Completely removing and replacing the bridge carrying westbound I-44 over the Gasconade River required a closure of less than 20 days.

Sliding Bridge *Speeds* Delivery

BY STEVE HAINES, P.E., AND CHIP JONES, P.E.

HALFWAY BETWEEN ST. LOUIS and Springfield, Mo., I-44 crosses the scenic Gasconade River along the northern border of Mark Twain National Forest. Built in 1955, prior to even the earliest portions of the Interstate Highway System, the bridge carrying the westbound lanes experienced considerable deck deterioration in recent years. As a result, Missouri Department of Transportation (MoDOT) scheduled the bridge for replacement in early 2011. The project included total replacement of the superstructure and repairs to the existing bent caps. MoDOT let the project with a maximum of 60 days of closure time allowed.

The replacement contract was awarded to Emery Sapp & Sons, Inc. (ESS) based on an aggressive construction schedule that limited the total bridge closure days to 35 days. After award of the contract, ESS enlisted Parsons to assist in developing an innovative slide-in construction scheme to replace the bridge on a greatly accelerated schedule in order to further reduce the amount of time the road would be closed to traffic. The ultimate goal was to limit the closure to 20 days total, which would earn ESS a $600,000 early completion incentive ($40,000 per day, capped at 15 days).

Parsons worked with ESS to develop the construction scheme to build the proposed replacement bridge adjacent to the existing bridge while maintaining traffic on the existing bridge. Once the replacement bridge was constructed, traffic was shifted temporarily to the eastbound span, while the existing westbound bridge was demolished and repairs were performed on the existing substructure. Once the repairs were complete, the replacement bridge was slid laterally more than 40 ft, using a hydraulic skidding system, and positioned on the reconstructed bents in less than 12 hours.

Proposed Bridge Replacement

The proposed replacement bridge was designed by MoDOT Central Bridge Office with the assumption that conventional construction methods would be used to construct the bridge. The layout consisted of a six-span bridge with the middle four spans being a

▲ 64-ton push/pull hydraulic jack.

◄ Final bridge location on the repaired existing bents.

▼ Replacement bridge at approximately the half-way point, moving from right to left.

Photos in this spread by Steve Haines.

◄ Slide plate, shown after the bridge has been slid into place.

Steve Haines, P.E., is a project engineer with Parsons, Denver. He has 16 years experience with the latest knowledge in bridge-moving techniques to minimize the impact to the traveling public and has performed bridge moves using multiple accelerated construction methods, including slide-in methods and Self-Propelled Modular Transporters. Chip Jones, P.E., is a division manager for Emery Sapp & Sons, Columbia, Mo. With more than 22 years of heavy construction experience, he has overseen dozens of complex infrastructure projects. His innovative approach has led to the successful completion of these projects throughout his 12-year tenure with Emery Sapp & Sons.

continuous unit and both end spans being simple spans for a total bridge length of 670 ft. The 36-ft, 8-in.-wide bridge is a composite steel plate girder with an 8½-in.-thick reinforced concrete deck. The four-span continuous unit used a four-girder cross section with a girder web depth of 72 in. and girder spacing of 9 ft, 8 in. The end simple spans also used a four-girder cross section with a girder web depth of 42 in. and girder spacing of 9 ft, 8 in. All structural steel was ASTM A709 Grade 50W.

Temporary bents designed to handle the loads due to the construction of the replacement bridge and the loads applied during the sliding operation were constructed adjacent to the existing bents while traffic remained on the existing westbound bridge. The proposed replacement bridge was at the same elevation as the existing bridge to eliminate any required bridge approach work. Building at the same elevation also limited any vertical jacking of the bridge required for the sliding procedures or during placement of the permanent bearings.

The top of each temporary bent was cast at a constant elevation to facilitate sliding the replacement bridge into place. This constant elevation required a minor modification to the original design to accommodate the normal crown section of the bridge, which in the original design would be created by using a stepped bent cap. To create the crown with the constant elevation bent cap, each bearing sole plate was thickened the same amount as the removed step. This method placed all the bearings at the same elevation at the top of the bent cap.

Sliding Setup and Procedure

The replacement bridge was built on top of sliding bearings under each girder at each bent location to eliminate any bearing transitions prior to performing the sliding operation. That allowed the contractor to slide the bridge into place using hydraulic jacks placed at each bent. The sliding interface between the top of the bent cap and the bearings was a standard stainless steel and Teflon interface. Stainless steel sheets were placed on top of both the temporary bents and the repaired permanent bent caps. The sliding pads placed under each girder were elastomeric pads with ⅛-in. Teflon sheets bonded to the bottom of each pad. The elastomeric pads attached to the Teflon sheets allowed for any minor rotations that occurred during the construction activities. The elastomeric pads also compensated for any minor variations in the bent cap during the sliding operation.

The sliding materials and slide-in procedure were performed by heavy lift contractor, Mammoet. The total weight of the bridge superstructure was 2,050 tons. The hydraulic jacks used to slide the bridge over into place were 70 ton hydraulic jacks, one at each bent location, and all jacks were interconnected to control the differential rate at which the bridge was pushed into place.

The jacks were connected to the steel superstructure using connection plates bolted to the bearing stiffeners. The bent diaphragms were redesigned to transfer the pushing loads more efficiently into the superstructure, which was the only modification to the structural steel required due to the slide-in procedure.

During the sliding operation, the jacks reacted against a steel slide plate that had been cast into the top of the temporary bents. Notches fabricated into each side of the slide plate spaced at approximately the stroke length of the jack provided the reaction points for the jacks. After each push cycle of the jacks, the jacks self-retracted and were pulled forward to the next adjacent notch. Pushing the bridge into place required a total of 12 cycles.

Transitioning to Permanent Bearings

Once in its final position, the bridge was transferred from the temporary sliding bearings to the permanent bearings. That required only minimal lifting because the slide-in procedure positioned the bridge very nearly at its final elevation.

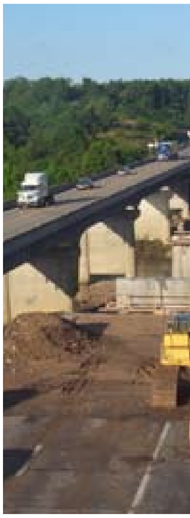
The bearing transition was performed individually at each bent location. Due to limited space on top of the bent caps, the bent diaphragms were designed to handle the jacking loads required to transition the bearings. Six jacks were used to lift the bridge at each bent location. The jacks were controlled to extend at the same rate and raise the girders all at the same elevation.

The transition sequence began with raising the bridge


▼ Completion of steel erection.


▼ Deck reinforcing complete and ready for concrete placement.


▼ Demolition of the existing westbound bridge begins on May 6.



▲ Replacement bridge fully open to traffic on May 24.

▼ 8:30 a.m.: Final preparations before the bridge move on May 16.

▼ 3:30 p.m.: Half-way point of the bridge move.

▼ 7:00 p.m.: Final placement of the bridge.

Photos in this spread by MoDOT.

slightly to unload the temporary sliding bearings and remove them along with the stainless steel plate and the shimming material. The permanent bearing was then placed at each girder and the bridge was lowered into place. Once the jacks were unloaded and removed, the stainless steel plate and shimming material that was supporting the jacks was removed. This operation was performed individually at each bent until all sliding material had been removed and the bridge had been transferred onto its permanent bearings.

The slide-in procedure ultimately provided a very efficient replacement method that reduced the impact to the traveling public. Westbound traffic was switched to the eastbound bridge on May 5, 2011, which was the first significant impact on the traveling public. On May 16, 2011, the replacement bridge was slid into place in less than 12 hours. On May 23, 2011, one lane of the replacement bridge was opened to traffic, and fully opened the next day, which beat the goal of limiting the closure to 20 days.

The slide-in procedure required only minor modifications to the MoDOT-designed steel superstructure. The inherent flexibility of the steel superstructure allowed the structure to be moved into place without any damage or cracking occurring to the superstructure. MSC

Owner
Missouri Department of Transportation

Design Engineer
Missouri Department of Transportation, Central Bridge Office

Specialty Move Engineer
Parsons, Pasadena, Calif.

Steel Detailer and Fabricator
DeLong's Inc., Jefferson City, Mo. (AISC and NSBA Member)

General Contractor
Emery Sapp & Sons, Inc., Columbia, Mo.

Specialty Move Contractor
Mammoet, Houston