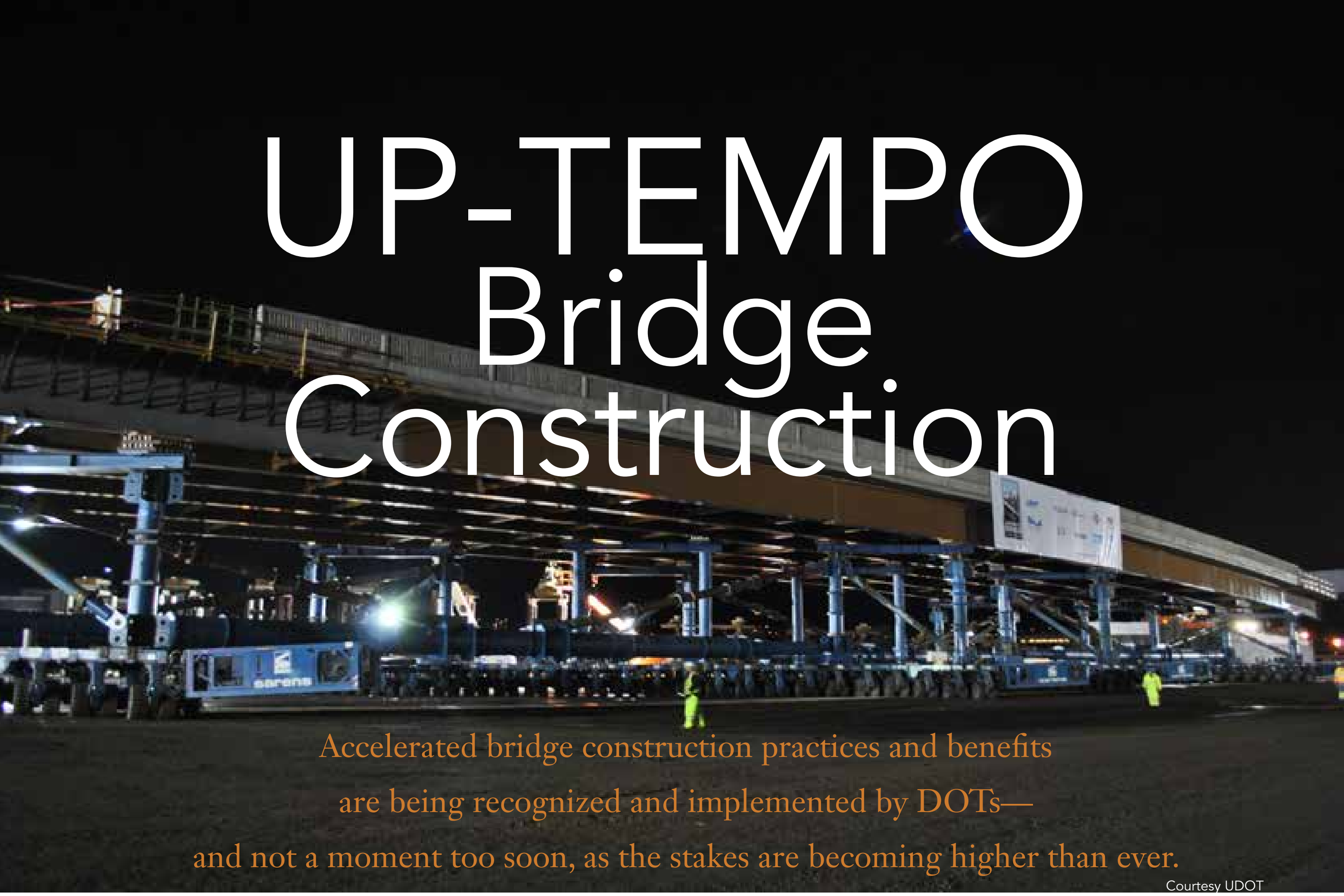
UP-TEMPO Bridge Construction



Accelerated bridge construction practices and benefits are being recognized and implemented by DOTs—and not a moment too soon, as the stakes are becoming higher than ever.

Courtesy UDOT

BY MARY LOU RALLS, P.E.

WHAT IS THE OVERALL health outlook for the nation's bridges?

A quarter of the 607,380 bridges in the U.S. are classified as substandard (structurally deficient or functionally obsolete)—and 210 million vehicles cross these substandard bridges every day in the 102 largest metropolitan regions alone, according to the American Society of Civil Engineers' 2013 *Report Card for America's Infrastructure*. In addition, the average age of the nation's bridges is over 40 years, with an estimated 30% of existing bridges already older than their 50-year design life. To make matters worse, to upgrade existing substandard bridges and the bridges being added daily to this group would require billions of additional dollars every year for the next decade. While progress is being made to reduce substandard bridges, the above statistics resulted in a grade of C+ for bridges in the aforementioned report card.

Traffic must continue to flow as these substandard bridges are being replaced, and cost efficiencies are needed to optimize the use of the limited available funding. Accelerated bridge construction (ABC) can help address these challenges, and much progress has been made in the use of ABC over the past decade. According to the 2014 *Annual State Bridge Engineers' Survey* of the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Bridges and Structures (SCOBS)—in which 47 state departments of transportation (DOTs) responded—ABC has been used in 43 states, and only three state DOTs responded that they have not used ABC. During the same period, progress has also been made towards ABC as standard practice. One state, Utah, has adopted programmatic implementation of ABC, and a number of other states are moving in that direction.

Although sometimes overlooked due to the competitive nature of the transportation industry, construction contractors can be, and in some states are, significant partners with owner agencies in moving ABC to standard practice. And contractors are increasingly supporting the use of ABC principles for a variety of reasons. The improved constructability and cost savings when building multi-span bridges with repetitive elements is a primary reason. Others include safety concerns for crews and the traveling public when working in water or over electric power transmission lines, or working on bridge replacements in locations with limited site distance or space or high traffic volumes. The ability to minimize work in environmentally sensitive areas also provides an incentive for contractors to consider ABC technologies even on low-traffic-volume roads.

Prefab is the Key

So how is ABC defined? Perhaps its most widely recognized characteristic is the use of prefabricated bridge elements and systems (PBES)—and to fully grasp the meaning of ABC, one must first understand PBES as presently defined. The Federal Highway Administration (FHWA) has provided PBES definitions—search "PBES" at **www.fhwa.dot.gov**—that have generally been adopted by the SCOBS Technical Committee for Construction (T-4); SCOBS has designated T-4 as the focal point for ABC implementation among the states. *Element*

➤ Massachusetts 93Fast14 involved the replacement of 41 spans on 14 bridges during 10 weekend closures.

➤ A folded plate girder during fabrication.

➤ Utah DOT's Sam White Lane Bridge over Interstate 15 was moved into position via self-propelled modular transporters.

➤ The Milton-Madison Bridge over the Ohio River between Kentucky and Indiana during lateral slide of its four river spans.

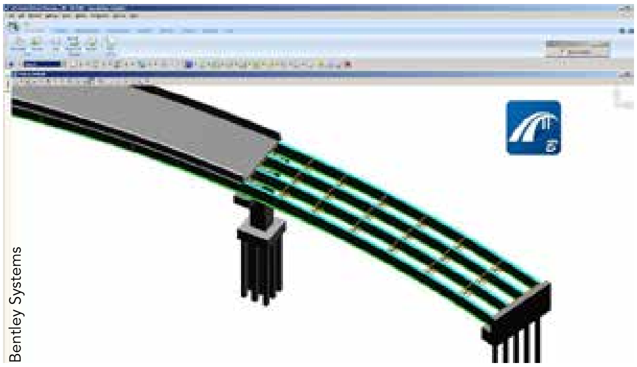
categories are prefabricated decks, beams, piers, abutments and walls. In addition, the miscellaneous elements category includes precast approach slabs, prefabricated parapets, deck closure joints and overlays. Various elements in each of these prefabricated element categories have been constructed in the U.S. to date. Prefabricated *systems* include whole superstructure systems and combined superstructure/substructure systems that can be installed in one piece at one time. In general, prefabricated elements can be erected with conventional construction equipment, whereas prefabricated systems require innovative construction equipment due to the significantly heavier system self-weight. Below are three examples of the most commonly used PBES.

Modular decked beams. Currently, one of the most popular prefabricated ABC elements is the modular decked beam, consisting of either steel or concrete beams pre-topped with concrete deck. An example of modular decked beam use is the 2011 Massachusetts 93Fast14 project on Interstate 93 through the city of Medford. (The project, a 2012 NSBA Prize Bridge Awards winner, was featured in the September 2014 article "Piece by Piece," available at **www.modernsteel.com**.) In this project, 41 spans on 14 bridges were replaced during 10 weekend closures. The modular decked beams for this project were composed of two steel I-shaped girders pre-topped with a composite concrete deck. Deck closure joints between beams were 32 in. wide and filled with high-early-strength concrete. The width of these joints was selected to reduce the width and weight of the modular decked beams to facilitate shipping and handling as well as permit conventional reinforcing lap splices within the closure joints. (Filling narrow closure joints with ultra-high-performance concrete—UHPC—is becoming a popular option, one made possible through FHWA's extensive research and development activities in collaboration with state DOTs and industry.)

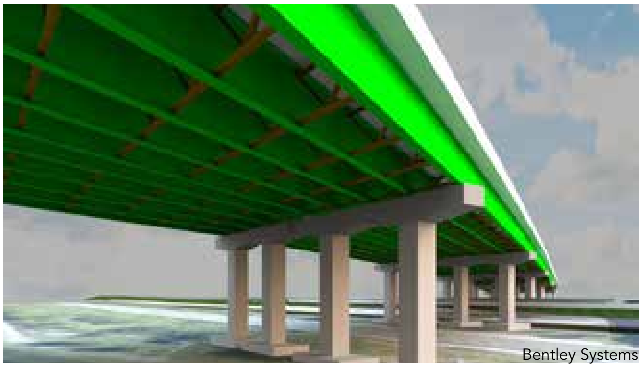
Another modular innovation was introduced at the University of Nebraska-Lincoln, with development continued at Florida International University: a streamlined modular decked steel beam cross section known as the "folded steel plate girder bridge system." In 2014 this solution was incorporated in Nebraska's Primrose East Bridge in Boone County. The 50-ft-long, 32-ft-wide, single-span bridge has four 28-in.-deep girders that were match-cast with 8-in.-thick concrete deck panels and end diaphragms by the contractor at a nearby staging area. The contractor then transported the decked beams to the site for erection, and the 8-in.-wide deck closure joints were filled with UHPC.

Self-propelled modular transporter moves. When it comes to prefabricated bridge systems, two installation methods

Mary Lou Ralls (**ralls-newman@sbcglobal.net**) is principal of Ralls Newman, LLC, in Austin.



An intelligent, parametric 3D steel bridge model.



Bridge information modeling (BrIM) can speed overall bridge project time while reducing clashes and enhancing accuracy.

are currently seeing wide use. They install complete superstructure spans composed of steel or concrete beams pre-topped near the final bridge location with full-width, full-depth composite concrete decks. The first installation method uses self-propelled modular transporters (SPMTs), which are ideal for use on bridge projects over Interstate highways or other high-traffic volume roadways. The initiative for widespread use of SPMTs to move bridge spans in the U.S. began after the 2004 FHWA/AASHTO/Transportation Research Board (TRB) International Scan on Prefabricated Bridge Elements and Systems toured SPMT companies in Belgium and the Netherlands and observed the speed and flexibility with which bridge spans were being installed with SPMTs. The Florida Department of Transportation was the first in the U.S. to use SPMTs to remove and replace spans over a U.S. Interstate. Taking place in 2006, the project was on Interstate 4 northeast of the city of Orlando and incorporated SPMTs during partial overnight closures of the highway. Since then, scores of bridge spans have been installed with SPMTs. Another example is the Utah DOT's Sam White Lane Bridge over Interstate 15 in the city of American Fork. This 354-ft long, 77-ft wide, two-span continuous steel plate-girder superstructure—with a 48° skew and a 1,910-ton self-weight—was moved into position during an 8-hour overnight road closure in 2011.

Lateral slides using hydraulic jacks or winches. The second prominent ABC installation method for prefabricated systems is the lateral slide. This is an ideal technology for high-traffic-volume bridge replacement projects over low-traffic-volume roadways or river crossings. While lateral slides have been used occasionally over the past decade to move spans into place, their use has increased significantly since FHWA's 2013-2014 Every Day Counts 2 (EDC-2) "slide-in bridge construction" initiative focused on this technology. The largest truss slide to date is the Milton-Madison Bridge on U.S. Route 421 across the Ohio River between the towns of Milton, Ky., and Madison, Ind. In 2014 the four 48-ft-wide steel through-truss river spans, totaling 2,427 ft in length and 15,260 tons in weight, were slid into place using computer-controlled hydraulic strand jacks. (The project was featured in the August 2014 news section and also in the February 2012 article "Move that Bridge," both available at **www.modernsteel.com**).

Different Angles on ABC

In addition to PBES, the bridge design and construction community is taking a multifaceted approach to ABC and exploring and implementing other initiatives as well.

Bundling bridges. A primary goal of bundling bridges in a project is to reduce cost with volume. The Missouri DOT's Safe and Sound Bridge Improvement Program, completed in 2012, and the Pennsylvania DOT's Rapid Bridge Replacement Program, currently underway, are examples of two DOTs that consolidated improvement/replacement work on hundreds of substandard bridges into single projects. Bundling bridges can also be an effective tool on a smaller scale for bridge owners with multiple relatively short substandard bridges within a limited distance. For example, cost efficiencies can be achieved in a county or multi-county project with a half dozen single-span bridges within a short distance, all replaced with prefabricated elements of the same type and length stockpiled prior to construction.

Bridge information modeling. Bridge information modeling (BrIM) can speed overall bridge project time from planning through construction while reducing clashes and enhancing accuracy. This is accomplished by using data, developed in design, for fabrication and construction as well as other phases in a bridge's life cycle. Although BrIM is more widely known for its use on large projects such as the Tappan Zee Bridge, the general benefits of BrIM—data reuse, change management, and collaboration—can be realized in bridge projects of all sizes. Like its building counterpart (BIM), it can help ABC and other projects see faster production with fewer errors, resulting in time and cost savings.

State DOTs are starting to use this 3D intelligent modeling in their planning, design, and construction of bridges across the county. Currently 29 DOTs plan to implement it in their agency's culture during 2015 and 2016. An additional 15 states and the Federal Lands Highway plan to integrate it pending a two-year assessment cycle. By December 2016, it is expected that 16 DOTs will have the new methodology institutionalized, 17 will be in the assessment phase, 12 will be in the demonstration phase and two will be in the development phase.

Total cost estimation tools. ABC significantly reduces the number of days in the work zone, but to date, bridge owner and contractor savings related to the reduced number of days in the work zone are not typically included in cost comparisons between ABC and conventional construction. Similarly, the most frequent reason for the use of ABC is to reduce traffic congestion, but in many cases user costs are not included in cost comparisons between ABC and conventional construction. Work has been done in some states and is underway in others as well as at the ABC University Transportation Center (ABC-UTC) at Florida International University, to develop tools to estimate total costs of ABC and conventional construction. For example, the Connecticut DOT has recently developed an ABC decision matrix that includes estimated construction inspection overhead costs associated with differing project durations for conventional construction versus ABC. It also includes measures to weigh the cost of conventional construction with overbuild and/or temporary construction with minor long-term traffic impact, versus the cost of ABC with road closures, detours or more significant short-term traffic impacts. In addition, it captures contractor costs. Another example is an ongoing ABC-UTC research project to create a framework for evaluating and using construction and user costs as part of the decision-making processes associated with bridge construction, as well as a total cost analysis and estimation tool.

When it comes to such estimates, keep in mind that a specific project's design can be significantly different when taking an ABC approach versus a more conventional approach. A paradigm shift is needed when considering costs, as the idea of a conventional cost estimate versus an ABC cost estimate is an old train of thought. There should be no one type of estimate versus another. Proper project planning leads to the most appropriate project cost. Within the project planning process, the objective is to define the goals of a project—and in most cases this means to reduce the impacts to the public. If ABC is a tool that aides in meeting the established goals of the project, then any additional cost of using ABC is secondary to those goals. One should define the project goals and set the project budget to account for all project needs and requirements.

Future Opportunities to Advance ABC

Owner agencies are typically the stakeholders in the best position to take the lead in making ABC standard practice because of their obvious influence and their consideration of the traveling public that crosses their bridges. The collaboration of academia, industry organizations and consultants, in partnership with bridge owners and construction contractors and suppliers, provides the opportunity to accelerate the advancement of ABC as standard practice.

But making ABC standard practice does not mean that ABC is actually used on every bridge project. Instead, it means an owner agency, in support of its traveling public, considers ABC as the default in the initial planning phase of every bridge project and has a decision-making tool that evaluates whether ABC or conventional construction is the best solution for that specific project. It means an owner agency's leadership and staff members understand the benefits and challenges of transitioning to ABC as standard practice and that they are committed to following through in collaboration with their bridge community. Each owner agency must determine how best to transition to ABC within their organization; for starters, owners could designate a champion to lead a multi-disciplinary team specifically charged with transitioning to ABC as standard practice.

The framework and opportunity to take advantage of ABC's benefits are now known, and the momentum is growing across the country for ABC as standard practice. And in the face of the daunting statistics on substandard bridges in the U.S., ABC is becoming more important than ever. ■