State of Accelerated Bridge Construction (ABC) in the United States

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State of the Accelerated Bridge Construction (ABC) in the United States

An Honors Thesis submitted in partial fulfillment of the requirements for Honors in Civil Engineering and Construction Management

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Under the mentorship of Dr. Junsuk Kang

ABSTRACT

The purpose of this project is to develop a toolkit for the design and construction of bridges using prefabricated materials primarily to reduce the closure time and on-site construction time of newly constructed bridges or bridges undergoing renovation. The research focuses specifically on short span bridges in Georgia (40, 60, 80, and 120ft spans).

Areas of primary concern for this project were design, constructability, structural analysis, the use of concrete and steel girders, cost efficiency, and industry surveys. In this particular portion of the study, the surveys proved to be most effective when combined with information obtained existing research as well as published project reports by contractors and DOTs. The surveys were created by the research team and included questions regarding the engineering entity’s experience with ABC, the level of acceptance of ABC techniques in their state, the number of completed projects in recent years, impediments to the use of ABC techniques, and the ongoing research on ABC topics in the entity’s state.

Constructability issues were given special attention, as they proved to be a major impediment to the use of ABC by other entity’s which remain reluctant. Lack of general experience also played a major role. The Georgia DOT seeks to employ ABC techniques in the future, so this project will help identify what is needed to begin designing projects that utilize ABC, what further research needs to be conducted, and which design details need more attention.

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April 2015
Department of Civil Engineering and Construction Management
University Honors Program
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ACKNOWLEDGEMENTS

A special thanks to the Georgia Southern Allen E. Paulson College of Civil Engineering and Information Technology and its Dean, Dr. Mohammad S. Davoud, Ph.D, P.E., as well as Dr. Mike Jackson, Ph.D, P.E., Chair of the department of Civil Engineering and Construction Management, for providing the opportunity to participate in this research, the Georgia Department of Transportation, as well as the Georgia Southern University Honors Program and its principals, Dr. Steven Engel and Dr. Francisco Desiderio, for approving the original thesis proposal and therefore allowing this study to get off the ground.
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1 - INTRODUCTION AND RESEARCH APPROACH

Accelerated bridge construction (ABC) encompasses the techniques used in the prefabrication of bridge sections to decrease the closure time required to construct or renovate a bridge. This study focuses on short span bridges, between 40 and 80 feet, for the state of Georgia. Special attention was given to various areas of ABC, generally regarding design, constructability, and analysis, and specifically regarding the use of concrete and steel girders, concrete-steel girders, prestressed concrete, as well as cost efficiency, success and error reports from other states’ completed projects, and industry surveys. Several specific case studies were conducted to evaluate the performance and design-to-finish process of a bridge which utilizes prefabricated modular systems.

ABC techniques have been performed in the past and are currently being investigated for more extensive use. Garver, an engineering consultancy out of Arkansas, details the process of a traverse slide, a bridge sliding technique used to replace a bridge superstructure. There is no one ABC technique in use in the United States. Instead, there is a family of ABC construction technologies that are in use that cover the majority of ABC projects. In construction, the foundation and wall element technologies are in the early stages of deployment, while others are mature and in use on a regular basis. The innovative contracting techniques work well with ABC, as well as other types of construction.

ABC is a bridge construction that uses innovative planning, design, materials, and construction methods in a safe and cost effective manner to reduce the onsite construction time that occurs when building new bridges or replacing and rehabilitating existing bridges.

ABC Improves:
- Site Constructability
- Total project delivery time
- Material quality and product durability
- Work-zone safety for the traveling commuters and contractor personnel

ABC Reduces:
- Traffic Impacts
- Onsite construction time
- Weather-related time delays

ABC can minimize:
- Environmental impacts
- Impacts to existing roadway alignment
- Utility relocations and right of way take

Commonly, ABC is employed to reduce the traffic impact since the safety and flow of public travel and the flow of transportation directly correspond to the onsite construction flow of the activities. There are other common and equally viable reasons to use ABC which range from site constructability issues to time management issues.

Conventional Bridge Construction, commonly referred to as cast-in-place (CIP) methods, is construction that does not focus on the reduction of onsite construction time. Conventional construction methods involve onsite activities that are time consuming and weather
dependent. Conventional construction includes onsite installation of bridge substructures and superstructures, placing reinforcing steel, and concrete placement, followed by concrete curing. Effectiveness of ABC is determined by two factors: onsite construction time and mobility impact time. Onsite construction time is the period of time from when a contractor alters the project site location until all construction related activity is removed. Some examples involved include maintenance of traffic items, construction materials on site, equipment, and workforce. Mobility impact time is any period of time the traffic flow of the commuters is reduced due to onsite construction activities. The fewer amount of disruptions, the better and least expensive.

The use of prefabricated bridge elements and systems (PBES) is one of the most crucial strategies employed to meet the objectives of ABC. PBES are structural components of a bridge that are built off-site. These elements help reduce the onsite construction time and commuter impact time that occurs from conventional construction methods. Combining PBES with the “Fast Track Contracting” method can create a high-performance and fast paced construction project. Components of PBES include, but are not limited to:

- Precast footings
- Precast wing walls
- Precast pile foundations
- Prefabricated caps and footings
- Prefabricated steel/concrete girder beams

The manual will encompass every step in the construction process from the foundation to the paving of the deck. It will also outline the construction process of the offsite prefabrication area, transportation of elements, and setting of the prefabricated bridge elements. Cost estimation comparisons with conventional bridge construction practices versus accelerated construction techniques will be included into the manual to give an idea of the cost outline.

A main objective in this project is creating a user friendly example design document and interactive design flowcharts with design aides such as MathCAD and SAP2000. Both steel and concrete girder design examples were developed, and modified to allow for easy understanding. The base design examples were taken from the SHRP 2 document “Innovative Bridge Designs for Rapid Renewal” (SHRP2 2013). Modifications were made to the original design document by using GDOT standard criteria for highway bridges, information obtained from a design example created by the Federal Highway Association, and the latest AASHTO LRFD Bridge Design Specifications, 6th Ed. (2012). All design examples in this project were created using MathCAD, which allows readers such as Georgia city or county engineers to easily follow the extensive procedures involved in ABC bridge design. Simplicity is stressed throughout the examples and even in the standard drawings in this project. The proposed ABC toolkit will provide guidelines to assist local governments and third-party designers in employing GDOT design standards for accelerated-built bridges.
2 - DOT SURVEYS

In the summer of 2014, a survey (SHRP2 2013) was sent out to various agencies in order to inquire as to their experience with ABC. The survey was open from May until August and was used to evaluate their successes and to find out what worked, as well as to evaluate their failures to find out what did not. This survey consisted of questions which gauged the experience of bridge owners. Their responses were noted in our research and state DOTs from all 50 states were contacted regarding their own ABC experiences via a more generalized 7-question essay put together by the Georgia Southern research team. They were asked questions specifically regarding:

- The amount of experience they have had with ABC in recent years and how many projects they have completed
- The general level of acceptance of ABC in their state
- Which agency generally engineers the projects to have components of ABC
- Which impediments, if any, are keeping these agencies from opting to use ABC techniques as opposed to traditional methods
- The availability of standardized elements and the benefit thereof
- The condition of ongoing or completed projects
- Current research regarding ABC

Results from our interviews were obtained from 40 of the 50 states, which were summarized in Appendix B. With the exception of Arkansas, Nebraska, and North Dakota, all of those states have completed ABC projects in recent years and ABC has become standard in Utah.

2.1 - Results

These results are summarized in the attached Appendices which feature a map of ABC experience by state and a table of survey results. The map in Appendix B displays only those states which explicitly reported how many projects had been completed.

Alabama:

The Alabama DOT has completed one project in the past 5 years. The level of acceptance of ABC within the state is low and contractors are doubtful about its use for typical bridges. However, they think ABC could be successful for long structures that require substantial repetition of elements. Alabama is currently involved in the research and testing of four systems of rapid deck replacement on structures in the northern region of the state.

Arkansas:

The Arkansas DOT has no active ABC program. Their perception is that ABC projects will be more expensive and thus counter to their desire for cost savings.

California:

Caltrans described several recent projects in which various ABC methods were employed. For The DOT indicates that meaningful incentives / disincentives greatly motivated
the contractor. There are several limitations that inhibit the greater use of accelerated
construction for Caltrans. These limitations include seismic concerns limiting their use of
precast pier elements, long term durability, and concerns about the ability to balance the
increase in construction costs for ABC projects against the user costs savings.

**Delaware:**

The Delaware DOT has completed less than 10 projects in the past 5 years. These
projects were all engineered to employ ABC techniques, so there is generally good acceptance
for innovation within the Delaware DOT. The DOT has been involved with projects which make
use of precast elements but is not currently conducting research on ABC.

**Florida:**

The Florida DOT has conducted multiple ABC projects in recent years, and though it is
not a standard practice, it is considered in every project. Florida has access to standardized
elements but contractors tend to avoid subcontracting work to precasters because they make
their profits from placing steel and concrete. FDOT does not mandate the use of ABC, but
rather leaves the decision up to the contractor. Each bridge projects has performance
specifications that the contractor must meet, but because the contractor is given more
responsibility in this method, there are uncertainties about contractor construction methods.

**Georgia:**

GDOT has completed one ABC project in recent years. The decision to use ABC
techniques is left up to the contractor, and GDOT does consider the standardization of
prefabricated elements a way to lower costs associated with ABC.

**Hawaii:**

Hawaii has been using ABC concepts since the introduction of precast-prestressed
concrete elements around 1959. However, based on the current definitions that qualify
projects to be “ABC”, Hawaii started utilizing ABC in 2001 with the use of adjacent slab beams
made of precast-prestressed concrete. Hawaii has completed over 20 projects since 2001. The
level of acceptance of ABC in the state is very high and it is reported that some ABC projects
presented a lower cost than cast-in-place projects. Government incentives would encourage
further use of ABC in the state, and though standardized elements are available, ABC is only
used when it proves to be economically beneficial. The use of precast elements for the
superstructure such as girders for longer spans or slab beams for shorter spans. These elements
save the contractor money in forming, shoring, and performing the stressing of tendons or
prestressing of strands in the field. These elements can also be fabricated ahead of time while
other field work is being done, thereby saving time.
Illinois:

Illinois has completed a several projects using ABC methods in recent years. Bridge projects undergo a “Bridge Planning State” during which ABC is evaluated based on site needs and cost versus benefit analyses. As with other DOTs, it is imagined that the standardized elements would be useful in curtailing ABC costs.

Indiana:

The Indiana DOT has completed two ABC projects in recent years which utilized the bridge slide technique. Projects are designed to utilize ABC techniques and it is imagined that the availability of standards would make ABC more efficient.

Iowa:

The Iowa DOT has extensive experience with ABC and has completed many ABC projects in recent years. There is good acceptance in the state and the DOT designs projects to be accelerated.

Kansas:

The Kansas DOT has used prefabricated materials, including precast concrete girders and precast deck panels, even before FHWA’s “Every Day Counts” initiative. Their first official ABC project was designed in August 2014 and let in November 2014. It is modeled after Iowa’s Keg Creek bridge project and will use a preinstalled foundation, precast columns, abutments, and pier caps, a conventional weathering steel rolled beam superstructure, and precast, full depth segmental deck sections post-tensioned together. Bridges are designed to employ ABC concepts in the design phase. Contractors can also request to utilize ABC with KDOT’s permission, and this would normally happen after the project is let. Kansas law prohibits delivery methods other than design-bid-build. The 2014 project only attracted one bid because of its high price. It will be relet in June 2015.

Louisiana:

The Louisiana Department of Transportation and Development has extensive experience with ABC methods, specifically using precast elements such as span and cap segments, as well as float-out, float-in construction to erect long span bridges over its many waterways. They have also used precast flat slab bridges for projects off the federal highway system. LDOTD reports that though these bridges do not provide the service life of their CIP counterparts, they are more easily constructed in remote areas. While soil conditions in the state preclude them from precasting longer girder spans, they feel that standardization would be possible for shorter span bridges. Often contractors request that crane mats be used on the top of the structure. Therefore, a standard element that takes into account crane loads would be ideal. The department plans to continue to use ABC techniques in the future.
Maine:
Maine DOT has completed several ABC projects in recent years. There is a high level of acceptance of ABC in Maine and it is believed that standardization of elements could help lower costs of precasting as it might encourage fabricators to invest in standard forms for bridge elements.

Maryland:
The Maryland DOT has completed several projects using ABC techniques in recent years and has not experienced any problems worth noting. The biggest hindrance to further use of ABC is the lack testing of techniques.

Massachusetts:
MassHighway has not completed any ABC projects but is interested in the implementation of pilot projects in order to build familiarity with ABC techniques. Availability of standardized elements would be useful as the need to develop custom details would be reduced and the problem of a lack of familiarity can be offset by learning what standardized elements have been successful in other locations.

Michigan:
Michigan DOT has some experience with ABC methods. It has completed projects that have been designed to utilize ABC concepts and projects that have been accelerated by the contractor. Standardization could make ABC methods more accessible to designers and would help contractors gain meaningful experience. This would help lower costs and improve quality in the long run.

Minnesota:
Minnesota has completed approximately 20 projects that have employed ABC techniques. There is a good level of acceptance in the state of ABC. The DOT designs projects to employ ABC in design-bid-build projects, but in design-build projects, ABC is proposed by the contractor and generally approved. VE proposals are also considered during construction. The standardization of elements would help, but not substantially. UHPC addresses the precast connection issue, but it is expensive and requires a high level of expertise on the behalf of the contractor and supplier. MnDOT is participating in an NCHRP project to help define tolerances for precast elements and design criteria for lateral slides and SPMT moves.

Mississippi:
For the Mississippi DOT, ABC is only applied selectively at this point and is reserved for emergency reconstruction or projects with special conditions such as emergency access or site
constraints. The DOT senior management must be convinced of the advantages of acceleration. MDOT would appreciate having a catalog of ideas to choose from as opposed to prescriptive standards when trying to decide how or whether to pursue an ABC project.

**Missouri:**

The Missouri DOT cited various examples of recent ABC deployment. These projects are substantially more expensive than the DOT’s conventional approaches but done with accelerated techniques due to traffic constraints. Their experience is that ABC significantly increases project expenses and must be used judiciously.

**Montana:**

Montana has not completed any ABC projects besides the Highway 89 Pondera County Marias River Crossing, which employed a GRS-IBS abutment system. This design included a wall radial edge as opposed to the more common straight edge design which, according to the DOT, was an on-site adjustment. The block required for the abutments are made to order and the manufacturer was not equipped to produce rounded edge blocks. Montana DOT is still researching GRS-IBS systems.

**Nebraska:**

Nebraska DOT has not used ABC methods on any complete projects, but there have been instances where bridge elements have been accelerated. There is not a perceived need for ABC in Nebraska, so it is not widely accepted and its applications have been limited. If ABC is to be utilized, the DOT will design the bridge in such a manner. However, contractors have used discretionary methods to accelerate construction such as using more man-hours. Standardization of elements is seen as a way to both lower costs and increase the quality and durability of finished bridge projects. Nebraska is currently researching the use of precast deck panels and the heavy lifting of remotely assembled superstructure modules.

**Nevada:**

The Nevada DOT has experience utilizing SPMTs as well as the bridge slide technique and precast arches. ABC is widely accepted when it is used for the right application, but the decision is left up to the contractor to use ABC or not to. NDOT has several projects that have involved the use of GRS-IBS abutments and fully prefabricated superstructures.

**New Hampshire:**

Although there have been projects that are noted as examples of ABC success, there seems to have been little follow-up to that project. In conversations with DOT staff, this particular issue was raised. The response was that there are simply not enough people at the agency interested in ABC as a project delivery tool. There are no questions about the
effectiveness of the project but just insufficient motivation to do it again. The University of New Hampshire continues to do research in the area but the DOT does not have the same level of interest. ABC is generally accepted, but when given the option, contractors in New Hampshire seem reluctant to utilize it. When considered feasible and appropriate, projects are engineered to make use of ABC techniques, rather than leaving the proposal to use ABC up to the contractor.

**New Jersey:**

The New Jersey DOT provided an extensive interview focused mainly on the issue of project and agency impediments. ABC has not taken hold because the DOT’s engineers and in particular, the project managers, do not think about it as a solution in many situations. This notion is related to their past practices and impediments established by other units within the DOT structure. The agency is generally risk averse and ABC raises the level of risk associated with a project. The level of risk needs to be shown to be manageable in order for the concept to gain traction. Therefore, there is currently no agency impetus for ABC. The DOT recognizes a need to study and update the user cost model and its application, but there is no mechanism to screen or choose projects for ABC and systematic approach is not in place.

**New Mexico:**

NMDOT has completed approximately 10 projects in recent years. ABC is moderately accepted in the state and it is assumed that standardization of elements would help. NMDOT completed several projects, specifically 2 which utilized a full depth precast deck panel system and 1 that utilized precast pier caps, abutment caps, and wingwalls.

**New York:**

The New York State DOT reports having completed at least 10 projects that employ ABC methods. The department also states that though ABC is the exception rather than the rule, more and more ABC techniques are gaining acceptance, especially downstate in the region around New York City. Generally, projects are designed to utilize ABC, but contractors do submit substitution proposals opting to use ABC methods. Standardization would be less effective because the most beneficial applications of standardization tend to be less standard, such as projects in urban areas. There were several pilot projects that were initiated which make use of ultra high performance concrete (UHPC) for joints between precast components, deck bulb tee beams for one bridge, and full depth precast deck panels for another. NYSDOT is involved with research for UHPC investigating fatigue in precast element joints.

**North Carolina:**

The North Carolina DOT has several recent ABC projects including the reconstruction of seven bridges on Ocracoke Island using 24-hr a day construction to replace the bridges in 90
days. The Washington Bypass project employs an innovative construction gantry allowing for complete construction of a new viaduct from the top without any intrusion into environmentally sensitive areas.

NCDOT has a project selection criteria for ABC projects. There has been discussion about the role of the Alternative Project Delivery Unit, a unit specifically set up to work on design-build projects, value engineering (VE) proposals, and alternative contracting mechanisms. They typically allow for innovation in several ways: as a proposal from the contractor in design build contracts, as an as-designed solution for special projects, and as a VE proposal. The DOT is currently exploring the use of MSE abutments as well as geosynthetic reinforced soil abutments (GRS-IBS) as a means of expediting foundation construction.

North Dakota:

North Dakota has not completed any ABC projects and there is a generally low level of acceptance of ABC in the state. The decision to use ABC is nonetheless left up to the contractor.

Oregon:

Oregon DOT has completed 8 projects in the past 5-10 years using ABC techniques. There is a high level of support for ABC in Oregon and there is a shift happening from contractor-employed ABC techniques to DOT-designed ABC projects.

Pennsylvania:

PennDOT has used precast elements and SPMTs several times over the past 5 years. ABC is considered in every project, but it is left up to the contractor to employ ABC techniques unless ABC has a clear advantage. In these cases, PennDOT will engineer projects to utilize ABC. It is believed that standardization will only provide limited improvement, as past efforts at standardization have not translated into profits for contractors. It is predicted that once ABC methods become more mainstream, costs and risks will decrease to the point where their continued use will be economical. PennDOT is not currently involved in the implementation of ABC methods to any projects, but is involved in research in structural details that could be applied to ABC in the future.

South Dakota:

South Dakota most recently completed an ABC project in 2001 using an SPMT to move a steel truss superstructure to its abutments. The bridge was spanning a railroad yard, so closures and outages had to be kept to a minimum. ABC is seen as favorable in South Dakota if the project conditions warrant its issue as with the formerly stated example. There is significant interest in using ABC methods to construct jointless decks of adequate length for little or no increased cost.
Tennessee:

The Tennessee DOT has made limited use of ABC techniques, having completed one project in recent years that incorporates ABC methods. ABC is always considered for bridge projects, but it is not often used. Standardized elements are considered to be useful for ABC within the state with proven installation and serviceability records.

Texas:

Texas has dabbled into ABC but the biggest hindrance to performing projects that utilize ABC is the ratio of incentives to disincentives. It was noted that low-bid contractors may not have the ability to perform ABC. The suggested solution is to consider selecting the contractor which offers the best value as opposed to the contractor that offers the lowest bid.

Project size is also an important consideration for ABC. Since most candidate bridges are either small or medium sized, contractors will not become efficient with the new methods employed on ABC projects during the short timeframe of an individual project. Additionally, precast components used for bridge substructures are only practical when lack of access makes the construction of CIP components difficult or when there is sufficient repetition. In the case of sufficient repetition, precast components are more economical and their construction is more efficient and quick. Proficiency can only be built through experience. Contractors would like to have a choice whether to use ABC or not to, so it would help to use the Florida approach and lay out requirements and specifications that need to be met.

Utah:

The Utah DOT has standardized the practice of ABC as of 2010. There is unanimous support at the senior management level for ABC and the project selection criterion used frequently leads to the conclusion of the use of ABC as opposed to traditional methods.

Presently, UDOT is delivering its ABC program through a combination of design-build contracts and a method known as Construction Manager/General Contractor (CM/GC), both of which have proven to be successful. At the same time they are developing ABC standards for modules such as deck panels, precast substructures, new prestressed beam sections and other details. These standards will give them increased flexibility to let contracts using various mechanisms and communicate their ABC intentions to the design and construction community. Once ABC standards become available for engineers to use in the creation of as-designed ABC bridge plans, they will explore the use of more conventional design-bid-build contracts. They believe that precast elements will offer an additional opportunity for cost savings in substructure construction.

During early phases of implementation, there was some additional reluctance from the contracting community. UDOT held a series of workshops and scan tours to help learn from other agency practices. Some contractors have made successful changes to their business practices to compete in the ABC arena while others are still holdouts. Successful contractors
have demonstrated a willingness to get into the precasting business. The projects let to date have demonstrated a 5:1 – 6:1 ratio of user costs saved to construction costs incurred. With repetition, costs have decreased. Recent bridge project lettings indicate that full depth precast decks are cost competitive and occasionally less expensive than traditional CIP concrete decks. There is a time and quality savings as well.

**Vermont:**

The Vermont DOT has a generally good acceptance of ABC and has completed at least 5 projects using ABC methods in recent years. Projects are typically engineered to utilize ABC, but Vermont is considering the Florida approach and allowing the contractor to decide whether or not to use ABC to meet design specifications laid out by the DOT. VDOT is investigating incentive/disincentive clauses to encourage the use of ABC by contractors.

**Washington:**

The state of Washington has completed various projects that have employed ABC methods in some form or fashion. These projects have been completed using traditional design-bid-build procurement with the redesigning of structures to accommodate ABC approaches. Projects have included complete bridge prefabrication as well as large scale prefabrication of superstructure and substructure elements. In general, the belief is that the use of prefabrication and ABC techniques did not have an effect on project quality but had a beneficial impact on project safety. WashDOT does not have a specific requirement to consider user impacts as project cost components, but they have used incentive/disincentive clauses to motivate the project completion.

**West Virginia:**

West Virginia has completed at least 5 projects in the past several years. It is generally accepted within the DOT and the completed projects were designed to utilize ABC. They were the result of incentive/disincentive clauses that were designed to motivate contractors to develop ABC approaches. An availability of ABC specifications for construction would benefit the DOT and there is interest in methods that minimize environmental disruption.

**Wisconsin:**

Wisconsin is just beginning to implement ABC practices. Its first project was a re-decking of a major structure with a full depth precast deck panel system. The level of support for ABC is not very high since the practice is so new to Wisconsin and is not well established. The DOT is funding research for precast substructure units and looking for opportunities for a demonstration project.

**Wyoming:**
Wyoming has completed several projects involving the use of precast elements and decked bulb-tees for country road bridges. There is generally a good level of acceptance for ABC in Wyoming and it is used where appropriate. There is interest in standardization, specifically in seeing the design standards that have been used by other states. This would lead to more designs utilizing ABC in Wyoming.

2.2 - Impediments

The impediments to ABC are widely noted, as many states cited the increased cost to be a major discouraging factor in choosing to use ABC.

Alabama:
Alabama is experiencing ABC impediments in manpower and elevated costs.

Arkansaw:
The Arkansaw DOT is primarily concerned with the elevated initial costs of ABC. Their belief is that ABC projects are more expensive and therefore counter their desire to save money. There are limited incentives to use ABC and there is no active program to utilize ABC.

California:
The limitations experienced by Caltrans in ABC utilization include seismic concerns for the use of precast pier elements, long term durability, and the elevated initial cost. It is widely noted that the cost of ABC exceeds the cost of CIP, though the time savings for ABC also exceed those of CIP. Caltrans considers time savings to be a secondary priority behind financial savings.

Delaware:
The Delaware DOT noted that higher initial costs were an impediment to further use of ABC. Also, work hours were longer for construction workers which posed a problem for contractors having to pay these workers.

Florida:
Though ABC has a generally high acceptance in Florida, many impediments have been noted. A lack of staging space for SPMTs has been an issue in highly urbanized areas. Also, contractors are inexperienced with ABC methods. During the design phase, site traffic constraints will need to be accounted for since traffic maintenance and phased construction has posed a problem of its own. Common to other state DOTs, the elevated cost is an issue and FDOT tries to balance out ABC costs with user costs.

Georgia:
GDOT is experiencing some of the same problems other states are in regards to the higher cost of ABC, but there is a growing interest in the utilization of ABC techniques.

Hawaii:
The only impediment Hawaii DOT is facing is the encouragement of governing agencies of the use of ABC for them. These agencies fail to consider factors such as the use of temporary detours to construct bridges which are being replaced or repaired. The use of ABC should be somewhat restricted, as ABC is not applicable for all bridge construction projects.

Illinois:
The main hindrance experienced by the Illinois DOT is the expectation of a higher cost for ABC and that the user costs are difficult to quantify.

Indiana:
The lack of overall knowledge and proper pricing methods serve to be impediments to the Indiana DOT.

Iowa:
There are several impediments to ABC in Iowa despite its high acceptance. There are low traffic volumes and contractors are reluctant to adopt ABC because of the perception that it is less profitable. Contractors also believe ABC is too complex and are discouraged by low incentives. Higher level management is supportive of the use of ABC wherever warranted, yet in some cases production level engineers find ABC design to be slow and frustrating. For this reason, it is believed that standard plans and shapes would ease the design process as well as save money from reuse.

Kansas:
The biggest obstacle to Kansas ABC is the cost difference between ABC methods and cast-in-place methods. Cast-in-place bridges have less joints and are therefore cheaper and easier to maintain in the long run.

Louisiana:
None reported.

Maine:
Cost is the biggest impediment to the use of ABC in Maine since it generally costs more to precast elements rather than to use CIP methods.
None reported.

Massachusetts:
The general lack of familiarity with ABC is a major impediment since MassHighway has not completed any projects. There is a conservative CIP culture among contractors, but it is believed that increased exposure through the completion of pilot projects will help overcome the tendency of contractors to use traditional methods. The hope is that more experience with ABC will diminish concerns about financial risks as well.

Michigan:
The main hindrances to ABC in Michigan are cost, constructability, and quality/performance issues. Life cycle cost analyses with accurate accounting of the benefit to the public would be useful for addressing higher costs. It is also believed that constructability and quality issues will be addressed by the experience of completing ABC projects in general.

Minnesota:
Contractors in Minnesota are concerned overall that the reduced timeframes on projects results in an overworked, fatigued staff. The elevated cost is also an issue. It is difficult to decide to use ABC methods when the decision is made late in the design phase.

Mississippi:
The Mississippi DOT is reluctant to use precast columns or footings because of concerns about connection durability and would welcome the development of durable connections for these precast elements. They also do not use integral abutments because of concern about approach slab connection details. MDOT has heard complaints from contractors about the diminished profitability of projects using large precast elements. This is a concern but perceived as more of a “political” issue than a true construction concern. The DOT expressed that in their opinion, many bridge construction projects are not on the critical path – the roadway elements drive the schedule. In this case they see a diminished value in acceleration. As a small state, they feel that a regional consensus is required for ABC to move forward since contractors and fabricators in their part of the country work in multiple states.

Missouri:
The Missouri DOT is concerned about seismic and durability issues and is working with local university partners for ABC assistance.

Montana:
The main impediment to ABC in Montana is the low traffic volume. There is growing interest in GRS-IBS systems, but the overall perception is that ABC is not needed at this point in time.

Nebraska:

ABC in Nebraska is primarily hindered by higher costs. Contractors are hesitant to use precast elements because of the amount of work that would subsequently get subcontracted. There are urban areas of Nebraska that would be associated with higher user delay costs, but the user costs of lower traffic roads and rural routes do not warrant the use of ABC.

Nevada:

The main concern the Nevada DOT has with ABC is the connection durability issues for seismic activity. There are also questions about the efficiency of ABC methods and elements.

New Hampshire:

The New Hampshire DOT indicated that there are not very many opportunities where acceleration appears justified. It was also reported that the Epping project, one of New Hampshire’s successful ABC projects, is 2.2 times as expensive as a conventional bridge replacement and that until the cost premium could come down to 0-25%, there would be some difficulties in promoting ABC. Contractors are hesitant as it involves the use of new technology and want to keep their own employees working rather than subcontracting work to precasters.

New Jersey:

When the DOT has tried to accelerate prior projects, their own construction engineering department has been reluctant to support the schedule. The schedules are frequently lengthened based on traditional practices and thus the DOT is unable to accelerate the project. It appears that the traffic operations staff has been an impediment to prior efforts. They have only allowed short closure windows which prolongs projects. The NJDOT incentive-disincentive opportunity on projects is tied to the computation of roadway user costs. The thought is that these costs are typically very low and do not justify acceleration as a strategy. Designers are reluctant to suggest innovative approaches because there is concern that the DOT PM will not accept such proposals. There is no incentive to be creative and state does not procure contracts requiring innovative design and construction solutions. There has been limited support from the FHWA engineers to support the State’s own initiatives to use prefabricated technologies or accelerated approaches.

New Mexico (Case Study):

According to the New Mexico DOT, ABC techniques are considered by NMDOT in every bridge project. Issues were noted on the 2013 Eagle Draw Bridge renovation on NM 13.
According to the report, the precast deck panels cost approximately 2.5 times the cost of cast-in-place (CIP) construction based on the bidder’s prices. The primary pay items for the precast deck panels were the prestressed, post-tensioned concrete, the 8.5 inch precast deck panels, and epoxy urethane overlay used to create a smooth driving surface and to seal the joints between panels. If the job was done using CIP methods, the primary pay items would have been the deck concrete in which the deck would have only been 8 inches, and epoxy coated rebar.

The project was NMDOT’s first full depth precast deck panel project. Fabricators, contractors, and designers had no prior experience with full depth precast deck panels. This was one of only two full depth precast deck panel projects constructed by NMDOT. There were 5 iterations of the shop drawings for the precast deck panels alone and it took 4 months for the drawings to be approved. There were twice the amount of shop drawings required for the precast deck panel than required for CIP construction.

There were also issues in fabrication. The bridge deck had a crown down the center of the bridge which meant that one panel could not be used across the entire bridge width. To remedy this issue, closure pours were used at the abutments, piers, and down the center of the bridge. This caused the exposed rebar from the deck panels to come in conjunction with the rebar from the closure pours. The rebar therefore had to be field bent to avoid the adjacent reinforcement and the shear studs at the prestressed girders.

The precast deck panels had to be moved transversely over the width of the bridge because the post-tensioning ducts were not lining up in adjacent panels. This uneven alignment was visibly noticeable along the edges of the deck. There were also problems with the precast girders making strength and this issue slowed the entire project since the girders had to be set up before the deck panels.

As far as construction is concerned, the contractor could only shut down NM 13 for 60 calendar days, but it could not be shut down until all precast elements were fabricated and accepted by the NMDOT. Fabrication took longer than expected, so the contractor decided to close NM 13 at their own risk. Fabrication was not complete after 60 days had passed, and the bridge was closed for over 120 days. The contractor was therefore assessed penalties.

**New York:**

Staging has presented itself as a problem for NYSDOT since the state is so heavily developed. Construction costs for ABC are also an impediment, specifically the use of precast, prefabricated elements and offsite construction using roll-in methods. There is also concern about the durability of precast component connections and joints. There is also resistance by local contractors to use extensive prefabrication because of the large project share that becomes subcontracted out to specialists.

**North Carolina:**
None reported.

North Dakota:
North Dakota DOT’s primary concern is the high cost of ABC. NDDOT is also concerned with connection details and is hindered by the low level of support of ABC in the state.

Oregon:
Oregon DOT noted that as well as the elevated initial costs, connections for seismic activity presented a major problem in ABC. Connections in seismic zones must withstand a much higher transverse loading as well as a dynamic, repetitive loading. Most of the common connections have not yet been tested under lab conditions simulating seismic forces. Once the testing is completed, peer reviewed, and reported, ODOT will have a higher confidence level that connections of precast columns, footings, and pier caps can safely withstand the high horizontal and vertical uplift common in seismic events.

Pennsylvania:
Contractors in Pennsylvania are considered an impediment since they are generally unwilling to assume the additional associated risks with ABC. They are inexperienced and therefore have to subcontract work which leads to inflated bids.

South Dakota:
South Dakota is another state with low traffic volumes, so user costs do not balance out the cost of ABC.

Tennessee:
Impediments that plague the Tennessee DOT in utilizing ABC are questions about durability and quality of precast members, and connection issues, specifically attaching precast bridge decks to beams.

Texas:
The funding structure in Texas provides no owner incentive to use rapid renewal methods other than staged construction. TxDOT districts are limited to using only 5% of the project cost for incentives. Also, no more than 25% of the road user delay costs may be used for incentives. Although road user costs are considered, the owner has no way of collecting any savings from these costs. Therefore, if additional funds are spent to reduce road user costs, fewer funds will be available for other projects. Federal grants to the owner based on the value of savings would help owners capture savings from user costs and serve as an incentive that would promote rapid construction projects.
When using incentives and disincentives, an effective incentive amount must be large enough to pay for additional construction crews, additional (and/or special) construction equipment needed to accelerate construction and still result in profit. As an alternate, consider milestones with no excuse bonuses. If the contractor is able to complete the construction without any excuses, then they are awarded a bonus. The contractor will most likely submit their bid assuming that they will not be awarded the bonus.

**Utah:**

During the beginning stages of the ABC program, there was a fair amount of internal resistance, similar to the comments received from New Jersey. Internal middle management was the biggest obstacle, particularly getting past the hurdle of conservativism. It was easier to convince consultants and designers as well as the contracting industry of the merits of ABC than it was to convince DOT staff. There was enough of a core willing to try new things in all parts of the business (DOT, consultant, contractor) that a decision was made to move ahead with trial project implementation.

Although the DOT has moved aggressively towards ABC implementation, they too believe there are some unanswered questions and areas of potential improvement, though they are generally technical issues related to their existing experiences and not implementation related. Their concerns include issues such as seismic detailing, design consideration for structures to be moved, acceptable deformation limits during movement, a need for better specifications and some additional concern about connection details and durability. These issues notwithstanding, the DOT is aggressively moving forward with ABC as a standard delivery mechanism.

**Vermont:**

Vermont does not experience high traffic volumes, so road user costs are often too small to create meaningful incentive/disincentive clauses in contracts that would encourage acceleration of projects. It would be helpful if there was a way to incorporate savings from ABC methods, such as the elimination of the need of temporary bridges, into the incentive/disincentive clauses.

**Washington:**

None reported.

**West Virginia:**

West Virginia contractors are inexperienced in ABC and there is not a precasting industry in the state. There is also a lack of heavy lift contractors. If there were standards for ABC, contractors would likely make use of them. Therefore, ABC specifications and sample contracts would prove useful.
Wisconsin:

Contractors are most concerned about making money when performing ABC techniques in a project. Training would be beneficial to better educate the construction community in Wisconsin.

Wyoming:

Wyoming does not have a high traffic problem, and with lower traffic counts, the main impediment to the implementation of ABC is the justification of the higher costs associated with ABC.

2.3 - Industrial Surveys

The research team contacted various contractors around the country who had experience with ABC. The primary concern was to discover what types of issues were encountered during the construction or design process and how these issues were resolved.

Results

Engineers at Hugh Boyle Engineering (HBE) reported some issues they have experienced in ABC. On design-bid-build projects, the biggest problem they have experienced is in modifying the original designer’s details to fit an alternate ABC option or to make the original ABC design easier to construct. It is normally unknown whether the owner and or original engineer will accept the HBE proposed revisions. For this reason, HBE prefers to do design-build projects.

HBE has observed ABC designs that try to emulate a traditional design as opposed to looking for alternative methods. For example, a bridge would be designed to utilize a lateral slide, yet its abutments would be designed to be fully integral because the owner desires to use a fully integral bridge. The easy solution to this issue is to design the system to be semi-integral. Design details should always be evaluated calling into question the necessity of a particular design concept. It is imperative that if an entity desires to endorse innovative construction, it has to learn to rethink concepts instead of settling for the traditional ways of building and designing.

Precast element connections are also a concern. One of the most common issues observed by HBE is in tolerances that are either too tight or not related to any functional requirements. Also, the recognition of the flexibility of bridges is lacking. Flexibility impacts how loads are transmitted to equipments or supports used to move the bridge. This can be a serious issue for SPMT moves where the hydraulic system needs to balance the loads from the structure.

HBE has also noticed a disconnect between acceptable tolerances and methods used to slide bridges. A specification may allow an elevation difference of up to 1/8" over 10’ of a slide slab. A system can be designed that could accommodate significantly more difference but there are also systems that need less tolerance. For example on most slides done by HBE, only two slide supports per abutment are used because they are determinant. If one support goes up a
little, the load on the support barely changes. The change is caused by a slight twisting of the structure between abutments and these systems can accommodate much more than 1/8" per 10'. But there are cases when designers use a series of very stiff rollers under relatively stiff superstructures that require much less than the 1/8" tolerance but they still used the original specs of 1/8". With more than 2 supports the system becomes indeterminate and roller reactions are very sensitive to the roller elevation. On these systems a 1/8" variance over 10 feet might cause the entire bridge to rock over the high point. Essentially putting all the load on a single point. This can be dangerous when it is assumed by the designer that the loads will be evenly distributed to 5 supports. Currently HBE is not actively working on any ABC projects. They currently have a lateral slides under contract, however the owners are considering cancelling due to budget constraints.

Another contractor, Mammoet Construction, does not design or build bridges. However they do specialize in moving modules with SPMTs primarily in the utilization of skid or traverse sliding. Transporters are installed underneath the bridge section being constructed and are moved away to the construction site where they are connected to the structure. Bridge engineers take into account the fact that the bridge will be driven away. It is also imperative to check the supports under the bridge to make sure they will not damage the bridge. Support locations are adjusted to correct for this issue.

Shown below are a couple of pictures of bridges that Mammoet has moved:
3 - Conclusion

In conclusion, accelerated bridge construction reduces the construction time of bridges drastically. Professionals have provided information about the applications of ABC, noting that it should not be chosen as a delivery method just for the sake of choosing it. It should be used where it makes the most sense, where it proves to be the best option, and where staging is available. The purpose of this project was to investigate the lessons learned by other states and use them to the benefit of the Georgia Department of Transportation and its development of a standardized toolkit for ABC.

There were several issues that were common to most states. Connection issues were common, specifically their durability. DOTs are worried about the strength and long term performance of UHPC in closure pours as well as pier-substructure joints. The elevated cost of ABC was also noted as a common issue, simply because it is a new technology and manufacturers are not fully equipped to produce the needed modules in mass. The mass production of these modules can not begin until there is some type of standardization, but until then, ABC must continue as is until the manufacturers catch up. Contractors are also inexperienced in the construction of bridges with these methods and are therefore reluctant to try. For this reason, pilot projects are constantly being sought out by states that are interested so that studies can advance and builders can gain experience in the field. Staging is another important issue for areas that are dense and urbanly developed, as New York reported. Space is needed to fit SPMTs into the construction area. More rural states report a low average daily traffic (ADT) and therefore have less of a need for rapid renewal of bridges.

The information gathered from these states proves that ABC can be beneficial under the right circumstances. Further research must go on to make sure GDOT is able to be placed in these circumstances with the right materials. Utah DOT reported that the high initial cost of bridges, which almost every other state DOT feared, dissipates as contractors and manufacturers gain more experience. Standardization is needed to be sure that these bridges are of equal or better quality than their CIP counterparts. For this reason, this research has been conducted alongside another GSU ABC team which specializes in the structural design and analysis of prefabricated bridges. Their research will show the structural efficiency of these bridges, resolve any problems or questions about constructability durability, and connection issues, and ultimately assist GDOT in creating their design standards. There is also a team working on the cost estimation aspect of ABC design and comparing it to CIP. This will help the research by delivering a cost breakdown and comparison to GDOT to allow them to see which items are carrying the majority of the price and how these financial issues can be improved upon in the most efficient manner.
For details on additional research please contact Dr. Junsuk Kang in the Georgia Southern College of Civil Engineering and Information Technology, Department of Civil Engineering and Construction Management.
## Appendix A: Table of Survey Results

<table>
<thead>
<tr>
<th>State</th>
<th>Past experience</th>
<th>Level of Acceptance</th>
<th>Engineered by DOT’s or Contractor</th>
<th>Impediments</th>
<th>Availability of Standardized elements</th>
<th>Ongoing or recent projects</th>
<th>Ongoing or recent research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>1 project in the past 5 years</td>
<td>Generally Low</td>
<td>Contractor</td>
<td>High cost, Low experience</td>
<td>N/A</td>
<td>None</td>
<td>four systems of rapid deck replacement on structures in the northern region of the state</td>
</tr>
<tr>
<td>Arkansas</td>
<td>None</td>
<td>Low</td>
<td>N/A</td>
<td>High Cost</td>
<td>N/A</td>
<td>N/A</td>
<td>None</td>
</tr>
<tr>
<td>California</td>
<td>8 projects in the past 5 years</td>
<td>High</td>
<td>DOT</td>
<td>Seismicity, suitable staging, cost, durability</td>
<td>Standardization would further encourage ABC</td>
<td>I-40 Marble Wash Bridge, Oakland Bay Bridge</td>
<td>seismic performance of precast elements</td>
</tr>
<tr>
<td>Delaware</td>
<td>Less than 10 in the past 5 years</td>
<td>Moderate</td>
<td>DOT</td>
<td>Higher costs, extended hours</td>
<td>N/A</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Florida</td>
<td>Yes, multiple projects in the past 5 years</td>
<td>Considered for every project</td>
<td>Contractor</td>
<td>Staging space, experience, traffic maintenance, higher costs</td>
<td>Elements are available</td>
<td>Graves Avenue Bridge (SPMT usage)</td>
<td>None</td>
</tr>
<tr>
<td>Georgia</td>
<td>Yes, 1 project in the past 5 years</td>
<td>Moderate</td>
<td>Contractor</td>
<td>Higher costs, extended hours</td>
<td>N/A</td>
<td>None</td>
<td>standardized prefabricated elements</td>
</tr>
<tr>
<td>Hawaii</td>
<td>20 projects since 2001</td>
<td>Very high acceptance, lower cost than cast in place methods</td>
<td>DOT</td>
<td>Government incentives</td>
<td>Elements are available</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Illinois</td>
<td>Multiple projects in the past 5 years</td>
<td>Low</td>
<td>DOT</td>
<td>Higher costs</td>
<td>N/A</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Indiana</td>
<td>2 projects</td>
<td>Low</td>
<td>DOT</td>
<td>Experience, higher cost</td>
<td>Availability of standards would make ABC easier</td>
<td>One unspecified project</td>
<td>None</td>
</tr>
<tr>
<td>Iowa</td>
<td>Multiple projects over the past 5 years</td>
<td>Moderate</td>
<td>DOT</td>
<td>Low demand, experience, higher cost</td>
<td>Prefabricated bridge elements used</td>
<td>I-92 Cass County Bridge, US 6 Keg Creek Bridge (completely prefabricated)</td>
<td>None</td>
</tr>
<tr>
<td>Kansas</td>
<td>1 project in the past 5 years</td>
<td>Low</td>
<td>DOT</td>
<td>Methods other than design-bid-build are prohibited by state law, higher cost</td>
<td>Kansas is reluctant to use standardized prefabricated elements</td>
<td>Project similar to Iowa’s Keg Creek project (completely prefabricated)</td>
<td>precast concrete bridge elements</td>
</tr>
<tr>
<td>Louisiana</td>
<td>Extensive experience with</td>
<td>High</td>
<td>DOT</td>
<td>Precast bridges have a shorter service life than</td>
<td>Common use of precast</td>
<td>Maree Michael Bridge and Creek Bridge</td>
<td>None</td>
</tr>
<tr>
<td>State</td>
<td>Description</td>
<td>Cost</td>
<td>Contractors</td>
<td>Quality Issues</td>
<td>Standardization Issues</td>
<td>Example</td>
<td></td>
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<tr>
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<td>-----------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Maine</td>
<td>Several projects over the past 5 years</td>
<td>High</td>
<td>DOT</td>
<td>Desired standardization for lower costs</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Maryland</td>
<td>Over 20 projects in the last 5-10 years</td>
<td>Moderate</td>
<td>Contractors</td>
<td>None</td>
<td>Standardization may help but ABC is employed where it makes sense</td>
<td>Prestressed slab deck replacement is routine</td>
<td>None</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>1 project completed in the past 5 years</td>
<td>Moderate</td>
<td>DOT</td>
<td>Experience</td>
<td>Desired to reduce customization</td>
<td>I-93 Fast 14 (Salem St, Boston)</td>
<td>None</td>
</tr>
<tr>
<td>Michigan</td>
<td>Some experience within the past couple of years</td>
<td>Moderate</td>
<td>Contractors</td>
<td>Cost, constructability, quality/performance issues</td>
<td>N/A</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Minnesota</td>
<td>20 various projects</td>
<td>Moderate</td>
<td>Contractors</td>
<td>Extended hours, decision making process</td>
<td>Full depth precast deck with superstructure lateral slide</td>
<td>NCHRP Project, determining tolerances for precast elements</td>
<td></td>
</tr>
<tr>
<td>Mississippi</td>
<td>Several reconstruction projects following Katrina</td>
<td>Low</td>
<td>DOT</td>
<td>Connection issues</td>
<td>Local fabricators would embrace new technologies if a commitment to a large number of projects was made</td>
<td>None</td>
<td>Joint and connection durability between precast elements</td>
</tr>
<tr>
<td>Missouri</td>
<td>Multiple ABC methods have been applied.</td>
<td>Moderate</td>
<td>DOT</td>
<td>High cost, seismic durability issues</td>
<td>MSE wall abutments</td>
<td>New Mississippi River Bridge Crossing (St. Louis)</td>
<td>Innovations in substructure construction</td>
</tr>
<tr>
<td>Montana</td>
<td>None</td>
<td>Growing</td>
<td>DOT</td>
<td>Low traffic volume</td>
<td>N/A</td>
<td>Highway 89 Pondera County South Fork/Dry Fork Marias River Crossing</td>
<td>GRS-IBS</td>
</tr>
<tr>
<td>Nebraska</td>
<td>None</td>
<td>Low</td>
<td>Contractor</td>
<td>Higher cost</td>
<td>Standardization is seen as a way to reduce costs and increase the quality and durability of finished projects</td>
<td>N/A</td>
<td>use of precast deck panels, heavy lifting of remotely assembled superstructure</td>
</tr>
<tr>
<td>Nevada</td>
<td>Experience utilizing SPMT, bridge slide</td>
<td>Moderate to High</td>
<td>Contractor</td>
<td>Questionable efficiency</td>
<td>Unspecified projects involving</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Projects Duration</td>
<td>Contract</td>
<td>Incentives</td>
<td>Precast Description</td>
<td>Additional Notes</td>
<td></td>
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</tr>
<tr>
<td>New Hampshire</td>
<td>Several completed projects</td>
<td>Low</td>
<td>Contractor</td>
<td>No real impediments</td>
<td>Extensive use of precast elements</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Connection issues</td>
<td>GRS-IBS abutments and fully prefabricated superstructure s</td>
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<td></td>
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<td></td>
<td></td>
<td>Main Street Bridge (Epping, NH)</td>
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<td>Unspecified research being conducted at the University of New Hampshire</td>
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</tr>
<tr>
<td>New Jersey</td>
<td>Many projects over the past 5 years</td>
<td>Moderate</td>
<td>DOT</td>
<td>Incentives</td>
<td>Precast elements used</td>
<td></td>
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<td></td>
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<td></td>
<td>Route 70 bridge over the Manasquan River,</td>
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</tr>
<tr>
<td>New Mexico</td>
<td>10 projects in the past 5 to 10 years</td>
<td>Moderate</td>
<td>DOT</td>
<td>Higher cost, experience, lack of construction personnel</td>
<td>Standardization would help</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>2 projects that utilized full depth precast deck panels, 1 project that</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>utilizes precast pier caps, abutment caps, and wingwalls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td>10 total projects</td>
<td>Moderate</td>
<td>DOT</td>
<td>Higher costs, staging areas</td>
<td>Precast elements used</td>
<td></td>
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<td></td>
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<td></td>
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<td>Van Wyck Expressway on Long Island</td>
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<td></td>
<td></td>
<td>UHPC research for fatigue in precast element joints</td>
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</tr>
<tr>
<td>North Carolina</td>
<td>Several projects over the past couple of years</td>
<td>Moderate</td>
<td>DOT</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Washington Bypass Project</td>
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</tr>
<tr>
<td>North Dakota</td>
<td>None</td>
<td>Low</td>
<td>Contractor</td>
<td>High cost, connection issues</td>
<td>Standardization may help</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>None</td>
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<td></td>
<td></td>
<td>Very little (topics unspecified)</td>
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</tr>
<tr>
<td>Oregon</td>
<td>8 projects in the past couple of years</td>
<td>High</td>
<td>DOT</td>
<td>High cost, seismic connections</td>
<td>N/A</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>UHPC for connections of full depth deck panels</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>None</td>
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</tr>
<tr>
<td>Pennsylvania</td>
<td>Several projects over the past 5 years</td>
<td>Moderate</td>
<td>Contractor</td>
<td>High Risk, experience</td>
<td>Yes, used precast elements and launching using SPMTs</td>
<td></td>
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<td></td>
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<td></td>
<td>Structural details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Dakota</td>
<td>Yes</td>
<td>High</td>
<td></td>
<td>Low demand, higher cost</td>
<td>2001 project over a railroad yard</td>
<td></td>
<td></td>
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<td></td>
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<td>Construction of jointless decks without increasing cost significantly or at all</td>
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</tr>
<tr>
<td>Tennessee</td>
<td>1 project in the past 5 years</td>
<td>Moderate</td>
<td>DOT</td>
<td>Durability issues, connection issues</td>
<td>Precast members and elements used</td>
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<td>None</td>
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<td></td>
<td></td>
<td>None</td>
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</tr>
<tr>
<td>Texas</td>
<td>Low</td>
<td>Low</td>
<td>Contractor</td>
<td>Incentives, experience</td>
<td>Only practical for use when lack of access</td>
<td></td>
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<td>None</td>
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</tr>
<tr>
<td>State</td>
<td>Description</td>
<td>Region</td>
<td>Authority</td>
<td>Standard</td>
<td>Current Practice</td>
<td>Notes</td>
<td></td>
</tr>
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</tr>
<tr>
<td>Utah</td>
<td>Extensive use of ABC techniques over the past 10 years</td>
<td>High</td>
<td>DOT</td>
<td>Standard</td>
<td>Available for use and currently being implemented</td>
<td>Standards for deck panels, precast substructures, new prestressed beam sections, seismic detailing, acceptable deformation limits, connection details and durability</td>
<td></td>
</tr>
<tr>
<td>Vermont</td>
<td>5 projects in the past 5 years</td>
<td>Moderate</td>
<td>Contractor</td>
<td>Low demand, higher cost</td>
<td>Yes</td>
<td>None</td>
<td>Incentive/disincentive clauses to help encourage ABC methods</td>
</tr>
<tr>
<td>Washington</td>
<td>Several projects that incorporated ABC techniques</td>
<td>Moderate</td>
<td>DOT</td>
<td>None documented</td>
<td>Completed projects using complete prefabrication or superstructure and substructure elements</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>West Virginia</td>
<td>5 projects in the past 5 years</td>
<td>Low</td>
<td>DOT</td>
<td>Underdeveloped ABC contracting industry, lack of heavy lift contractors and local contractors, No precasting industry in the state</td>
<td>None</td>
<td>None</td>
<td>Methods that minimize environmental disruption</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>Just beginning to implement ABC practices</td>
<td>Low</td>
<td>Contractor</td>
<td>Experience</td>
<td>Precasting available</td>
<td>Re-decking of major structure with full depth precast deck panels precast substructure units</td>
<td></td>
</tr>
<tr>
<td>Wyoming</td>
<td>Several completed projects</td>
<td>Moderate</td>
<td></td>
<td>Higher costs, low traffic demand</td>
<td>Extensive use of precast decked bulb--tees for country road bridges</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Appendix B: Map of Survey Results
SELECTED BIBLIOGRAPHY


Utah Department of Transportation. 2008a. *ABC Standards: Full Depth Precast Concrete Deck Panels.* Utah DOT, Salt Lake City.


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Utah Department of Transportation. 2010b. *Precast Bulb Tee Girder Manual.* Salt Lake City