UTAH'S MOVE TO ACCELERATED BRIDGE CONSTRUCTION AS STANDARD PRACTICE

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ABSTRACT

The Utah Department of Transportation (UDOT) has initiated a structured approach to making Accelerated Bridge Construction (ABC) its standard practice. UDOT has constructed a number of bridges with prefabricated elements and systems and developed a decision chart to determine when ABC is needed. UDOT used this experience to draft its first two ABC standards and hosted a workshop with FHWA that brought national experts and local industry together to provide recommendations for the standards and identify the next steps. This workshop was followed by a local industry meeting to get additional feedback on the draft ABC standard specifications before updating and incorporating them into upcoming projects. A request for proposals and contract award continued the process of ABC standards development. This paper describes the structured approach and lessons learned to date. The cost results of the move to ABC and the public and industry response are also discussed.

Keywords:
Accelerated Bridge Construction (ABC), Bridge Replacement, Minimized Traffic Disruption, Construction Manager/General Contractor (CMCG) Methods, Prefabricated Bridge Elements and Systems (PBES), Self-Propelled Modular Transporters (SPMT), Utah Department of Transportation (UDOT)

INTRODUCTION

"Quality Transportation Today, Better Transportation Tomorrow"[1] is the mission statement for UDOT. Obtaining better transportation tomorrow is a challenge for Utah, which experienced a 47 percent increase in population between 1990 and 2007[2]. Vehicle miles traveled increased 71 percent during that same time period while an additional four percent capacity was added to the highway system. Estimates for 2010 include a 61 percent increase in population, a 99 percent increase in vehicle miles traveled, with an increase in highway capacity of only five percent. UDOT's strategic goals, known as the "Final Four," address these challenges. The goals focus on taking care of the existing system, making the system work better, improving safety, and increasing capacity.

Improving safety in work zones is not only a Utah priority, it is a national priority that receives more attention as the nation's aging transportation infrastructure requires increasing rehabilitation which increases the required number of work zones which impacts traffic flow. Approximately 1,000 people are killed in vehicle crashes in work zones across the nation each year. Drivers or occupants account for 85 percent of those killed in work zones, and almost 25 percent of the crashes involve large trucks[3]. About half the fatal work-zone crashes occur during the day and fatal work-zone crashes occur twice as often on weekdays as weekends[3]. The majority of vehicle-related incidents in which a construction worker was killed in the work zone involved a motorist leaving the traffic lane and striking the worker in the work space[4]. Over 40,000 people are injured each year in work-zone vehicle crashes[3] in addition to work-zone fatalities.

ABC can improve these statistics by decreasing onsite construction time and decreasing exposure time in the work zone. One initiative UDOT has undertaken to take care of its existing system and improve safety is a transition to ABC as standard practice. The goals of taking care of the existing system, making the system work better, and improving safety include reducing the construction impact on users as they travel through work zones by working off-peak hours for shorter durations. Side benefits of this initiative are improved constructability and quality assurance. Bridge spans are constructed in adjacent sites, away from traffic, and concurrent with onsite earthwork and foundation construction.

UDOT is taking a structured approach in the implementation of this initiative. A number of bridges were constructed with prefabricated elements and systems and a decision chart was developed to determine when ABC is needed. Two standards were then drafted for Full-Depth Precast Concrete Deck Panels and Self-Propelled Modular Transporters (SPMTs) to move bridges. UDOT and FHWA hosted a workshop in early 2008 for national experts and local industry to provide recommendations. This workshop was followed by a local industry meeting to obtain additional feedback on the draft ABC standards before updating and incorporating them into upcoming projects. A request for proposals and contract award continued the process.

ABC DEFINED

UDOT defines ABC as a family of products that include a variety of prefabricated elements and systems that are build offsite, away from traffic, and transported to the site and quickly installed. Prefabricated elements include full-depth deck panels, steel and prestressed girders, bent caps, columns, footings, parapets, and approach slabs. Prefabricated systems include prefabricated superstructure spans that are driven, skidded, launched, pivoted, or lifted into place with SPMTs and installed with innovative construction equipment such as heavy lift cranes or strand jacks. ABC can be delivered in Utah through design-bid-build, design-build, or construction manager/general contractor (CMCG) methods and can include A+B bidding methods, lane rentals, incentives/disincentives, and total closures. UDOT partners with its design and construction industry from the start for optimum results that address the needs of the traveling public.

PAST ABC PROJECTS

UDOT's initiation into ABC began with the need to reconstruct Interstate 15 in time for the 2002 Winter Olympics. The entire 17-mile corridor was completed ahead of schedule, in four and a half years using a design-build approach. Prefabricated bridge elements included partial-depth precast prestressed concrete deck panels shown in Figure 1.

Figure 1 – First ABC Project: I-15 Design-Build

The panels served as stay-in-place deck forms to improve worker safety and construction efficiency. They also formed the bottom portion of the composite deck, significantly reducing the required cast-in-place deck concrete.

Subsequent ABC projects included six bridge deck replacements with full-depth precast deck panels. These projects used varying panel details and included the I-215 Bridge over 3900 South with longitudinally post-tensioned panels shown in Figure 2. UDOT continues to evaluate deck removal procedures and to date has not found an acceptable method to protect the existing composite connectors. Therefore, the connectors are removed as part of the deck removal process and new connectors attached by welding or drilling and epoxy methods.

Figure 2 – Post-Tensioned Deck: I-215 over 3900 South

The I-215 Bridge over 3760 South was replaced with a prefabricated precast-deck-on-steel-girders superstructure system that was moved into place with cranes as shown in Figure 3. The SR-150 Mirror Lake Highway Bridge deck was replaced with precast voided slabs.

Figure 3 – Superstructure System: I-215 over 3760 South

The Parrish Lane Bridge over I-15 was widened with precast concrete bent caps, shown in Figure 4 and full-depth precast deck panels.

Figure 4 – Precast Caps: Parrish Lane over I-15

The 4500 South Bridge over I-215 was UDOT's first totally prefabricated superstructure. SPMTs removed the deteriorated existing spans and drove the new bridge section into position over a weekend. See Figures 5 and 6.

Figure 5 – Removal with SPMTs: 4500 S over I-215


Figure 6 – New Span on SPMTs: 4500 South over I-215

Over the summer 2008 UDOT has moved multiple superstructure spans with SPMTs and has implemented a system to measure, real time, strains/stresses and displacements in the spans and transmit to the web for monitoring during the moves.

DECISION CHART

FHWA developed the "Framework for Prefabricated Bridge Elements and Systems (PBES) Decision-Making"[5] to help bridge owners determine whether more extensive use of PBES will provide benefits for a bridge project. Figure 7 shows the decision framework. The first consideration is the need for rapid onsite construction. Other factors such as safety and environmental issues are considered and costs that may be less for PBES independent of the need for speed or other factors.

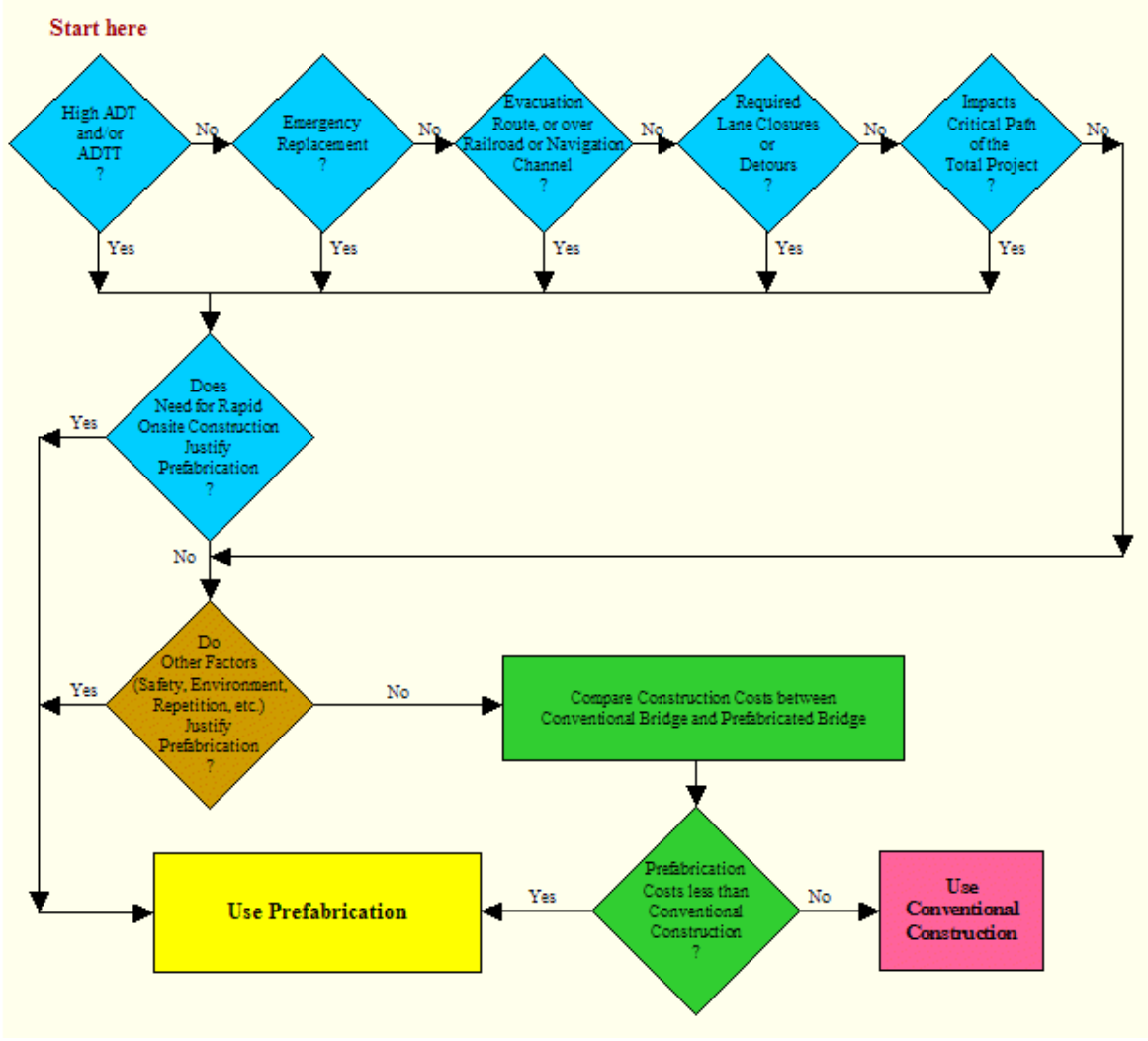

Figure 7 – FHWA Framework for PBES Decision-Making

UDOT used the FHWA decision framework to develop its own Decision Chart to incorporate ABC effectively and economically. The UDOT Decision Chart shown in Figure 8 includes the issues of most concern in Utah and quantifies them to be consistent with the needs for its projects. UDOT uses its Decision Chart in the planning stage to evaluate each bridge project to determine whether ABC is the best solution.

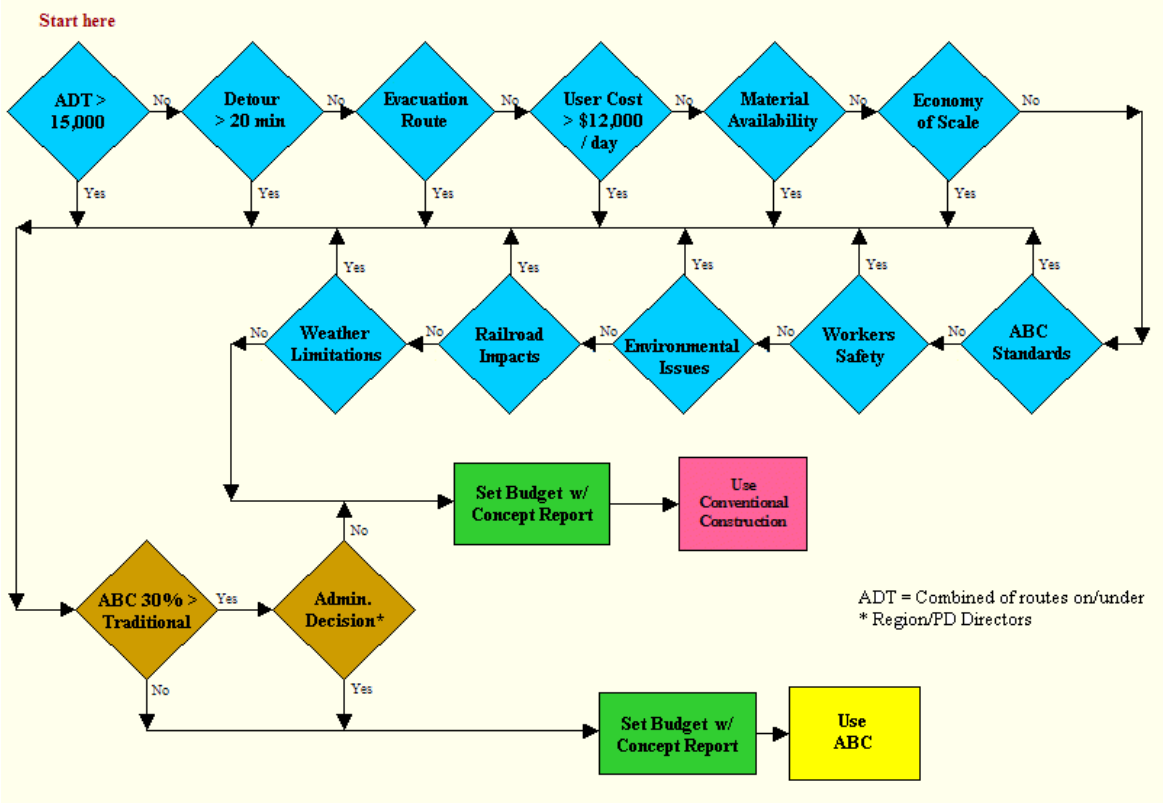

Figure 8 – UDOT Decision Chart

TWO ABC STANDARDS

The initial UDOT ABC projects used a variety of prefabrication details. UDOT standardized its ABC details to provide a more consistent product and improve efficiency for the local design and construction industry. UDOT selected full-depth precast concrete deck panels as one of its first two standard products because many of the past and upcoming rehabilitation projects involved replacing bridge decks. UDOT selected SPMTs to quickly remove and replace bridges as the second ABC standard products because of the short construction season and the need to avoid rush-hour traffic impacts during bridge replacement projects.

FULL-DEPTH PRECAST CONCRETE DECK PANEL STANDARDS

The design consultant team reviewed the full-depth deck panel details used on the last six UDOT bridge deck replacement projects and developed a draft set of precast deck panel standard drawings with an accompanying manual.

The draft drawings require the designer to complete and sign detail sheets specific to the bridge project and approve with the seal of a professional engineer licensed in the State of Utah. The drawings are used for straight bridges with parallel girders and skews up to 25 degrees. The maximum girder spacing is 12 feet for prestressed concrete panels and 10 feet for precast reinforced concrete panels. Draft standard drawings were developed

for general notes, general layouts, typical panel plan, precast reinforced concrete panel and pretensioned concrete panel reinforcing, longitudinal closure pour details, shear stud blockout details, miscellaneous panel details, weld tie and shear key panel connections, longitudinal post-tensioned panel connection, and parapet details.

STANDARDS FOR SPMT USE TO REMOVE AND INSTALL BRIDGES

The design consultant team developed draft standard drawings for the use of SPMTs to remove and install bridges with an accompanying manual. Span deflection and twist monitoring spreadsheets for as-cast, before and after lift, in transit, prior to setting, and after setting conditions were also included. These spreadsheets were developed to ensure relative deflections were within acceptable tolerance during the move.

NATIONAL WORKSHOP AND LOCAL INDUSTRY FEEDBACK MEETING

UDOT hosted a national workshop and a follow-on local industry feedback meeting to streamline the implementation process of its first two ABC standards and its transition to ABC as standard practice.

NATIONAL WORKSHOP

UDOT and FHWA hosted an invitation-only, one and a half day ABC Standards Workshop in January 2008. The workshop brought together bridge experts from Departments of Transportation, the design and construction industry, and academia both local and from across the country. The purpose of the workshop was to obtain input from both a national and a local perspective on the two draft standards and on transitioning to ABC as standard practice.

National experts gave presentations and UDOT presented details on its to-date ABC projects and ABC projects planned for the next few years. A presentation was then given on the draft full-depth deck panel products followed by participant discussions on this initial effort. Participants discussed how best to proceed in developing products for the use of SPMTs to remove and install bridges. A luncheon presentation on ABC considerations for seismic regions was followed with an academic panel discussing research on various aspects of ABC.

The participants were then divided into breakout session teams to identify opportunities and obstacles to UDOT ABC standard practice by 2010. The participants then came together to discuss, consolidate, and prioritize the identified opportunities and obstacles. They reconvened their breakout teams to develop recommendations to implement the top identified opportunities and address the top identified obstacles, again followed by a feedback session to consolidate and get group consensus. The second day began with the final breakout session to develop proposed UDOT 2008-2010 action plans to achieve ABC standard practice by 2010, incorporating the previous day's recommendations. The teams were asked to include the proposed activity, by whom, for whom, by when,

resources needed, and estimated budget. Participants again came together to discuss, consolidate, and prioritize the proposed action plans.

The top priority recommendations of workshop participants included using prefabricated components for the entire bridge, using complete bridge move-ins, standardizing a model for quantifying user costs, improving public relations and public involvement, and various recommendations related to developing standards. The workshop was documented in a report available on the UDOT website[6]. UDOT continues to consider participant recommendations in its initiative to make ABC standard practice.

LOCAL INDUSTRY FEEDBACK MEETING

The draft full-depth deck panel and SPMT products were updated per discussions at the national workshop. The updated drafts were mailed to local designers, fabricators, and contractors in advance of a one-day local industry feedback meeting. The purpose of the meeting was to give local industry the opportunity to provide additional feedback related to their use of these standards in upcoming projects. The meeting was well attended with good discussion. The feedback on the draft standards was as varied as the attendees involved, which included designers, fabricators and contractors as well as others. Comments ranged from acceptance to clarifying limits of applicability and improving constructability and details.

UPDATED ABC STANDARD SPECIFICATIONS

The draft full-depth deck panel and SPMT standards were finalized and posted on the UDOT website[7] following the local industry feedback meeting. The full-depth precast deck panel draft standard drawings in pdf and dgn formats are available for download with an accompanying manual. The draft standard drawings in dgn format for the use of SPMTs to move bridges with an accompanying spreadsheet for span deflection and twist monitoring in the as-cast, before and after lift, in transit, prior to setting, and after setting conditions are also available.

CURRENT ABC STANDARDS DEVELOPMENT

A contract was awarded in spring 2008 to develop the second round of ABC standards. Standard drawings and specifications to minimize repetitive design effort will be developed under the contract for precast pretensioned concrete girders and cast-in-place box culverts. ABC standard specifications and design aids will be developed for precast approach slabs, footings, columns, bent caps, and parapets. Prefabricated wildlife crossing structures will be developed and acceptable parameters for the removal of existing cast-in-place bridge decks.

UDOT will seek local industry input and buy-in for the new draft standards by holding an industry workshop as it did with its first two ABC standards to present the new draft

standards to local contractors, fabricators, and consultants and get their input. UDOT will evaluate input from the workshop and interact with local industry to refine the standards and finalize the standards after industry input prior to their use on upcoming projects.

UDOT will continue to incorporate lessons learned from construction of ABC projects. Ongoing feedback from designers, fabricators, and contractors will be assembled and this feedback and lessons learned will be used to refine the current standards for precast deck panels and the use of SPMTs to move bridges.

UDOT will continue to assess and implement strategies to enhance the ABC performance by accelerating other areas including project delivery to shortening the time from funded concept to final constructed project, decision-making during the design and construction phases, and construction of critical path, non-bridge parts of the project.

PUBLIC AND INDUSTRY RESPONSES

UDOT pays attention to the needs of the public by building bridges with minimal impact to their travel times through quality processes that minimize future maintenance needs. UDOT partners with local industries to ensure bridge projects that are successful for all stakeholders. The response has been positive from both the public and industry partners.

PUBLIC RESPONSE

The main reason UDOT is transitioning to ABC as standard practice is to reduce the impact of its increasing number of construction work zones on the traveling public. UDOT rated nearly 100 percent satisfaction with project results in a public opinion poll following the fall 2007 weekend I-215 closure for the replacement of the 4500 South Bridge.

INDUSTRY RESPONSE

UDOT has kept the local design and construction industry in the loop during development of ABC standards. Efficiencies are expected from the use of the ABC standards because past ABC projects have been constructed with a variety of prefabricated element details. The local industry understands the need to minimize traffic disruption and the benefits of standardization and has been an active partner in the transition to ABC as standard practice.

To date most bridge construction contractors on UDOT's ABC projects have been medium to large companies. However, a larger portion of the bridge work is typically prefabricated in ABC projects, and contractors may use a prefabrication subcontractor or prefabricate the components themselves. Such flexibility should encourage small bridge contractors to participate in these projects.

In addition to the state-owned bridge projects previously discussed, UDOT has initiated efforts to assist local governments in their use of prefabricated bridge systems. The first project of this type is a prefabricated superstructure replacement to be constructed this year on a two-lane, low-volume road.

COSTS

Historically projects have been awarded to the contractor with the lowest construction bid without consideration of transportation system user impacts because much of the work was new construction. Times have changed and much of the work required today is rehabilitating existing facilities while maintaining traffic flow. A new business model is needed that takes into account the cost of additional time that users must spend traversing construction work zones, detours, or sitting in traffic queues. This business model combines the construction cost curve with the user cost curve to obtain the total project cost curve with its lowest societal cost. UDOT uses this new business model to evaluate the total costs of its projects and as a result has received political capital and public praise.

UDOT is evaluating construction costs in addition to user costs for its ABC projects. UDOT incorporated a maximum 30 percent additional cost for ABC over conventional construction in its Decision Chart with the expectation that costs will decrease with the integration of ABC into standard practice. The 30-percent number is an estimated percentage of additional per bridge cost statewide that UDOT felt would allow a breaking point for costs not known at the conceptual phase of the project. This percentage includes initial start-up costs for developing the process at a programmatic level.

Both time and cost savings are anticipated using ABC. UDOT is now beginning to see cost reductions as the number of ABC projects increase in its transition to ABC as standard practice.

LESSONS LEARNED

UDOT has learned much to date as a result of its past ABC projects and its current initiative to transition to ABC. Becoming educated nationally and internationally through participation in conferences and domestic scanning tours is a priority to streamline implementation. Developing a business model is a key component including a decision tool and program of future work. Keeping track of costs is important. Seeking additional funds for demonstration projects will encourage use of innovative techniques because of the potential for improved processes without increased cost to existing budgets.

Standardized prefabrication details will streamline implementation by the industry and give them confidence that future projects will incorporate those details. Using innovative contracting strategies will encourage contractors to buy in to the owners' reduced onsite construction timelines. Education and communication internally, with industry, and with

the public will facilitate buy-in by all stakeholders and customers as they understand the goals and benefits of transitioning to ABC as standard practice.

CONCLUSIONS

Utah's aging bridge inventory and increasing travel volumes are the driving force behind the use of ABC. UDOT priorities are to reduce the impact of its increasing number of construction work zones on the traveling public, to increase safety of both the traveling public and construction crews in the work zone, and to increase quality and thereby extend the service life of its bridges. UDOT is also evaluating total societal costs of its projects. Much has been learned in the initial stages of its transition to ABC as standard practice.

ABC is the future of bridge construction in Utah and will continue to grow and improve as more ABC standards are developed and refined with lessons learned. UDOT values the public and its industry partners and will continue to work with them to address their needs. ABC as standard practice is helping UDOT achieve its mission of quality transportation today and better transportation tomorrow.

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