SPMT *Solutions*

by Craig A. Shutt

For the Rawson Avenue Bridge projects, the two spans were constructed on opposite sides of the expressway. Photo: Henry G. Russell Inc.

Constructing bridges off line and moving them into place offers key benefits to owners and contractors. As a result, more bridges are being designed and built using these techniques. This article is part of a series looking at some of the key considerations when using accelerated bridge construction (ABC) approaches to construct bridges. It describes the use of self-propelled modular transporters (SPMTs), which are becoming more popular with owners, designers, and contractors as they understand the concepts and see the advantages of ABC.

A single SPMT is a multiaxle platform operated through a computer-controlled system. Each axle line generally consists of four wheels arranged in pairs. Each pair of wheels can pivot 360 degrees around its support point. Consequently, an SPMT has complete freedom to move in all horizontal directions. These motorized vehicles, moving at walking speed, can lift and carry large and heavy loads, including entire bridge assemblies, from off-site locations to their final position. The SPMTs are then moved off site, allowing traffic to be restored within hours of completion. Otherwise, construction of the bridge is similar to that of a bridge built in its final location.

This moving equipment often is used when construction sites are restricted, and prefabricated components need to be assembled off site and moved into place along a route that is longer than is practical for slide pads or rollers to navigate. More engineering is required for this type of move due to the added complications.

SPMTs can be linked longitudinally or laterally to provide the number and configuration of axle lines required by the load. Linked units can be synchronized to a central computer, providing four basic commands: steer, lift, drive, and brake. The dimensions of SPMT units vary depending on the make and number of axles and wheels.

When using SPMTs to move bridges, tolerances must be kept extremely tight. Minor deviations that can be corrected during typical bridge construction cannot be adjusted as the bridge is moving and being set. As a result, tolerances must be strict enough to avoid excessive stresses on the bridge yet reasonable enough to generate optimum moving speed. These tolerances must be specified, adhered to, and continually monitored.

States Expanding Use

Some states, notably Utah, offer manuals that provide guidance for using SPMTs. Utah Department of Transportation's Innovate 80 program involved the replacement of 12 structures using SPMTs and made ABC techniques its standard in 2010. Utah projects have used SPMTs to carry bridges over distances as great as 1.25 miles and over grades as steep as 6%.

SPMTs can provide a range of benefits. Most significant is the reduction in closure times, sometimes to as little as a few hours. This improves accessibility and reduces user costs while also improving worker safety.

Additional benefits arising from the prefabrication of components can include the following:

- Longer curing times for all concrete components
- Control over the environment at the construction site

- More controlled environment for casting components, which reduces maintenance and improves quality
- Fewer deck joints than with other ABC methods
- Less required material
- Public favor from improving speed of construction

Construction Examples

The first bridge constructed in the United States using SPMTs was completed in Volusia County, Fla., in January 2006. The Florida Department of Transportation's construction team used SPMTs to replace a bridge over an interstate highway. During this project, the existing Graves Avenue Bridge was lifted and moved to the side of Interstate 4 (I-4) in only 22 minutes using SPMTs.

Self-propelled modular transporters move the first span of the Rawson Avenue Bridge from its staging area to the bridge location. Photo: Adam Tyksinsk and Rudy King, Wisconsin Department of Transportation.

The first span of the Rawson Avenue Bridge is moved into its final location. Photo: Adam Tyksinsk and Rudy King, Wisconsin Department of Transportation.

The relative elevations and spacings of the beams in the bridge built in the staging area must match those of the final location. Photo: Adam Tyksinsk and Rudy King, Wisconsin Department of Transportation.

Two new 143-ft-long concrete bridge spans were built alongside I-4 instead of over the interstate, reducing the need for road closures and traffic disruptions. Weighing nearly 1300 tons, the new spans were moved into place with SPMTs. Using this approach saved about four months of closure time, greatly reducing impact to drivers. Traffic needed to be detoured for only two weekend nights, using rolling roadblocks.

Pioneer Crossing Interchange in Utah along Interstate 15 used SPMTs to move twin two-span, precast, prestressed concrete bulb-tee-girder bridges into place in 2010. The twin design allowed the bridge to remain open throughout construction.

Each span weighed approximately 2300 tons, representing the longest and heaviest documented concrete spans to be moved using SPMTs. Each span was supported at each end with dual SPMTs with 20 axles each, which resulted in each span being supported by 320 wheels. The SPMTs carried a system of cribbing and lateral bracing that supported the spans at the required vertical elevation. The bulb-tee girders were supported at the twentieth points from the ends of the spans.

The first span was set in October 2009, while the second was set in June 2010. Each span was placed with a single eight-hour traffic closure, significantly reducing user costs. (For more on this project, see the Winter 2011 issue of *ASPIRE*.™)

Rawson Avenue Bridge

A recent use of SPMTs took place in June 2013 when the Wisconsin Department of Transportation (WisDOT) reconstructed its Rawson Avenue Bridge along Interstate 94 in Oak Creek, just south of Milwaukee. The new $4.2-million bridge was built in two staging areas on either side of the highway and then moved into place using SPMTs. The entire move required only a 12-hour highway closure, with each move itself requiring an estimated two hours.

The 188-ft-long bridge features two spans (98 ft 6 in. and 86 ft 6 in.) consisting of WisDOT wide-flange, prestressed concrete girders. With a width of 138 ft 2 in., the bridge has fourteen 45-in.-deep girders per span spaced at 10 ft 1 in. The intermediate support consists of multicolumn precast concrete piers with precast column caps, supported by spread footings. The spans weighed approximately 1545 and 1345 tons, including the 10-in.-thick deck, parapets, and sidewalks.

Each span was moved using two lines of SPMTs, with each line consisting of six SPMTs connected end-to-end. Each SPMT had six axles with four wheels per axle, providing 24 wheels per SPMT, 144 wheels per line, and 288 wheels for both lines. Each line of SPMTs supported a steel beam that ran along the bridge's width. Shims were used between the top of the steel beam and the underside of each concrete beam to accommodate differences in elevation.

Relative girder elevations were maintained during the move. In the staging area, the supports were located at 6 in. from the girder ends. This location also served as the final bearing locations after the bridge move. During the move, supports were located approximately 16 ft 9 in. from the girder ends. This distance allowed the SPMT support system to be rolled into place while the bridge was supported by the temporary structures.

Superstructure capacities were examined to ensure the SPMT support locations did not cause excessive negative moment over the supports. This can occur because the SPMTs reduce the girder span lengths, reducing the positive moment at midspan. The contractor had flexibility in locating the supports and could have suggested alternative locations if needed but used the design engineer's locations.

Crews worked together to provide the necessary site-specific subgrade demands in the bridge staging areas and travel path, ensuring a smooth ride. This included determining the allowable soil loads and specifying ground improvements due to undesirable soils or loading conditions. Proof rolling was performed throughout the travel path, with underperforming areas undercut and backfilled with compacted fill. Steel plates were placed along the travel path to the interstate roadway.

Six self-propelled modular transporters in each line were used to move the Rawson Avenue Bridge. Photo: Adam Tyksinsk and Rudy King, Wisconsin Department of Transportation.

The movements of the self-propelled modular transporters are controlled by a single driver. Photo: Adam Tyksinsk and Rudy King, Wisconsin Department of Transportation.

Both spans of the Rawson Avenue Bridge were placed during a 12-hour overnight closure of the expressway. Photo: Adam Tyksinsk and Rudy King, Wisconsin Department of Transportation.

Conditions Monitored

Weather was monitored throughout the move to ensure wind speeds never approached the 30-mph cutoff. A local weather-monitoring system provided current conditions prior to and throughout the move.

The superstructure's twist tolerance of 2 in. was continuously monitored throughout the move using taut piano wires. The wires were set about 2 ft off the bridge deck between diagonal corners and consisted of upper and lower line limits across one diagonal and a measurement line across the other diagonal. If the measurement line approached the limit lines, the SPMT was stopped so adjustments could be made.

Abutment and pier diaphragms were cast after the bridge was in place. This approach reduced the dead load to be moved and allowed continuity reinforcement to be placed over the pier to provide a monolithic and integral connection.

Completing a successful move with SPMTs in a limited time frame requires close coordination of all activities. These include controlling traffic, removing barriers between the staging area and the bridge site, providing illumination for night moves, ensuring availability of worker lifts for easy access, and ensuring ready access to backup equipment. It also is essential for the general contractor to work closely with the heavy-moving subcontractor from the project's inception.

This is the fourth part in a series examining approaches to accelerated bridge construction. This report was produced with information that included interviews with Mike Dobry, principal structures engineer and Larry Reasch, vice president and manager of the structures department, at Horrock Engineers. Information also was derived from the Utah Department of Transportation's SPMT Manual *and the Federal Highway Administration's December 2006 issue of* Focus *magazine. Information about the Rawson Avenue Interchange Reconstruction Project was obtained from Fact Sheets produced by the WisDOT as well as William Oliva and staff of WisDOT.*

To learn more about self-propelled modular transporters (SPMTs), visit www.fhwa.dot.gov/bridge/pubs/07022/chap00.cfm. A copy of Utah Department of Transportation's *SPMT Manual* can be downloaded at http://www.udot.utah.gov. For additional photographs or information on this or other features, visit www.aspirebridge.org and open "Current Issue."