UP & at 'em

A lift bridge rehabilitation project takes place with the lift span in the raised position. And while the bridge was held high, construction time stayed low.

BY JEFF NEWMAN, P.E., AND GEOFF FOREST, P.E.

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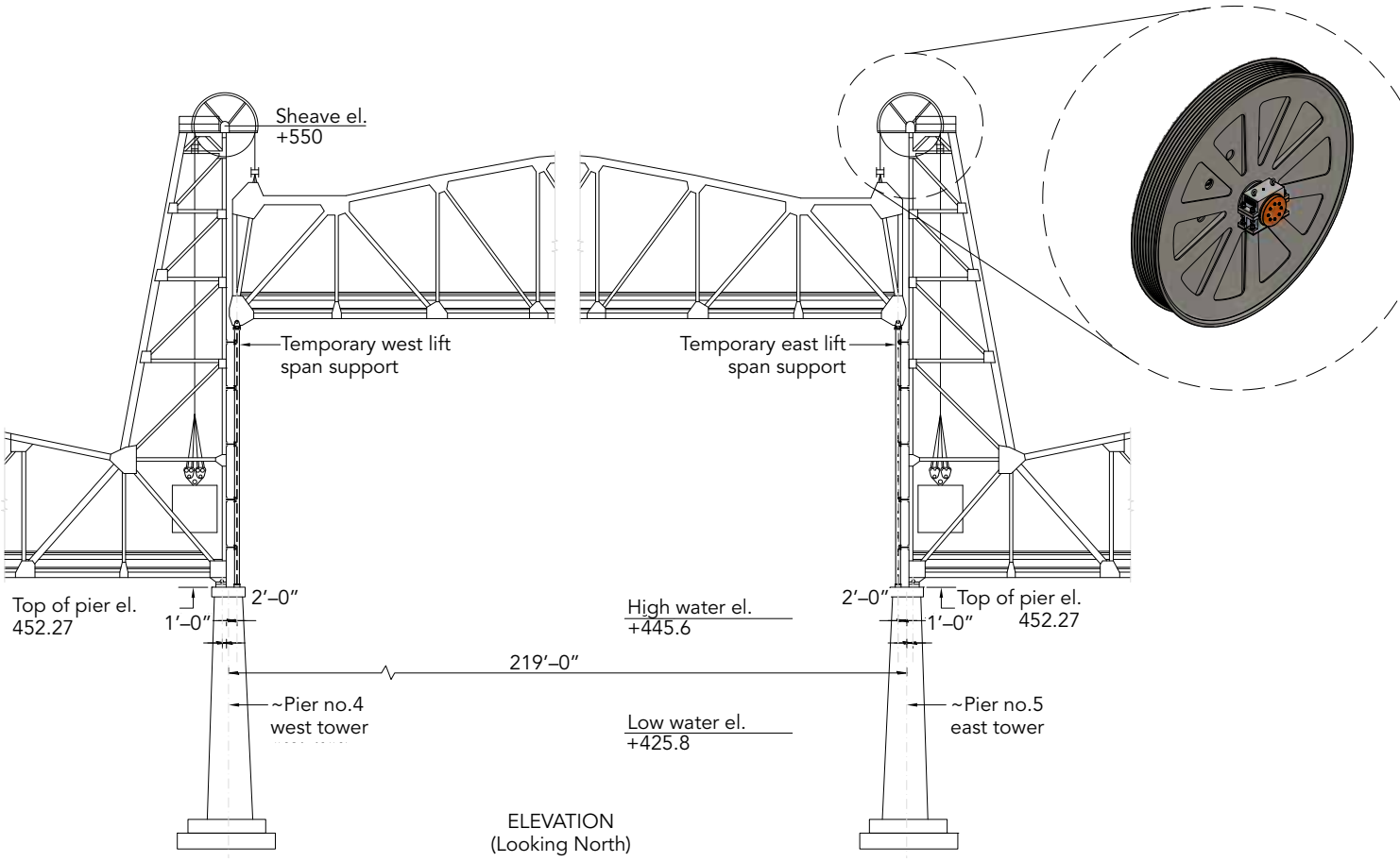

AS ANY BRIDGE INSPECTOR will tell you, it's best to catch small problems before they become big.

In the summer of 2012, a routine inspection of the Florence Bridge, a movable bridge over the Illinois River in Florence, Ill., called for immediate closure of the bridge. The culprit was visible buckling of one of the bridge's main columns that could potentially lead to a partial bridge collapse.

Given the bridge's importance as a major crossing of the Illinois River in the area—it carries Illinois Route 106 over the river—the Illinois Department of Transportation (IDOT) needed to find a solution to bring it back into service as quickly as possible. Fortunately, IDOT had a standing, on-call contract with bridge engineering firm Modjeski and Masters (M&M). The contract allowed IDOT to immediately engage M&M, which was able to quickly mobilize engineers to investigate the damage, develop a response plan and assemble a project team.

Upon closer inspection, M&M confirmed that the damage extended beyond the buckling column. As the column provides support for one of the bridge sheaves, the sheave itself was also shifting laterally, cutting into the trunnion support column. It was feared that continued operation would cause further buckling and could ultimately result in a failure of the whole column and movable span of the bridge.

Staying Open

During the preliminary investigation a definitive cause could not be clearly identified. However, M&M determined that a significant contributing factor for buckling was a mechanical design issue—no longer used in the industry—causing the sheave to move incongruent to its shaft, in turn creating a cork-screw effect.

Over an eight-week period, the M&M team aggressively streamlined the design phase in order to quickly establish a recommendation and contract plans for repairs. A number of the features that were included in M&M's designs ultimately contributed to the rehabilitation of the bridge.

Although the bridge was to remain closed to vehicular traffic, the M&M team recommended that the lift span be supported in an open position, thus allowing barge traffic to continue; ordinarily this type of work would be performed with the lift span sitting in the lowered position. A structural system was designed to support the span in the raised position and involved placing the span on structural "stilts." These stilts were supported at the live load strike plates and extended 55 ft high to support the live load bearings on the lift span. Intermittent anchors attached the stilts to the existing towers for stability. During the active repairs, the stilts carried the full dead load of the lift span.

Today's standards require the designer to provide means and methods for supporting the bridge counterweight in the future for situations such as the one the bridge was experiencing. The Florence Bridge was originally designed and built in 1929, an era when this forethought was not standard practice. As such, the structure had no built-in support to unload the counterweight, and M&M had to analyze and strengthen the structure so that the contractor, Midwest Foundation, could safely and successfully support the counterweight during construction.

With the lift span supported in the fully open position, a jacking system was required to raise the counterweight 20 in. in order to alleviate the weight for the rehabilitation effort. Because of the significant jacking and support effort required, along with other considerations, it was agreed to expand the project's scope and

▲ The lift span was supported in the open position, thus allowing barge traffic to continue during the rehabilitation work.

include replacement of all sheaves and trunnions, counterweight ropes and trunnion bearings. Although the machinery replacement was considered fairly standard for the industry, what made this job unique was the implementation in the field—which, again, took place with the lift span in the raised position to provide a minimum 65 ft of navigation clearance above the Illinois River (high water to low steel).

Realignment

The buckled column and removal of dead load (jacking) caused a loss of the bridge's original alignment. Achieving precise alignment with the installation of the new column was critical for the repair, and M&M required Midwest Foundation to conduct precision surveys, determining existing and final alignments before and after jacking to optimize mechanical functionality.

Installation of the column itself was a complex process that involved hand-cutting the existing column to create an accurate fit. Achieving precise alignment in a shop where the environment is controlled and all work is conducted by machines is one thing. At this bridge site, teams needed to achieve the same precise alignment by hand, working 105 ft above the Illinois River in the dead of winter. Despite the challenges, the new column was aligned within 0.005 in. per ft, relative to the adjacent column, and the repurposed welded sheave with forged trunnion assemblies, each weighing around 10 tons, were aligned using the same precision survey data to at least 1/16 in. accuracy or better.

The closure of and repairs to the Florence Bridge were originally met with both public and political resistance, as is to be expected when a bridge is unexpectedly closed (and causes a 40-mile detour). However, as the public began to understand the impact the buckling had on the safety of the bridge, and the extent of the repair being conducted on an accelerated timeline, perception began to shift. The bridge reopened in April 2013 after only ten months of closure—particularly impressive given that projects of this type can typically take up to two years. The expedited timeline was the result of quick response/mobilization, excellent coordination and information sharing with all parties, innovative solutions and spare sheaves available for repurposing—but most importantly the willingness to problem-solve as a team.

Over the course of the project, M&M worked closely with IDOT to deliver a comprehensive rehabilitation of the entire 1929-built Florence Bridge. If and when another rehab is to happen, there is a plan already in place. ■

Owner
Illinois Department of Transportation

Structural Engineer
Modjeski and Masters

General Contractor
Midwest Foundation Corporation

Steel Fabricator and Detailer
Shawnee Steel and Welding, Inc., Merriam, Kan. (AISC Member/NSBA Member/AISC Certified Fabricator)