule to produce 281 bridges. This tremendous effort was achieved in spite of significant challenges posed by floods. First, the Mississippi River flooded extensively in southeast Missouri in the spring, followed by Missouri River flooding in the northwest and central portions of the state through late summer into fall, which eliminated access to several scheduled bridges in each instance. The project's size, schedule flexibility, and interchangeable bridge parts provided alternative bridge construction sites, and played a big role in maintaining this record-setting performance in 2011.

Fastest Bridges by Structure Type

Structure Type	No. of Spans	Time, days unless noted otherwise
Adjacent beams	1	8
Adjacent beams	2	31
Adjacent beams	3	28
Adjacent beams	4	33
Box culverts		27†
Spread beams with concrete deck		13

† night-time hours of traffic impact

Stacking and storing bridge beams on site prior to construction provided added efficiency.

Chariton County Route 11 Railroad Bridge, the final bridge of Missouri's Safe & Sound Bridge Improvement Project, completed November 8, 2012.

The final year of construction was 2012, and construction stayed at the record pace of nearly 10 bridges per week through the majority of the season, completing 117 bridges, with the final bridge of the project completed in early November—almost two years ahead of schedule.

The overall rate of construction averaged 42 days per bridge and 20 bridges completed per month, with an accelerated pace during the peak of each construction season of 10 bridges completed per week. Ten separate locations presented the option of constructing two or three bridges in close proximity, under a single road closure. Pursuing these opportunities alone saved over 400 road closure days, as compared to sequential construction. The large number of bridges also afforded the opportunity to shift construction schedules to avoid conflicts with local community events, which helped build public acceptance of the project.

Successful Completion

Overall, Missouri has shown the public will accept road closures for construction, provided the closure time is minimal and there is flexibility on timing to coordinate with local events. The overall condition of the Missouri bridge system was dramatically improved at a much faster rate than typical design and construction processes could achieve. The Safe & Sound Bridge Improvement Project is testimony to teamwork and innovation, through the use of a design-build process for a statewide system improvement.

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