WHITEPAPER: Fast-track Bridge Replacement
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Global Engineering Service Provider
Fast-track Bridge Replacement
Utah cracks down on construction-related traffic delays with accelerated bridge construction and “bridge move” techniques.
By Vance Hanson, P.E., Senior Project Manager

For many years, conventional bridge replacement design and construction techniques required replacement of one-half of a bridge at a time. Because traffic was detoured to one side of the bridge while construction progressed on the other side, construction often took a year or more to complete.

In 2002, Utah DOT (UDOT) implemented an accelerated bridge construction (ABC) program to significantly shorten construction time, decrease impacts to the traveling public, and increase safety.

UDOT’s program began slowly, utilizing precast elements such as deck panels, approach slabs, and abutments. From 2002 to 2007, the state DOT and its contractors developed a comfort level with these techniques. In 2007, the program evolved to include “bridge move” techniques.

The concept behind ABC bridge move techniques is quite different from the conventional method of demolishing all or part of an existing bridge and then constructing a new bridge in its place. A bridge move involves constructing a replacement bridge on a site near the bridge to be replaced. Once completed, the old bridge is removed and the new bridge set into place. This reduces the impact to drivers from approximately two months of traffic delays per construction phase to a matter of hours.

UDOT’s bridge replacement project on State Route 66 over the Weber River incorporated an incentive/disincentive associated with the calculated user cost of a detour to the next bridge upstream. The contractor built the new bridge at a different location and then used bridge-jacking with rollers to move it to the bridge site, thus minimizing the bridge closure time.

MORE INFORMATION
ACCELERATED BRIDGE CONSTRUCTION IN UTAH
The theory behind Utah DOT’s (UDOT) accelerated bridge construction (ABC) program is that as the contracting community develops techniques and expertise in accelerated bridge construction, the additional costs of these alternative methods will decrease and road/bridge closure times will shrink, reducing the overall impact to the traveling public as compared to the more time-consuming methods of traditional bridge construction. ABC methods would then be determined by the right balance between construction costs and indirect costs such as user costs and improved safety.

UDOT awarded the first self-propelled modular transporter (SPMT) project in 2007. Since then, a total of 35 Utah bridges have been replaced using SPMT or bridge-jacking techniques. The projects were funded with traditional state and federal funds.
MOVING BRIDGES
Several accelerated bridge construction options are available to move a new bridge into place. Two of the options used by UDOT involve utilizing self-propelled modular transporters (SPMTs) and bridge-jacking (“transverse slide” in UDOT terminology). For both of these options, the new bridge is constructed on temporary abutments in a location that does not disrupt traffic flow, and new permanent abutments are constructed under the existing bridge. Once the new bridge is complete and the concrete has achieved its required strength, the old bridge is demolished and the replacement bridge is moved into place on the new abutments.

Using self-propelled modular transporters to move the new bridge into place generally requires that operators drive the transporters under the new bridge, lift the bridge off of the temporary abutments, drive it to the final location, and lower it onto the new permanent abutments. Constructing the bridge on top of the SPMTs would be costly due to the rental cost of the transporters — you'd have to rent the transporters for at least two additional months.

Lifting and lowering the bridge is accomplished with the transporters' hydraulic lift system. Additional specialty hydraulic jacks provided by the SPMT contractor can be used if additional lift is required.

The bridge-jacking process is accomplished by applying a horizontal force, either pushing or pulling, to move the bridge into place. Either Hilman Rollers (low-friction, high-capacity conveyors) or Teflon pads with lubricant are used as the interface between the new bridge and a skid track on the temporary and permanent abutments. With the rollers method, hydraulic jacks are used to lift the new bridge off the temporary abutment, with the rollers placed between the bridge and the skid track. The bridge is lowered onto the rollers and pulled or pushed into place on the new abutment. Hydraulic jacks are then used to lift the bridge, remove the rollers and track, and lower the bridge into its permanent position. For the Teflon pad method, the new bridge is constructed on elastomeric bearing pads on top of Teflon pads on a stainless-steel skid track. It is then pulled or pushed into place on the new abutment, and secured.

Of the two options, it generally costs less to use the bridge-jacking technique. UDOT estimates the cost-savings to be about 20%. However, the transporters have the logistical advantage — bridges can be constructed in a bridge staging area or in a “bridge farm” (large staging area where multiple bridges are constructed) and then moved long distances into place. Bridge-jacking, on the other hand, requires that the new bridge be constructed adjacent to the existing bridge. This brings about two major concerns as the bridge is being built over traffic: public safety and worker safety.

CONTRACTING ABC METHODS
Innovative contracting strategies such as design-build and construction manager/general contractor (CM/GC)
were helpful to UDOT’s ABC program when it first began, mainly because neither the engineers, contractors, nor UDOT had a lot of experience with accelerated bridge construction. These alternative project delivery methods allowed all parties to innovate solutions together in a holistic approach.

In 2007, UDOT used CM/GC to award the department’s first SPMT project, 4500 South over Interstate 215 in Salt Lake City. The project included construction of a single bridge that spans over both travel directions of I-215. The interstate was closed for 53 hours. The existing bridges were moved to a demolition staging area and the new bridges were moved into place via the transporters.

CM/GC contracting enabled engineers to interactively develop bridge design, permanent abutments, temporary bridge abutments, SPMT bridge travel paths, and bridge support elements with the contractor’s continuous input. At design completion, the contractor submitted a fixed price bid followed by negotiations with UDOT to achieve a target maximum price.

**TRAFFIC-REDUCING INCENTIVES/DISINCENTIVES**

In 2008, UDOT issued a request for proposals (RFP) for a design-build project along I-80 to replace four bridge decks at two interchanges in Parleys Canyon, Salt Lake City. The RFP encouraged, but did not require, the use of accelerated bridge construction techniques. Within the project limits, I-80 carries a significant volume of local and interstate trucking traffic. Due to the geography of the canyon, the closest detour route was assigned to Interstate I-84 — 40 miles away. The detour route would cause significant cost to roadway users in both additional vehicle miles traveled and user time delays.

To keep traffic delays to a minimum, UDOT developed an incentive/disincentive related to the closure of I-80. The DOT allowed the contractors two 24-hour closures of the interstate. The user cost disincentive, or deduction to the contractor’s price, of $2,500 was applied for every 15-minute increment in excess of the allowed time. The user cost incentive, or compensation to the contractor, of $640,000 maximum ($160,000 for each of the four bridge locations) was applied for any time less than the allotted 48 hours of closure time. This approach allowed the construction methods to be driven by the lowest overall cost when considering both construction and roadway user costs.

With the incentive/disincentive in mind, the contractor (Wadsworth Brothers), engineer (Stanley Consultants), and SPMT specialist (Mammoet) evaluated both the use of self-propelled modular transporters and traditional crossover detours. They determined that replacing the entire superstructure using the transporters was more economical than replacing the decks with traditional methods. The team won the project and removed and replaced the bridges in 37 hours over two weekends, beating the allowed closure time of 48 hours.

In the early years of the ABC program, UDOT mandated accelerated bridge construction. This, however, was the first project in Utah where the
contractor opted to use self-propelled modular transporters to remove/replace a bridge.

GAINING INDUSTRY ACCEPTANCE
During 2009, seven years after UDOT’s ABC program was launched, accelerated bridge construction methods gained traction with local contractors. For the following projects during that same year:

- UDOT advertised a bridge replacement on State Route 66 over the Weber River in Morgan, and incorporated an incentive/disincentive associated with the calculated user cost of a detour to the next bridge upstream. The selected contractor opted to use bridge-jacking to minimize the bridge closure time.
- UDOT issued a design-build RFP for another set of bridges to be constructed over the Weber River.

LESSONS LEARNED
Through trial and error, Utah DOT (UDOT) has developed the following best practices for implementing accelerated bridge construction (ABC) methods:

- **Get commitment from internal leadership.** UDOT’s leaders supported the decision to require ABC methods, even though they initially carried higher construction costs over traditional methods.
- **Get educated.** UDOT senior staff and local contractors participated in national and international ABC bridge scan tours to learn the tricks and pitfalls from other agencies that use accelerated bridge construction techniques.
- **Develop a business model, including a decision-making tool and program of work.** UDOT developed an ABC rating procedure and decision flow chart to identify the best opportunities to implement accelerated bridge construction methods. The rating procedure included ratings for traffic, detour time, bridge classification, user costs, economy of scale, use of typical details, safety, and railroad impacts. UDOT also developed a decision matrix to help evaluate indirect benefits of the ABC techniques. To access the decision-making procedures, go to http://go.hw.net/utahabc.
- **Seek funding for demonstration projects.** On Aug. 17, 2011, U.S. Transportation Secretary Ray LaHood announced that the Federal Highway Administration’s Highways for LIFE program awarded nearly $20 million in grants for 17 ABC projects in as many states. Highways for LIFE has also provided funding for SPMT demonstration projects for the Maryland State Highway Administration, Minnesota DOT, and Rhode Island DOT.
- **Implement standardization.** UDOT developed and is continuing to develop standard engineering practices through lessons learned. These include standard structure drawing and design approaches for the challenging aspects of precast elements (i.e., approach slab connection details).
- **Use innovative project-delivery methods.** Innovative contracting strategies such as design-build and construction manager/general contractor played a key role in development of the ABC program by allowing the engineers, the contractors, and UDOT to innovate solutions together in a holistic approach.
- **Educate and communicate with both the industry and the public.** UDOT leadership and the project teams developed aggressive public marketing campaigns to tout the substantial cost savings to the public.
- **Implement a lessons-learned program.** Perform program reviews, find program deficiencies, repair the identified deficiencies, review design decisions, and measure design assumptions versus reality.
On I-80, the old bridge was moved out via self-propelled modular transporters (SPMTs). To move the new bridge into place, operators drove the transporters under the new bridge, lifted the bridge off of the temporary abutments, drove it to the final location, and lowered it onto the new permanent abutments. Watch a slideshow of this process at www.pwmag.com.

The project called for a detour that would be inconvenient and costly to drivers. The RFP required that the interstate be limited to two 12-hour closures with a significant penalty based on user costs for extended closure. The selected low-price design-build contractor — Flatiron, with Stanley Consultants providing design — used bridge-jacking on rollers to meet the RFP requirements.

- UDOT issued a design-build RFP for the reconstruction of I-15 in Utah County, which included 10 interchanges and 63 bridges. The project allowed the design-builder to evaluate the cost-effectiveness of ABC methods while maintaining the required traffic constraints. The selected contractor constructed four bridges using self-propelled modular transporters. The remaining bridges were constructed using traditional methods, since the contractor was able to maintain the required maintenance of traffic and user costs by widening the existing bridges and pavement and shifting traffic to one side of the corridor.

**THE VALUE OF FAST-TRACK CONSTRUCTION**

Due to the nature of low-price and best-value (design-build) bidding, there’s minimal data showing the actual bid difference between traditional versus accelerated bridge construction when considering all of the indirect cost benefits. And since UDOT implemented the ABC program in 2002, only one project was competitively bid with contractors bidding different approaches:

- **I-80 Mt. Delle to Lambs Canyon, Salt Lake City**
  - **(including incentive/disincentive)**
  - **Low bid, SPMT — $9 million**
  - **Second lowest bid, traditional construction — $10.5 million**

But as demonstrated by the projects mentioned in this article, UDOT has been able to use ABC methods to:

- Reduce traffic congestion during construction
- Speed up delivery of design and construction
- Minimize road user costs associated with traffic delays
- Encourage innovation
- Incite competitive pricing
- Improve worker safety, and safety to the traveling public, by moving bridge construction away from road traffic and reducing traffic impacts.

The U.S. DOT Federal Highway Administration website touts UDOT as one of the forerunners in embracing accelerated bridge construction techniques: “By accelerating project delivery, UDOT has gained trust from political representatives and praise from the community.

For Utah, ABC is a means to meet the goal of providing the best value to both roadway users and the general public.”

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