Bridging the Past

BY JOE DENEAULT, P.E.

The Blennerhassett Bridge completes a strategic West Virginia corridor—using 30 million pounds of high-performance steel.

JOHN DENVER SANG ABOUT RUSTIC COUNTRY ROADS IN WEST VIRGINIA, but it's an innovative steel bridge that will be the final link in one of the state's most critical transportation corridors for the 21st century.

The Blennerhassett Bridge, scheduled for completion in September 2007 (construction began in early 2005), will be a signature span across the Ohio River, setting new standards for the use of high-performance structural steel in the Mountain State.

"Our division made an executive decision to use high-performance 50- and 70-grade steel," says Ben Beerman, P.E., project manager for the West Virginia Division of Highways (DOH). "That gives us a lot of benefits. The long-term magnitude of what you get with this product cannot be overstated."

More specifically, high-performance steel gave engineers a viable option for the long approaches to the bridge, as well an expected bridge life of up to 75 years.

Multiple Challenges

It would be difficult to overstate the challenges that state officials faced in getting the bridge project on track. The $120 million span, which will serve as the final link in Appalachian Corridor D connecting West Virginia with Ohio, represents the single-largest contract in DOH history.

"Work on Corridor D began in the early 1970s and 1980s between I-77 at Parkersburg and I-79 at Clarksburg [in West Virginia]," says Randy Epperly, P.E., associate vice president for HNTB Corporation in Charleston, W.Va. and a former deputy state highway engineer with DOH. "Work on the remaining 11 miles between Ohio and I-77 was stopped in the mid-'80s due to environmental, historic and funding issues."

Many of those issues centered around Blennerhassett Island Historical State Park—in the Ohio River—a popular area that presented several historical and environmental concerns. Planners had to mitigate the impact on wetlands, mussels and migratory birds, but historic preservation proved an even bigger hurdle.

"The issue that drew the most attention and public involvement was the historic nature of the island itself," Epperly says. "Not only is the island a state park, but it also has an old mansion that was built by Harmon Blennerhassett and visited several times by Aaron Burr. The original mansion was destroyed, but the state recreated the mansion on the upper end of the island. It still has all the trappings of the old mansion. We had to do a lot of coordination with state and federal historic preservation people."

The initial environmental-impact study said that no piers could be used on the island, which, in effect, tied the hands of bridge designers. As such, the new bridge would need to span the Ohio River, Blennerhassett Island and the back channel of the Ohio River, requiring a span of approximately 4,000 ft. The bridge was also required to incorporate a low-profile design that would be difficult to see from the new mansion site, approximately 1½ miles upstream, and was to have a paint scheme that would blend into the surrounding area.

Designers, working with these criteria, developed a suspension bridge concept. Although popular with the public, the bridge's projected cost quickly spiraled

The west arch was set in place off of Pier 3 in July 2006.

The use of high-performance structural steel allows the Blennerhassett Bridge to be constructed with fewer piers.

out of control, climbing to nearly twice the original estimate. Environmental and historical stakeholders were open to alternative designs, and the resulting studies showed that allowing construction on the island would lead to significant cost savings.

Michael Baker Jr., Inc., who developed the environmental impact statement and was chosen to design the bridge, completed an environmental re-evaluation in 2003, followed by DOH's selection of a tied-arch design for the main span over the Ohio River. Additionally, three piers would be located on the island.

A tied-arch is a form of arch bridge in which the bridge deck resists the outward forces of the arch. The deck "ties" the ends of the arch together under tension, similar to the string of a drawn bow. The tied-arch design, which used the second edition of the LRFD specifications from the American Association of State Highway and Transportation Officials (AASHTO) for design criteria, met the budget goals and also moved up the target completion date by about a year. Although several other tied-arch bridges have been erected in the state, none has ever been built on the scale of Blennerhassett Bridge (see sidebar).

Project Facts

- The project is budgeted at $120 million.
- The overall project will use 30 million lbs. of structural steel.
- The arch will include 12 million lbs. of structural steel.
- Approximately 131,000 bolts will be used on the arch span.
- An additional 14,000 bolts will be used on the approaches.
- The main span will be 878.5 ft long and rise 175 ft.
- The structure's total length will be more than 4,000 ft.

Raising the Bar

The main span across the Ohio River's east channel will have a length of 878.5 ft and a rise of 175 ft. In addition, the project features a 497-ft approach bridge on the Ohio side of the river and a 2,633-ft approach bridge on the West Virginia side. The total length of the structure will be 4,009 ft., making it the longest network tied-arch span in the United States.

The bridge will be four lanes (100 ft) wide and will consist of two abutments and 11 piers. Seventy-five drilled caissons provide the foundations for 10 of the 11 piers and one abutment. These caissons were drilled with polymer slurry at the bottom to help control the sandy/silty soils. Caissons, which range in diameter from 54 to 108 in., were constructed both on land and in the Ohio River. The remaining pier and abutment are founded on driven-steel piling.

According to Beerman, steel has been integral to the project from day one, and concrete was ruled out for a tied arch of this span.

"Here at the state, we have taken the

approach that we don't mix structural types, such as steel with concrete," he explains. "You are looking at approach spans of up to 400 ft, which are outside the capacity of concrete. The use of high-performance steel allows for much larger spans, long-term serviceability and fewer piers. That means a limited footprint on Blennerhassett Island."

The steel bridge is being built to last, adds Jim Shook, P.E., bridge unit leader for DOH. "We really like the toughness of the high-performance steel," he says. "Blennerhassett Bridge is a long span and 100 ft wide, and the steel will give us a nice service life."

Engineers generally expect a minimum service life of 50 years for this type of bridge, Epperly says, and he expects Blennerhassett to last as long as 75 years. In addition, the design will allow rehabilitation work to be done without significantly disrupting traffic flow.

Sum of the Parts

In all, 30 million pounds of high-performance weathering steel will be used on the bridge by the time it is completed. Here is a brief overview of how structural steel is being used throughout the project:

Bridge approaches. The approach bridges on both sides of the river use hybrid steel-plate girders composed of grade 50W and HPS 70W steel, with span lengths ranging up to 400 ft. Of the approaches, Shook says: "There is an incredible amount of steel in the approaches, and the plate girders are as long as we have ever used."

Arch and tie beams. The main channel of the Ohio River is being spanned by an 878-ft tied arch that will use 12 million lbs. of structural steel. The arched rib sections are designed as "mill-to-bear" connections to reduce the number of fasteners required at splice points.

The steel plates that make up the tie beam are being bolted rather than welded together for greater redundancy. This way, if any plate fractures, the bolted connections will prevent the cracks from spreading to adjacent plates.

Hangers. The design team determined that a network of inclined hangers would stiffen the structure considerably, reducing live-load deflections and bending moments in the arch and tie beams to a fraction of what they otherwise would have been. This arrangement saves 2 million lbs. of structural steel and results in an arch that is 10 times stiffer than a vertical hanger system.

"The network ties are a key aspect that enables us to get the nice, stiff structure that we needed," Shook says. "That was a key element."

In another innovation, hangers are being anchored inside tie girders and arch ribs. "We put the hangers inside the box," says Epperly. "This approach makes them more resistant to the weather and effects of the environment, and provides a little more protection against sabotage. In this day and age, you have to be concerned about security."

Cost Certainty

Both the state and the contractors are committed to bringing the project in on time and on budget. The Division of Highways, for the first time ever, paid for structural steel in the "raw state" to mitigate the impact of escalating steel prices; some states enforce escalation clauses while others choose not to use them. The contractor was paid for structural steel material costs up-front instead after fabrication and erection, the traditional payment method.

"The steel fabricators (PDM Bridge and Carolina Steel Corp.) didn't have to carry that cost all the way through," Shook says. "That saved the state a lot of money and also took out a lot of the uncertainty."

The state and contractors rely on several procedures to keep construction on schedule. For example, the contract stipulates specific turnaround times for review of shop drawings. Regular communication also is emphasized.

"We have bi-weekly progress meetings for all the members of the team," says Julie Hott, P.E., Blennerhassett Bridge project engineer for DOH. "We talk about what we plan to do, where we are behind and what we need from each other."

In late August, construction crews were setting arched rib sections. Structural steel work on the arch is expected to be completed in January, and the bridge is on track to be completed by Sept. 2007. (For the latest updates, visit **www.corridord.com**.)

"The original completion date was Aug. 14, 2007," said Scott Ratliff, lead project inspector for HNTB. "We have granted an extension for changes we have made that will take it into September. But we are on schedule. So far, there have been no major surprises."

Blennerhassett Bridge eventually will link Bridgeport, W.Va. to Cincinnati, and eastern cities to markets in the west. To engineers, it's a model of design efficiency. But to West Virginia's businesses and residents, it completes a vital link on the road to opportunity. And to a large degree, structural steel is making it all possible.

"The ability to withstand the high loads associated with a major arch is the name of the game," Beerman says. "The high-performance steel, hands-down, is doing very well." MSC

Project Team

Michael Baker was the primary design consultant on the project, with HNTB being a major sub-consultant. E.L. Robinson Engineering Company and H.C. Nutting Co. provided additional engineering services. HNTB, under a separate contract with the West Virginia Division of Highways, has provided construction engineering inspection services.

Steel was fabricated by AISC members PDM Bridge and Carolina Steel Corp.