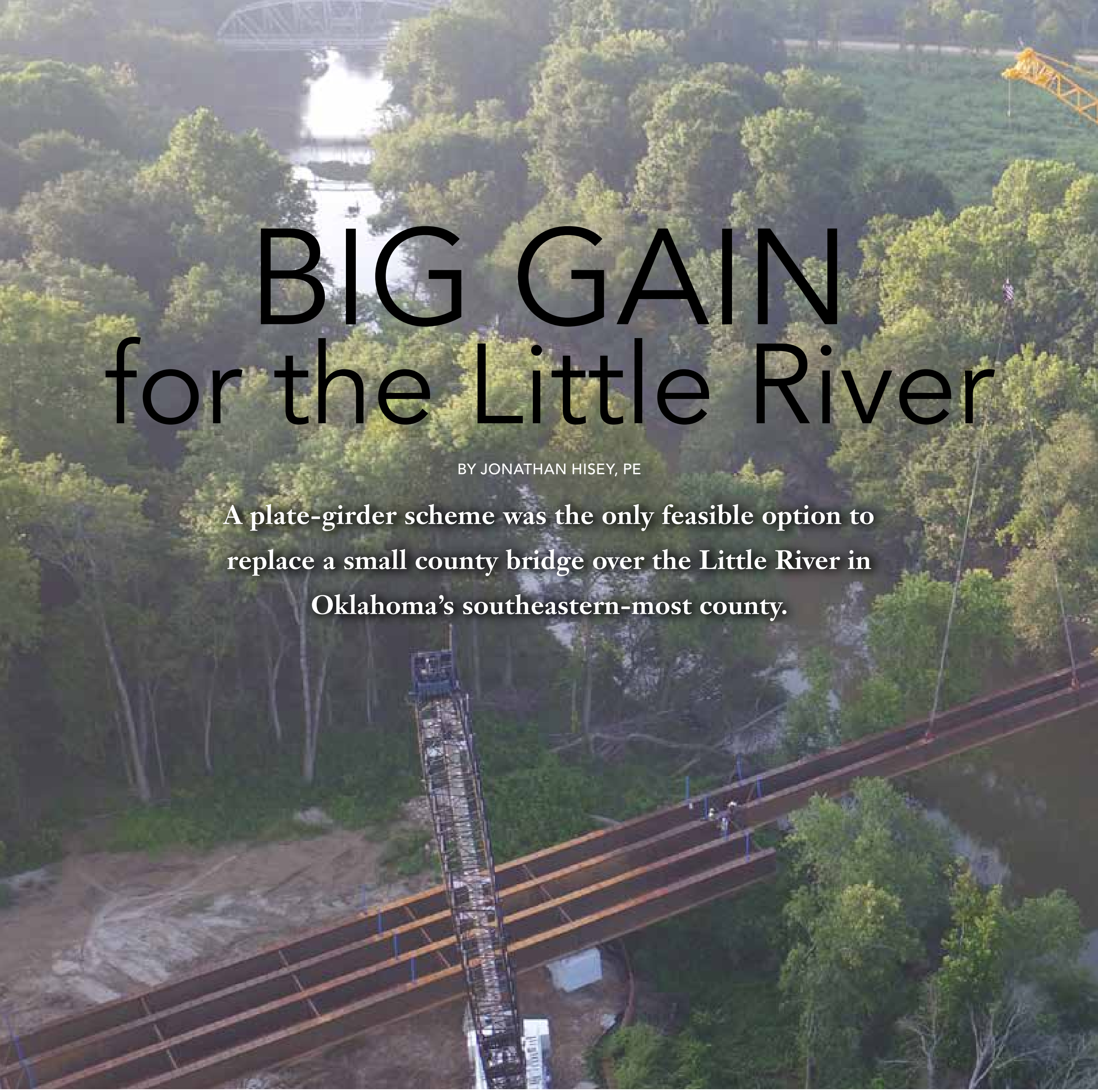

BIG GAIN for the Little River

BY JONATHAN HISEY, PE

A plate-girder scheme was the only feasible option to replace a small county bridge over the Little River in Oklahoma's southeastern-most county.

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THE LITTLE RIVER BEGINS in the Ouachita Mountains of southeastern Oklahoma and runs for 130 miles before entering Arkansas and finally the Red River.

It cuts across southern McCurtain County, Okla., and is crossed by seven bridges, three of which are owned by the county. One of these, a structurally deficient single-lane Parker through-truss, was in poor condition, with a weight limit of only three tons and a sufficiency rating of 9.4 out of 100.

Efforts were made to repair the substructure, but the condition of the truss eventually caused the Oklahoma Department of Transportation (ODOT) to close the bridge to all traffic in 2014. Temporary bridge options were investi-


Manhattan Road & Bridge

The bridge has span lengths of 100 ft, 237 ft and 100 ft.

gated, but the locally available bridge was too short and purchasing a temporary bridge was deemed too expensive. The closure created an 18-mile detour that was a major inconvenience to commuters, school buses, and local farmers and ranchers hauling livestock.

As a result, the bridge was slated for replacement as part of the Oklahoma County Improvements for Roads and Bridges (CIRB) program, which is overseen by the Local Government Division of ODOT. The design of the new bridge began with an initial three-span configuration of 120 ft, 160 ft and 120 ft, composed of simple-span plate girders.

Endangered Species and Schedules

However, significant construction challenges were encountered during the preliminary environmental clearance process. The Leopard Darter, an endangered species of fish, and several endangered species of mussels were present in the river, which would complicate and lengthen the time needed to obtain permits from the U.S. Army Corps of Engineers and their consultation with the U.S. Fish and Wildlife Service. Based on previous experience, the consultation process was expected to take two to three years.

The engineer of record, county commissioner and environmental consultant met with ODOT staff to figure out how to accelerate the timetable for replacement. It was determined that if

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all construction activities were performed outside of the Ordinary High Water Mark (OHWM) of the river, the federal nexus of oversight, consultation and review would be greatly reduced—which in turn would reduce the wait from years to months.

In order to move all construction activity outside the OHWM, the piers of the proposed bridge were moved outside the two-year water surface elevation. The end spans were sized to be long enough to create a total bridge length that would meet the hydraulic requirements necessary for the county road. Once the hydraulic design was analyzed, the structural team settled on final span lengths of 100 ft, 237 ft and 100 ft.

Preferred Plate

Most county bridges in Oklahoma are built using standardized prestressed concrete beam designs specifically developed by ODOT for county roads. However, given the span lengths and the remote location, the use of continuous parallel-flange steel plate girders was really the only option for the superstructure. The typical section of the bridge consisted of four girders on 9-ft, 2-in. centers, a 32-ft clear roadway, 8-in.-thick deck and an ODOT TR3 concrete traffic rail. The project, whose total cost was just over $4 million, used nearly 400 tons of structural steel.

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The entire bridge was completed by December 2016, and the 2,500 ft of approach roadway was completed in January 2017 and immediately opened for traffic.

Girder depth was limited to 6 ft to fit within the proposed roadway profile that had already been designed, and also to allow for the low beam elevation to clear the 25-year event water surface elevation. This created a span to depth ratio of 39.5, which is greater than the minimum ratio of 37 recommended in Chapter 2 of the AASHTO *LRFD Bridge Design Specifications*; this depth limitation did cause the flanges to be slightly wider than would have occurred with a deeper section. Ultimately, 24-in.-wide flanges with thicknesses ranging from 1 in. to 2½ in. were selected for the design. With a girder-spacing to girder-depth aspect ratio of 1.5, K-type cross-frames were used and spaced at approximately 25-ft centers.

The customary design practice for continuous girders normally uses end span lengths that are approximately 80% of the center span length. The Little River Bridge end span lengths are almost half of that, at only 42% of the center span length. The NSBA *Steel Bridge Design Handbook* (**www.aisc.org/nsba**) states that for bridges using integral abutments, end span lengths of less than 60% of an adjacent interior span are economically feasible with the use of integral abutments.

With this in mind, integral abutments were chosen for three reasons. First, the abutment would act as a counterweight. While there was no dead load uplift, some uplift would occur under the design live load. Second, integral abutments are simpler and less expensive to construct compared to conventional abutments. Third, expansion joints, which are prone to leaking and are maintenance problems, would be eliminated at the abutments.

Since most integral abutment bridges in Oklahoma are typically limited to 300 ft in length, a literature review was done to ensure proper detailing and design of the connection between the girders and the abutment. The girders were analyzed for both simple and fully fixed support conditions at the abutment, and shear connectors were designed for the web at the end of the girders to ensure proper connection to the concrete abutment diaphragm. Holes were also detailed through the web to allow reinforcing steel in the abutment diaphragm to pass through. Bearing assemblies at the abutments consisted of 1-in.-thick plain elastomeric pads with 1⅝-in.-diameter anchor bolts passing through the bottom flange.

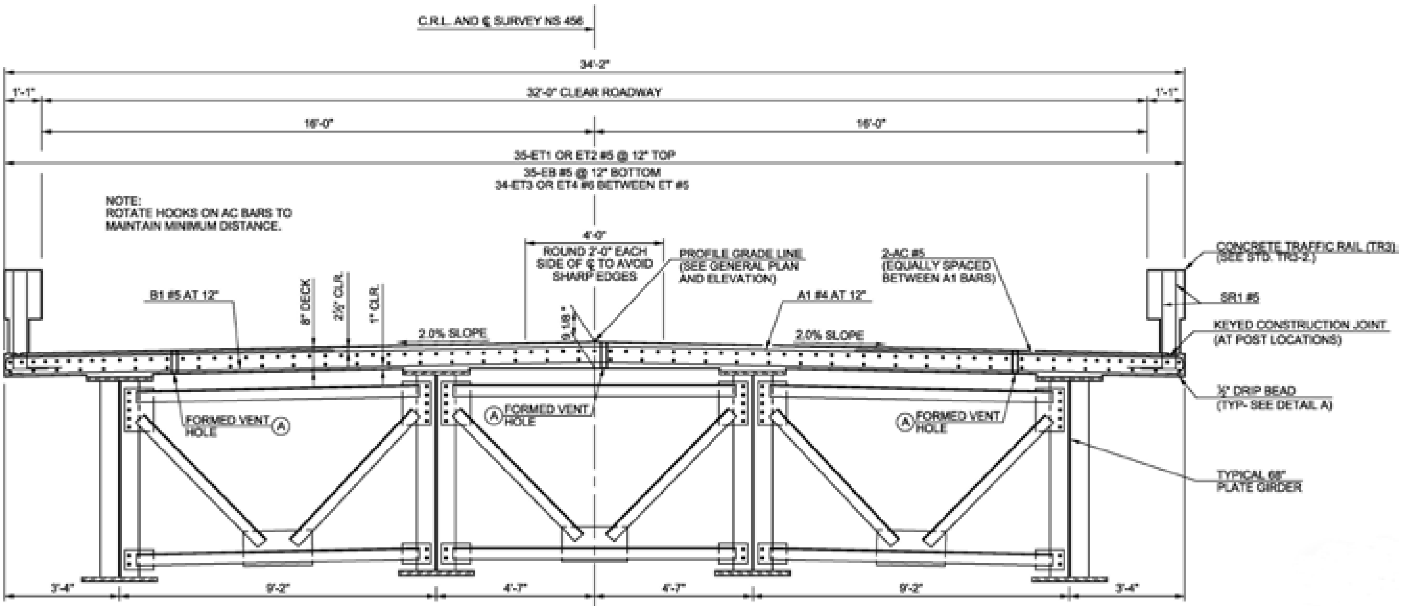
Per traditional continuous girder design practices, field splice locations were located at points of dead load contraflexure. However, due to the small end-span to center-span ratio, the contraflexure location in the end spans were approximately 20 ft from the abutment. Therefore, two field splices were placed in the center span 45 ft from both piers, with optional field splices located 67 ft from each end of the girder. The sole purpose of the optional field splices was to shorten field sections of the girders for shipping.

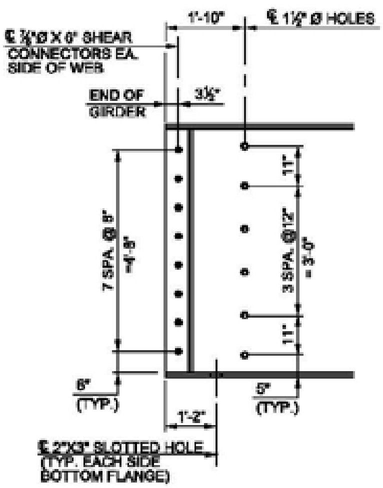
Staying Above Water

Since all construction activity would be prohibited below the OHWM, no cranes or equipment of any kind would be allowed between the piers. Before bridge design had progressed too far, two bridge contractors in Oklahoma were consulted on the feasibility of construction, given these constraints.

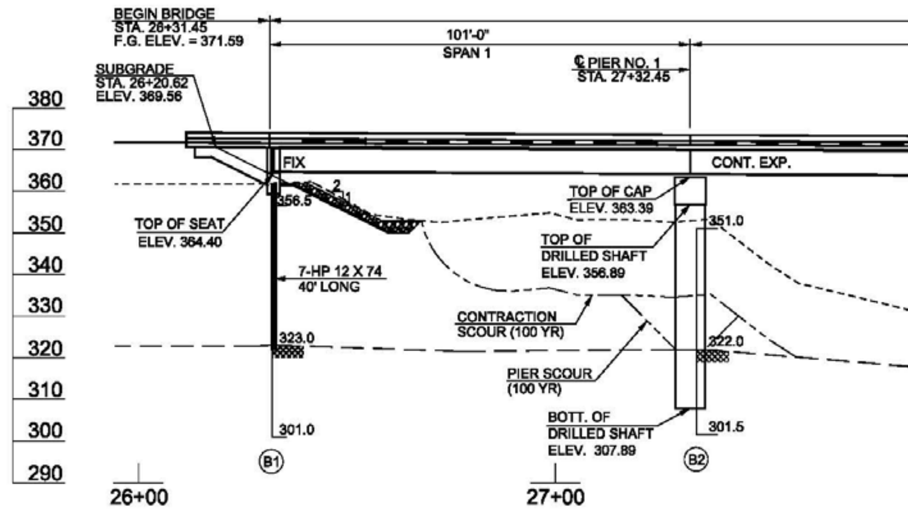
Two options were considered: using one large crane or using a barge in conjunction with several smaller cranes. The barge option was ruled out due to the exclusion of activity below the OHWM, the difficulty of launching a barge within the environmental constraints and the water level of the river. The contractor chose not to use the optional field splices, resulting in three equal 146-ft sections for each girder. While most cranes used in Oklahoma bridge construction range from 100 tons to 250 tons, the larger crane size was needed to place the 30.5-ton center sections while also reaching out nearly 165 ft for the furthest lift. A quote from a local crane service was obtained, and it was estimated that a 500-ton crane with a 140-ft reach would be needed to place the center section of the girder. Construction of the new bridge was awarded to Manhattan Road and Bridge in January 2016, but was slowed by spring rains and significant flooding on river, which delayed girder erection until late summer. To place the center section, Manhattan used an 818-ton Liebherr LTM 1750-9.1 mobile crane with a luffing jib.

A typical cross-section view between the four girders.





End-of-girder detail.



An elevation view of the crossing.

The project uses nearly 400 tons of structural steel.

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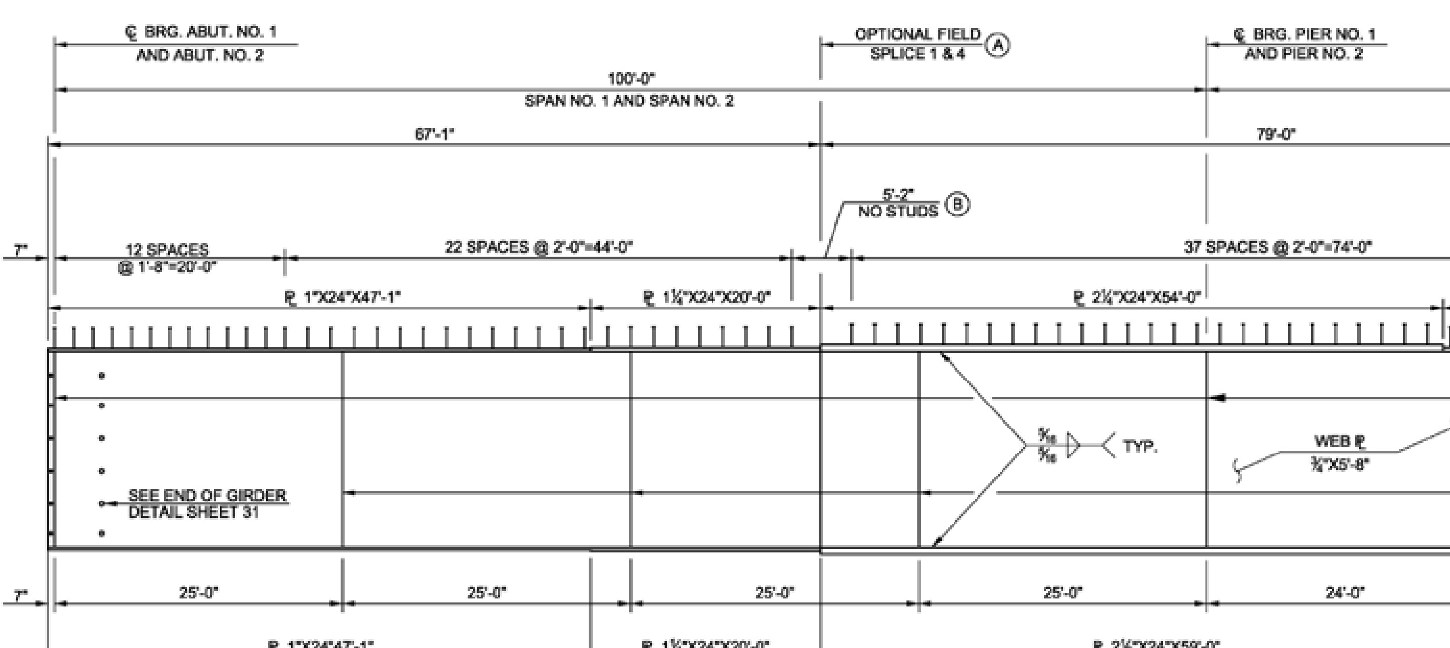
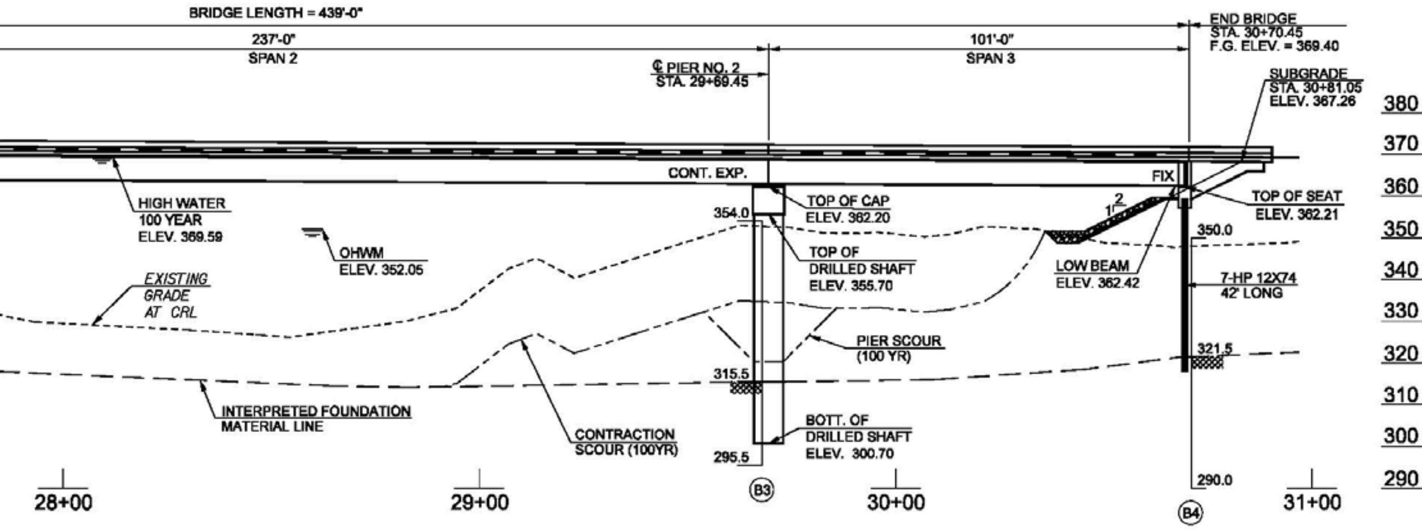




A luffing jib, while reducing the ultimate lift capacity, was required to gain the required lifting radius. While placing the furthest girder, the crane was operating at nearly 93% of lifting capacity. This required extensive safety precautions, since a lift exceeding 75% of a crane's capacity is classified as an OSHA Critical Lift.

Girder erection was completed by the beginning of September 2016, and the entire bridge was completed by December. The 2,500 ft of approach roadway was completed in January 2017 and immediately opened for traffic—a big success for this important crossing over the Little River. ■

Owner
McCurtain County, Okla.

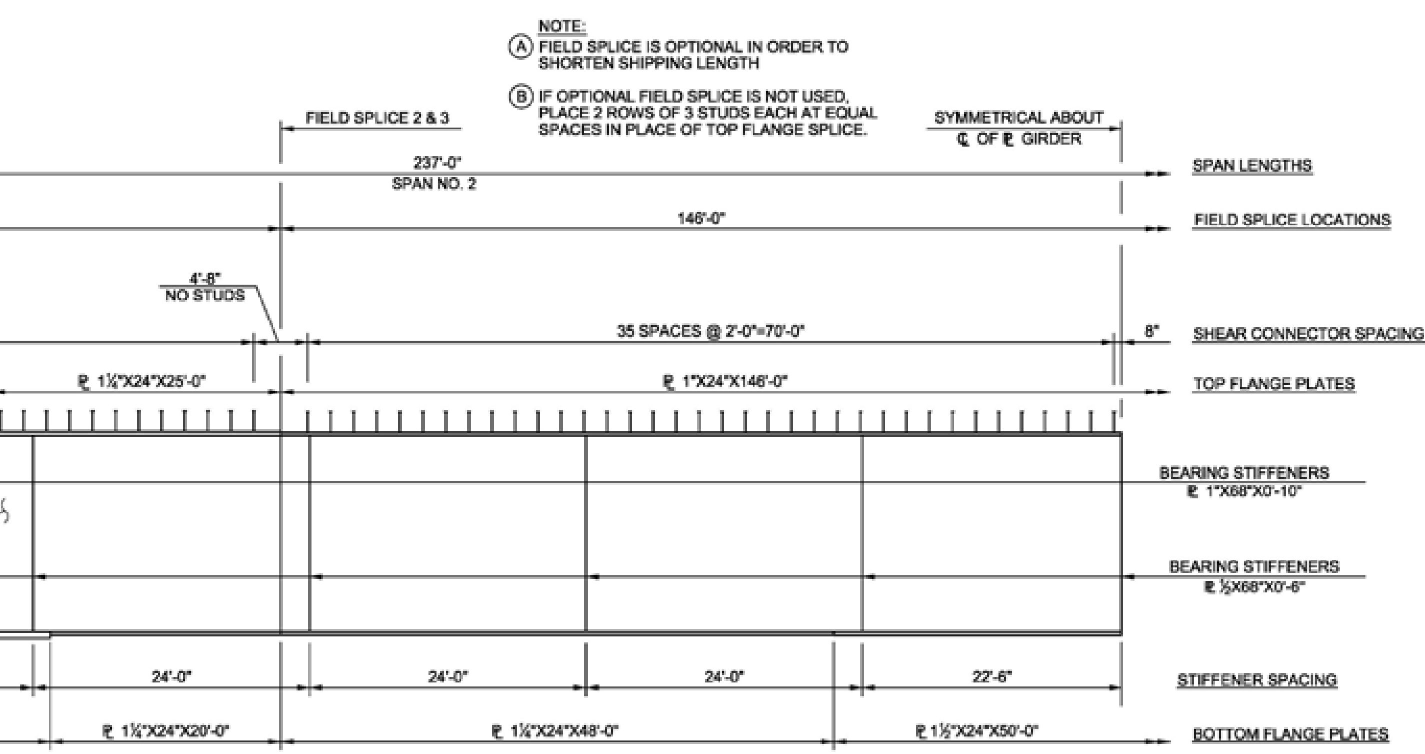
General Contractor
Manhattan Road and Bridge, Tulsa, Okla.

Designer
MKEC Engineering, Inc., Oklahoma City

Steel Team

Fabricator
W&W | AFCO Steel, Little Rock, Ark. (AISC Certified Fabricator)

Detailer
ABS Structural Corporation, Melbourne, Fla. (AISC Detailer)



An elevation view of the plate girders.