An Owner’s Perspective on Implementing an Accelerated Bridge Construction Program

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ABSTRACT

The Utah Department of Transportation has successfully implemented prefabricated bridge systems and accelerated bridge construction on 80 bridges utilizing different elements and technologies from full-depth prefabricated precast concrete deck panels, prefabricated precast concrete bent caps, total superstructure systems, self-propelled modular transport practice, and temporary bridge use. This presentation discusses the organizational lessons learned from implementing an Accelerated Bridge Construction Program.

Key words: accelerated bridge construction—precast—prefabricated bridge systems
ACCELERATED BRIDGE CONSTRUCTION PROGRAM

The Utah Department of Transportation (UDOT) first implemented prefabricated bridge systems (PBS) and accelerated bridge construction (ABC) in 2002. Since then, Utah has completed 80 bridges utilizing different elements and technologies of PBS and ABC that cover the range of full-depth prefabricated precast concrete deck panels, prefabricated precast concrete bent caps, total superstructure systems, self propelled modular transport (SPMT) practice, and temporary bridge use.

The goal of all of these innovations is the same—to find a way to replace or fabricate a bridge in an extremely short time. The purpose of these innovations is to shorten the time that bridges and construction projects are closed to the traveling public. The promise of ABC is that it creates construction closure times that are shorter than with traditional construction methods. The pinnacle of ABC methods involves using SPMTs and removing and replacing old or damaged structures in a matter of hours. This is a significant time savings compared to weeks, or even months, of closure called for by traditional methods.

The nature of construction has evolved. For the past 70 years, construction has involved building the Interstate and highway system where infrastructure did not exist. Construction included building roadways and bridges with new alignments and new sections in which limited impacts to the surrounding area and traveling public existed. Today, very little new or greenfield Interstate and roadway systems are being constructed. Projects involve roadway and bridge rehabilitations and the widening of existing systems. Unlike yesteryear, today’s projects impact the surrounding areas and traveling public tremendously.

With the new environment of construction projects, conventional construction techniques have reached their limit for decreasing user delays. The need to accelerate construction activities is imminent and the use of ABC meets this need. In most urban reconstruction projects, bridge construction is on the critical path. Using ABC methods provides the ability to remove bridge construction from the critical path in projects.

Traditionally, construction contracts in our industry are awarded to low bid. This business model worked extremely well when new roadway systems were being constructed with limited impacts to the surrounding areas and traveling public. This business model was used to build the U.S. Interstate system and thousands of miles of the secondary system. It was an extremely powerful economic tool and saved the country millions, if not billions, of dollars. The idea is a simple one—allow a contractor to elect a time and a method for completing a project and submit a bid. The process encourages several contractors to submit competing bids, and through the process, the lowest cost bid is selected. Ironclad contracts and specifications that the low-bid contractor signs are written, and the contractor proceeds to build the project. The result was wildly successful, and the mobility the Interstate system provides has made the United States an economic giant. This business model has served our industry and this country well.

Figure 1 shows the cost of a typical construction project. As owners or contractors experience changes to the specified construction schedule due to increased resource needs or lost opportunity costs, the cost of the project usually increases. Many a battle has been had over who pays for these increased costs and who is responsible. The lesson was that if the construction project schedule changes, an increased cost is incurred by one or more parties involved.
Today there are far fewer greenfield projects than in the past. There are very few transportation projects built that do not impact current users. The luxury of allowing a contractor to choose a schedule does not exist. Today’s projects have enormous impacts, especially to the traveling public. Because of these costs, today’s owners are under tremendous pressures to limit project durations. Figure 2 shows that user delays in work zones, which are a business cost to the public, increase linearly. These user delays also affect the economy of the area around the work zone—sometimes profoundly. As user costs mount, the pressures to decrease project durations increase. The steepness of the graph and the increased pressures on construction schedules depend on the volume of user traffic. The reality of today’s projects is that user cost increases are directly related to an increase in construction duration.
As owners are experiencing pressures to limit or decrease construction durations, it is time to start thinking about a different business model that considers user costs as part of project costs. The first attempts to accelerate construction have led owners to provide incentives and disincentives to contractors around project delivery time. This new business model is just an extension of the logic that it is worth money to owners and to the public to decrease project impacts. The new paradigm requires owners to look at projects differently; user costs are now included when calculating project costs. Adding the two previous graphs together produces a total project cost curve that incorporates user costs, as shown in Figure 3. The low point on the project cost curve is the lowest project cost considering society costs and a compressed timeframe.

![Figure 3. Project cost curve](image)

As shown, the total cost includes more than just the lowest construction cost used in the traditional method of construction projects. As user delays decrease, positive public perception of the department skyrockets. Savvy owners are willing to pay a little more for construction costs to shorten the impacts to the traveling public and decrease construction delays. As transportation departments continue to embrace this model and deliver projects on time and within budget, they gain public praise and political capital. This new business model is the mind frame of the future.

As with the introduction of any new technology or method, it has taken time and increased project costs to initially implement these ideas. Figure 4 shows that any new method typically costs more than traditional methods at first. Over time, the costs become less as familiarity with the new method increases. Proven innovative technologies have the potential to be less costly than traditional methods in the long run.

While owners’ first efforts to apply these techniques cost more than traditional methods, the time savings to road closures shows promise. For the initial projects that used PBS, UDOT paid a premium; however, UDOT was willing to absorb more upfront costs because there was the possibility of long-term tremendous economic benefit. UDOT’s initial projects have shown that the time savings to users would yield positive cost-benefit ratios if applied to the correct set of projects. Subsequent PBS projects have shown decreases in unit costs for prefabricated elements as the industry has gained experience and confidence with these methods.
As more projects use innovative technologies and as experience is gained, the cost of the projects will decrease, as represented in Figure 4. In the case of PBS, the promise that manufacturing prefabricated elements can be less expensive than cast-in-place can be proven by looking at examples from our industry and other industries. Consider precast beams as an example, which have proven to be far more economical and of higher quality than cast-in-place beams for transportation projects. Other construction industries, such as high-rise parking garage structures, have been using prefabrication as a way to speed project delivery and decrease construction costs for years. As the costs of ABC gravitate towards a minimum, project costs will decrease and bridges will less likely be a critical path item in a construction schedule.

![Figure 4. Innovative methods learning curve](image)

**Figure 4. Innovative methods learning curve**

**BENEFITS AND CHALLENGES**

In addition to the benefits that ABC can bring to schedule and to agency reputation, there are other benefits to implementing ABC, including increased safety and increased quality.

Safety benefits are realized in several areas of projects as owners implement ABC. Most of the benefits are associated with limiting work zone impacts to users. As user time spent in work zones decreases, the risks of accidents decrease. There are less user accidents because there are less user impacts on the projects. The second safety benefit relates to construction workers. Construction zones are generally already hazardous; the addition of constructing projects under live traffic has proven to be more deadly. By implementing ABC, the construction worker is exposed to less construction time in live traffic.

The quality ramifications of prefabrication are undeniable. The industry has known for years the effects of cure times and mix designs on the durability of concrete. Our industry has continually pushed those limits as a way to decrease construction duration and limit user delays. Additionally, site casting has many documented construction quality challenges, such as temperature changes, traffic vibrations, workmanship, and consistency issues. The use of prefabricated elements allows better cure times, more durable mix designs, and the advantages of a controlled manufacturing environment.
UDOT has faced several other challenges in the drive to implement ABC in projects. Some of the issues being addressed include

- Overcoming the reluctance of agency leadership to support ABC
- Overcoming the organizational barriers and building process to support ABC
- Gaining concurrence from the local industry—consultants, contractors, supplier, and internal staff

To implement ABC, UDOT needed the confidence and support of its senior leaders. UDOT was careful in the choice of projects and techniques to implement. UDOT leadership has been extremely supportive of finding ways to shorten project delivery times and implementing experimental projects that have been attempted and proven elsewhere. UDOT’s Project Development mantra is that they look for ideas on the leading edge, not the bleeding edge. The reluctance of agency leadership to embrace ABC has diminished over time as successful projects have been completed.

Institutional hurdles also had to be overcome. UDOT middle management, the institutional process, policies, procedures, and attitudes had to be addressed. The strategies to sell experimental projects that are successful have worked with the balance of the organization. The Bridge Division has developed into champions of ABC, is working to become experts in its applications, and has adopted the idea that all projects are considered for implementing ABC methods first and lapses to traditional methods only if the project cannot benefit from decreased schedules.

UDOT also faces the challenge of leading industry, contractors, and consultants to ABC. All of the projects that UDOT produces are a collaboration of UDOT with the business industry. The industry needs to understand what ABC can bring to project delivery. This group also needs to understand the business reasons and the business opportunities represented by changing from traditional methods. The strategies represented by demonstration projects are great, but the effort to excite business that was most successful was to invite the industry on scanning tours. UDOT hosted the local industry on several tours to see innovative ABC projects in New York, New Jersey, Louisiana, and Florida. These opportunities allowed business to see, touch and feel projects, and more importantly, to talk to business people who had already implemented ABC. These were people who could provide information and lessons learned. UDOT will continue to educate, nurture understanding, and support ABC with our home state transportation industry. UDOT cannot implement ABC without the buy-in and support of contractors and consultants.

To address the issues being faced, UDOT took an active role in seeing the ABC initiative advanced. UDOT is a small department of transportation from a small state but has a national reputation for innovation and a willingness to try new things. The journey to embrace ABC began many years ago as Utah began experiencing the shift from building new roads on new alignments to rehabilitating and improving existing roads. UDOT began dabbling in A+B contracting and Incentive/Disincentive contracting as a way to decrease user delays and user costs. UDOT began by placing time constraints for project completion on projects to limit impacts to the surrounding areas and to the traveling public. UDOT initiated the use of A+B contracting in which the contractor specifies a project duration and cost. Incentives and disincentives were added to contracts. As the project schedules decreased, the quality of construction using traditional methods became a concern.

In the 90s, UDOT had another reason to accelerate project delivery as Utah prepared for the 2002 Olympics and reconstructed 17 miles of I-15 in Salt Lake City. The $1.6 billion dollar design-build contract brought to bear another tool to accelerate project delivery. This contract was the largest in the United States at that time and was the first time UDOT had used this innovative contracting method. One of the innovations in the project was ABC. The contractor chose the use of half-depth precast concrete deck panels as a way to shorten construction time, increase quality, and lesson the strain on the labor pool.
for skilled labor. The project was completed on time and under budget, and the innovation led UDOT to begin trying a series of PBS and ABC construction techniques. The most recent ABC project used SPMTs and replaced a bridge over I-215 in Salt Lake City during a weekend closure.

LESSONS LEARNED AND BEST PRACTICES FROM IMPLEMENTATION

- **OBTAIN FUNDING FOR DEMONSTRATION PROJECTS**—Innovative Bridge Research Development (IBRD) and Highways for Life (HFL) funding provided significant funding for UDOT to jumpstart demonstration projects.
- **EDUCATE AND COMMUNICATE WITH THE INDUSTRY**—The idea that departments of transportation engage industry with presentations, workshops, and even simple discussions of ABC as a program and intent drives the ABC technology forward.
- **PERFORM SCANNING TOURS**—Several scanning tours were organized for UDOT directors, designers, managers, consultants, and contractors to gain support for this initiative. UDOT developed a flowchart for implementing ABC and met with the Utah Associated General Contractors (AGC) to gather input and to gain support for the program.
- **APPLY SYNERGY OF INNOVATIVE CONTRACTING WITH ABC**—With the use of ABC in projects, UDOT has found that the use of innovative contracting methods like design-build (DB) and construction management general contractor (CMGC) complement these technologies. UDOT and the Utah AGC have successfully applied innovative design and construction methods to deliver projects with very short delivery times. The collaboration between the industry and UDOT that these methods foster has advanced ABC implementation.
- **USE DECISION SUPPORT TOOLS FOR ABC METHODS**—UDOT has started developing a program that will apply the right ABC tool and project delivery method to specific projects. An ABC Decision Chart was created to help project managers plan projects adequately at the concept level.
- **IMPLEMENT STANDARDIZATION**—ABC Standard Drawing and Specification development has started for full-depth precast concrete bridge decks and the use of SPMTs. Future standards will be created for additional bridge superstructure and substructure elements. Building contractor expertise and the industry infrastructure to support the use of ABC is a priority for UDOT.
- **IDENTIFY A PROGRAM OF PROJECTS**—Identify a program of projects that will help industry understand the size of the business opportunity represented by ABC projects.
- **GET INVOLVED NATIONALLY**—The American Association of State Highway and Transportation Officials (AASHTO), Technology Implementation Group (TIG), and Transportation Research Board (TRB) are working on improving ABC. Literature, design guides, best practices manuals, and technical support are available to help states engage in ABC.

SUMMARY

ABC is a partnership between the owner, design industry, and construction industry. To transition from traditional methods of contracting requires the buy-in and support of all parties. UDOT is promoting the use of ABC at all levels. Programmatically, UDOT will use the agency and industry momentum to get over the hurdles involved with the use of ABC. UDOT is changing the way they think about how they evaluate costs and benefits of projects to justify and move forward with these new concepts. The exciting promise of ABC is that as more projects are completed and the engineering and construction industry knowledge increases, ABC will cost the same, if not less, than traditional construction methods and user delays and costs will be minimized.