IS ABC A GOOD FIT?
DEVELOPMENT OF THE ILLINOIS DEPARTMENT OF TRANSPORTATION'S ACCELERATED BRIDGE CONSTRUCTION EVALUATION METHOD

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ABSTRACT

The Illinois Department of Transportation (IDOT) has always strived to build bridges efficiently and the idea of accelerating bridge construction is not a new concept within the state. Through careful planning and the Federal Highway Administration's Every Day Counts initiative, the Department hand-picked several opportunities for Accelerated Bridge Construction (ABC). These demonstration projects were highly successful and helped the Department understand the advantages and disadvantages associated with ABC technologies. Based on the lessons learned from these projects and the potential economic and safety improvements utilizing ABC, the Department desired to develop an Accelerated Bridge Construction evaluation method for future design projects within their inventory. The main goal of the evaluation is to filter bridge projects and identify which structures are good fits for accelerating construction by interviewing the project information so to speak. This paper and presentation will provide a brief summary of the Department's successful demonstration projects; provide a basic overview of the newly developed ABC rating scorecard and guidelines; and provide a look ahead into the Department's design and construction planning. By gathering enough knowledge about the site during planning, IDOT hopes to nail the interview and find the right ABC candidates for the job.

THE ILLINOIS DEPARTMENT OF TRANSPORTATION

The Illinois Department of Transportation (IDOT) has been serving the residents of Illinois for more than a century by implementing programs to maintain and improve the state's transportation infrastructure. As long as there have been cars, highways, and air traffic, there has been an Illinois transportation agency (1). The Department has impressively developed one of the largest multi-modal transportation systems in the country that includes highways and bridges, airports, public transit, rail freight and rail passenger systems (1). As the fifth largest state in the US, IDOT sees more than 100 million visitors annually, maintains the third largest interstate network, and has the third largest inventory of bridges in the country (1)(2). Since the Department covers the entire state from the Mississippi river though rural Illinois to the third largest city in the country, IDOT is constantly seeking ways to proactively improve its infrastructure and meet the needs of its customers (1).

To accomplish this goal, the Department is headed by the Secretary of Transportation who works closely with the Governor's Office and the Illinois General Assembly. The Secretary of Transportation oversees 10 offices including the Office of Planning and Programming and the Office of Highway Project Implementation. Each of these offices is then divided into multiple bureaus that maintain the states 5 transportation regions and 9 transportation districts. With the central office headquartered in Springfield, IL, this organizational structure is responsible for the planning, construction, operation and maintenance of Illinois' extensive transportation network (1). Their mission is to provide safe and cost-effective transportation for the state of Illinois (1).

WHY ACCELERATED BRIDGE CONSTRUCTION?

The state of Illinois has a population that exceeds 12 million people with over 9 million licensed drivers that travel 108 billion miles along the state's transportation system (2). These travelers cross over 26,000 bridges throughout the state with almost 8,000 of these bridges under the Department's jurisdiction (2). The average age of the Department's bridges is 42 years old with varying condition states (1). The most recent infrastructure report card from the American Society of Civil Engineers (ASCE) stated that approximately 8.6% of the bridges in Illinois are structurally deficient (4). As a result, there is a real need to build better, safer and more efficient bridges.

IDOT's main goal is to ensure that destinations are reached in the safest, quickest and most cost-effective manner (1). IDOT does this very well but is striving to be more proactive to meet the demands of its aging infrastructure while working within the constraints of available funding sources. As a result, IDOT is looking for ways to bring the Illinois transportation infrastructure into the 22nd Century and innovation is one the key focal points (1). One of the recommendations from the ASCE Report Card was to include innovation in both design and construction of bridges to improve the safety, economy, durability, constructability and sustainability of the state's infrastructure (4). IDOT was already ahead of the curve and was investigating ways to implement innovation through the use of accelerated bridge construction. Accelerated Bridge Construction (ABC) is defined as bridge construction techniques that use innovative planning, design, materials or construction methods in a manner to specifically reduce the onsite construction time and mobility impacts that occur when building or replacing bridges (5). ABC technologies have many advantages over conventional construction such as enhanced quality and accelerated project delivery but more importantly, ABC provides a safer way to build bridges with less impact to the users. The drawback to ABC is the high initial cost and the potential for more planning and design coordination as well as construction lead time. Also, there could be conflicting priorities within an agency such as allocation of limited funding as well as balancing "real" costs with less tangible "user delay" costs (7). These drawbacks could make it difficult to sell ABC as the recommended choice.

Accelerated Bridge Construction is not a new technology and has been used for years throughout Illinois. Several ABC technologies have been used at various locations on the IDOT system including relocation methods such as lateral bridge slides, float-ins and lift-ins, and prefabricated bridge elements including deck panels, abutment and pier caps, wingwalls, parapets, deck beams, and culverts (7). IDOT has also utilized ABC materials including ultra-high performance concrete (UHPC) and high strength non-shrink grout, as well as ABC construction methods such as specialty forming and pre-assembled systems (7). However, IDOT wanted to do more with ABC in a responsible and economic manner. Their goal was to continue to develop ABC methodologies and practices. As a result, the Bureau of Bridges and Structures, which develops the structural design policies and practices for the Department, decided to implement ABC on several demonstration projects throughout the state. The demonstration projects highlighted two elements of ABC, slide-in bride construction and full depth precast deck panels with UHPC joints.

DEMONSTRATION PROJECTS

The following demonstration projects were programmed and constructed:

- IL-115 over Gar Creek bridge (SN 046-0152) – lateral bridge slide
- US 40 over West Fork Shoal Creek bridge (SN 003-0063) – lateral bridge slide
- Peoria Street over I-290 bridge (SN 016-1708) – UHPC and precast deck panels
- Campground Road over I-57 bridge (SN 041-0054) – UHPC and precast deck panels

These demonstration projects helped the Department evaluate the feasibility and benefits of ABC as well obtain a better understanding of the time and cost of construction. The lessons learned from these projects and the potential economic and safety improvements utilizing ABC helped drive policy decisions.

Due to the successes with these projects, the Department decided to move forward with development of a full ABC evaluation method for future design projects within their inventory. The main goal of the ABC evaluation was to filter bridge projects and identify which structures were good fits for accelerating construction. IDOT desired to make ABC consideration a part of its regular practice and identify a more realistic way to use ABC.

US 40 over West Fork Shoal Creek bridge (SN 003-0063)

IDOT decided to design their first bridge slide demonstration project in-house to allow more control of the process and gain more experience from the project. Based on the contract documents, the project is located in District 8, Bond County. The existing three-span steel bridge was replaced with a 108-ft-long, 35-ft-wide, single-span steel plate girder with 8" composite deck supported on cast-in-place (CIP) concrete semi-integral abutments (7). The new bridge superstructure was constructed next to the existing bridge and then rolled into place during a 21-day closure (7). The closure allowed for demolition of the existing structure, construction of new CIP abutments, and full slide of the new structure. The contractor was also required to produce a time-lapse video during the slide.

Project Highlights:

- Contractor: Keller Construction
- Designer: IDOT in-house design
- ABC Construction Engineering: Thouvenot, Wade and Moerchen
- Construction Inspection: IDOT D8
- Year Constructed: Summer 2017
- Road Closure Duration: 21 days
- Lateral Bridge Slide
- CIP abutments
- CIP approach slabs
- 8-hour time limit to laterally move the structure into position
- Conventional jacking system

Lessons learned:

Alternative methods were not allowed per the contract documents and the actual slide method was left up to the contractor. IDOT was concerned about torsion and deck cracking and required a detailed check after each movement during the slide. In addition, IDOT had provided a suggest construction sequence in the plans which showed the permanent structure being built on temporary supports to the south of the existing structure due to overhead power lines on the north side. However, the contractor elected to build the permanent structure to the north and deal with the overhead lines since the northern side of the bridge provided better access. Access was a key component to the contractors suggested construction procedure and even though switching sides required a unique sliding platform and had height restrictions, the contractor chose to go with the easier access path.

IL-115 over Gar Creek bridge (SN 046-0152)

IDOT elected to construct the new bridge at Illinois (IL) 115 over Gar Creek using the lateral slide (slide-in bridge construction) method with different requirements than the US 40 over West Fork Shoal Creek Bridge. They decided to use a tighter closure window and allow the use of precast elements. Based on the contract documents, the project is located in District 3, Kankakee County. The existing single-span precast box beam bridge was replaced with an 82-ft-long, 36-ft-wide, single-span rolled steel beam with 8" composite deck supported on precast concrete semi-integral abutments (6). The new bridge superstructure was constructed next to the existing bridge and then rolled into place during a 72-hour roadway closure (6). This project's slide-in-bridge-construction technique was highlighted by the FHWA's Every Day Count's program and IDOT received an AID grant from FHWA.

Project Highlights:

- Contractor: Tobey's Construction and Cartage, Inc.
- Designer: Milhouse Engineering
- ABC Construction Engineering: WHKS and Company
- Construction Inspection: IDOT D3
- Year Constructed: Fall 2017

- Road Closure Duration: 72 hours
- Liquidated Damages: $2000/hour
- Lateral Bridge Slide
- Precast abutment, wingwall and full depth precast approach slabs
- 4 hours to jack/slide/set - hydraulic roller jack system

Lessons learned:
The contractor gave a presentation as part of the 2018 ABC-UTC Webinar titled *Contractor Perspective on ABC – SHRP2 R04 Spotlight on IL 115 Gar Creek Bridge Lateral Slide* and offered valuable feedback during a questions and answer period. The contractor completed the bridge slide within the 72-hour window and had stated that the plans were developed to an acceptable level so that an alternative design would not have been beneficial (6). Bridges slides are fast and predictable and even though there were guide track complications and hydraulic roller binding during construction, the 72-hour window was a reasonable window to complete the work (6).

Peoria Street over I-290 bridge (SN 016-1708)

As a part of IDOT's Jane Byrne Interchange Project in the city of Chicago, the Peoria Street Bridge replacement over I-290 and the Chicago Transit Authority (CTA) utilized precast concrete deck panels with UHPC joints. The designer on the project had identified the Peoria Street Bridge as a possible opportunity for innovation since the structure would be completely closed during replacement and did not carry vehicular traffic (8). Three alternatives were proposed to IDOT during planning: precast deck panels with internal post-tensioning, AccelBridge proprietary system and precast deck panels with UHPC joints (8). IDOT selected precast deck panels with UHPC joints to gain valuable experience with the UHPC material (8). This project was the first use of these combined technologies in the state of Illinois. The existing structure was replaced with a 3-span, continuous steel plate-girder bridge with a total length of 273'-0" and a bridge width of 56'-4" (8). 52 precast deck panels were utilized and resulted in 20 different panel designs to accommodate the CTA and various bridge appurtenances (8). A latex concrete overlay was provided on the top of precast deck panels to meet aesthetic requirements (8).

Project Highlights:
- Contractor: Kiewit Construction
- Designer: TranSystems
- Construction Inspection: IDOT D1
- Year Constructed: 2015
- Pedestrian Bridge for University of Chicago (UIC) campus
- Chicago Transit Authority (CTA) station attached to bridge
- Complete closure
- State's first precast deck panel bridge with UHPC joints
- Shear pockets filled with non-shrink grout
- Transverse and Longitudinal joints filled with UHPC

Lessons Learned:
Since this project was the first use of these combined technologies in the state of Illinois, bid prices for the precast deck panels and UHPC were about 75% more than a conventional CIP deck (8). However, if this technology would be used in more applications throughout the state, local contractors would become more comfortable with the construction and the unit price would most likely decrease (8).

Campground Road over I-57 bridge (SN 041-0054)

From the success of the Peoria Street bridge project and as part of the FHWA Every Day Count Initiative-4 which focused on UHPC, IDOT decided to design the Campground Road Bridge reconstruction with precast concrete deck panels with UHPC joints. The project was designed in-house to again allow more control of the process and gain more experience from the project. The bridge could only be closed during the summer months, so the project was an ideal candidate for accelerated construction (7). The project is located in District 9, Jefferson County and consisted of replacing the existing steel superstructure. The existing structure consisted of a 4-span superstructure with 6½" concrete deck and bituminous overlay supported by hammerhead piers and stub abutments on steel H-piles. The existing substructure remained, and the superstructure was replaced with a new steel superstructure with 8" full depth precast

panels with UHPC joints. The panels spanned the entire width of the bridge and were overlaid with a 2¼" hot-mix asphalt surface course. IDOT received an AID grant from FHWA for this project.

Project Highlights:

- Contractor: Kilian Construction
- Designer: IDOT in-house design
- Construction Inspection: IDOT D9
- Year Constructed: Summer 2018
- 2-month closure window
- Precast deck panel bridge with UHPC joints
- Full length Shear channels filled with non-shrink grout
- Transverse joints filled with UHPC

Lessons Learned:

A lesson's learned meeting was held after construction was complete to identify the positives and negatives of using the precast concrete deck panels. The contractor, FHWA, IDOT construction, IDOT Bureau of Materials and IDOT Bureau of Bridge and Structures were all in attendance. IDOT had asked the contractor what worked well and what didn't work well on the project and requested feedback. The contractor had stated that the biggest issue was the detail of the transverse joint keyway between the panels (9). The bottom lip of the joint would hit the protruding rebar of the previous panel during placement and had suggested that no bottom lip be provided. In addition, the use of partial height full length channels in lieu of stud pockets caused additional conflicts during panel placement. The contractor had stated they would have preferred the shear pockets since the spacing and locations of the studs needed to be exact, and the girder top flange splice plates and bolts, as well as the panel vertical adjustment devices caused additional conflicts (9).

DEVELOPMENT OF IDOT'S ABC EVALUATION METHOD

Based on the success of the demonstration projects, the Department desired to continue the use of ABC on its projects and establish a standard method during planning and design to properly identify which structures were good fits for accelerating construction. IDOT was very interested in what other states were doing regarding ABC especially Wisconsin and Iowa and envisioned a similar flowchart and rating tool with general guidelines to help filter projects. IDOT envisioned a spreadsheet rating tool that was easy to use since consultants, in-house engineers, and District personnel without significant structural experience were all going to utilize the tool. The tool had to be easy to follow so that non-structural individuals could understand the information but robust enough to gather as much information about the project site as possible. The idea was to develop a tool that would allow Phase I planners to be able to communicate ABC decisions to Phase II designers at both the District and Bureau levels. The lessons learned from the demonstration projects would help lay the groundwork for the tool and guidelines. For example, based on the lessons learned from US40 over West Fork Shoal Creek project, contractor access became a critical factor to consider during plan development. Guidelines were included that suggested designers determine staging areas, delivery locations, crane placement, site access, and demolition locations when evaluating ABC. The Department has more flexibility to identify and acquire Right-of-Way and easements early in the plan development rather than during design plan preparation. As a result, constructability was an important consideration in developing the rating tool and several scoring constraints were included to cover the construction costs associated with these factors.

To successfully integrate the new ABC evaluation method, the tools were incorporated directly into IDOT's bridge planning process. The bridge planning process evaluates site information and possible bridge configurations to determine the most appropriate design and construction based on cost, safety and function (10). As part of the process, designers are required to identify and evaluate alternatives for effective methods to construct, repair, or replace a bridge with economics playing a vital role in all recommendations (10). It is known that bridges constructed using an ABC method could increase initial structure cost by more than 20%. Therefore, successful use of ABC requires a careful evaluation of the requirements for the bridge, site constraints and an unbiased review of the total costs and benefits. One of IDOT's early concerns was how to quantify societal costs such as business or environmental impacts and wanted to incorporate these indirect costs into the scoring of the tool. As a result, an entire category was established within the tool to cover the factors that impact the community at-large from a monetary

and non-monetary perspective. Scoring constraints for railroads, waterways, businesses, pedestrians, bicyclists, and the environment were established to evaluate the impacts to these entities based on construction. Scoring criteria was developed that allowed the user of the tool to make an educated decision about the impact.

In addition, IDOT was very interested in the existing condition of the bridge to help determine if ABC could benefit the project. The existing condition would help determine if staged construction could be utilized. In several cases, IDOT has experienced an increase of over 30% in construction cost due to staged construction and wanted to identify a way to compare the increase in initial structure cost utilizing ABC to staged construction. During the planning process, the cost of staged construction can get lost in the preferred option since closures and mobility impacts control the decision making. However, utilizing ABC with a closure could prove to be more economical and beneficial and IDOT desired a way to evaluate these options as simply and completely as possible. As a result, an entire category was established to cover the condition of the existing bridge and determine if the structure could be staged constructed. Since condition rating provides an accurate method for determining the condition of the bridge, the deck, superstructure and substructure ratings were included as scoring constraints.

Finally, IDOT was interested in scoring user costs in the rating tool since each District has a different method for calculating monetary impacts to the travelling public. Again, an entire category was established in the rating tool to standardize the user cost impacts across all Districts. Based on the FHWA definition for Road User Impacts, scoring constraints were established to cover travel delay, vehicle operating costs, crash costs, emission costs and impacts to nearby projects. Scoring criteria was modelled after the rating tools from the Wisconsin and Iowa DOTs.

BRIDGE CONDITION REPORT

IDOT's main goal was to identify which bridges should be investigated further for ABC as early as possible. The very first step in any IDOT project is to inspect the existing structure and develop a Bridge Condition Report (BCR). The BCR is intended to provide a format for Districts and local agencies to document a proposed scope-of-work for an existing structure to the Bureau of Bridges and Structures (BBS) (10). The BCR documents a bridge or structure's current physical condition and functionality (10). It also addresses structural and safety deficiencies and includes all pertinent information that is required to support the proposed scope-of-work (10). As a result, it was only logical that an ABC evaluation became part of the BCR process.

The overall BCR process did not change and a recommendation on the proposed scope of work for the bridge was still required prior to any ABC evaluation. Once the proposed scope of work was identified for the bridge, the project should then be evaluated for Accelerated Bridge Construction utilizing the new ABC Rating Scorecard spreadsheet as envisioned above. It was determined that the evaluation should only be included for scope of works identified as deck replacement, superstructure replacement, complete replacement or a new structure. Standardizing a rating tool to cover rehabilitation projects or retaining walls, culverts or three-sided structures was deemed too difficult; therefore, these types of structures were not included. If the project did not contain an existing bridge, IDOT still wanted an evaluation to determine if ABC would benefit the project. Since a BCR is not required for a new bridge, IDOT included requirements and formatting for a technical memorandum that incorporated the ABC Rating Scorecard evaluation.

ABC RATING SCORECARD

To help the Designer "think" through and gather enough information during the planning process of a bridge project, IDOT developed the ABC Rating Scorecard spreadsheet. The tool is a qualitative assessment of the impact ABC methods may have on a project when compared to conventional construction and acts as a filter to determine the suitability of bridge projects for ABC based on a set of variables and scoring criteria. The tool requires the user to assign a score for twenty-eight (28) input variables in four (4) major categories based on specific scoring criteria and constraint descriptions that have been established to compare ABC to conventional construction. The assigned weights for each

variable have been determined based on their importance in determining if ABC should be utilized on a project. The four (4) major categories are as follows:

Existing Structure Information – the variables in this category are intended to cover the urgency of the repair/replacement and to determine if staged construction is feasible based on the condition of the existing bridge.

Road User Impacts – the variables in this category are intended to cover the Road User Impacts associated with Travel Delay, Vehicle Operating Costs, Crash Costs, Emissions Costs, and Impacts to Nearby Projects. The variables are based on the definition of Road User Costs as outlined in the FHWA Manual "Work Zone Road User Costs".

Societal Impacts – the variables in this category are intended to cover impacts to users not covered by the Road User Impact category. These impacts include railroads, business, waterways, environmental and pedestrians.

Constructability – the variables in this category are intended to cover the construction costs, schedule and proposed structure geometry.

A description of each of the twenty-eight (28) input variables is included in the tool to provide specific scoring criteria to help guide the user. The input variables are scored assuming conventional construction. The scores were established assuming the higher the variable input score, the higher the likelihood that ABC would benefit the project. Once the user inputs scores for the twenty-eight (28) variables, the ABC Rating Scorecard automatically calculates a Total ABC Score based on the input. The Total ABC Score is based on the total weighted input score compared to the maximum weighted score of the spreadsheet. The Total ABC Score is then output as a percentage. In addition, the tool provides an individual Category Score for the four (4) categories as reference only. The Category Score is only used to gage which categories and variables provide the biggest impact to the Total ABC Score.

To help designers determine an ABC recommendation, a flowchart was developed based on the rating spreadsheet score. The flowchart was divided into three categories based on the scoring results and probability that ABC would provide a benefit to the project. If a Total ABC Score of 25 or less is recorded, Conventional Bridge Construction is the most logical choice to evaluate further. However, ABC can still be evaluated if the Department has identified the project as a program initiative. A program initiative can encompass a variety of initiatives, including (but not limited to) innovation, research needs, public input, local initiatives, pilot projects or stakeholder requests. These items should be considered on a project-specific basis. If a Total ABC Score of 60 or more is recorded, ABC is the most logical choice to evaluate further. The threshold of 60 is intended to capture any bridge receiving a score of 5 in all of the most heavily weighted variables. For ABC Rating scores between 25 and 60, the user should consider additional questions prior to making a final decision on ABC. These additional questions are intended to force the user to step back, think about the project as a whole, and decide if an ABC method really makes sense with all the project-specific information considered. These questions include:

Can the bridge construction be accelerated by ABC?

Do traffic volumes support the need for accelerated construction?

Do the site conditions support an ABC approach?

Do benefits of ABC outweigh additional costs?

If the answer to any of these questions is no, then Conventional Construction is the most logical choice to evaluate further unless the Department has identified the project as a program initiative. Once a recommendation is determined, the Designer should provide justification for the recommendation including the major factors, variables and scores affecting the Total ABC Score in the Bridge Condition Report. If there is general concurrence during the BCR process that ABC should be evaluated further, then IDOT desired minimal ABC information to be included in the Type Size and Location (TSL) plans. However, the submittal of the TSL can vary across projects. Not all Phase I projects include a TSL and

decision makers may be different between Phase I planning and Phase 2 design. As a result, it was decided that a coordination conference call or meeting be established with the Department to determine the goals of the project and the applicable ABC methods from a constructability, user impact, and project delivery perspective. The TSL development should then include the critical ABC factors that meet the goals of the project as determined during the coordination meeting. To aid designers, IDOT provided a plan development outline and considerations that were modelled after the IL-115 over Gar Creek bridge replacement since the contractor stated that the plans were developed to an acceptable level for ABC.

In addition to the ABC Rating Scorecard spreadsheet, IDOT wanted to define the different ABC technologies commonly used in the industry and discuss general guidance associated with each method to encourage the Designer to evaluate alternate bridge design and construction. Lessons learned on the use of UHPC with precast deck panels from the Campground Road over I-57 and Peoria Street over I-290 demonstration projects were included in the general guidance as well as the use of Prefabricated Bridge Elements and Systems (PBES), Bridge Movement and Installation Methods, Foundation and Wall Elements, Rapid Embankment Construction, and Fast Track Contracting. Some of these technologies have already been used on Illinois projects, but there are others that have not yet been tried that the Department believes may have potential application in Illinois and therefore were included.

LOOK AHEAD

The initial goal in developing the ABC tool and guidelines was to gather enough knowledge about the site and find the right ABC candidates for the job. However, the interview process is still on going and as the date of this paper, IDOT has yet to release the official policy requiring the use of the ABC Rating Scorecard during the Bridge Condition Report development. The Bureau of Bridges and Structures has been using the ABC Rating Scorecard internally as part of the BCR review process and has rated over 40 bridges using the tool. Based on these results and almost a full year of internal use, the Department is fine tuning the tool. In addition, BBS is vetting the ABC Rating process with the various Districts in the state. It should be noted that the Districts that were involved in the demonstration projects, especially D9 on the Campground Road project, have stated they would do an ABC project again (9). IDOT's vision is to release the ABC Rating Scorecard, flowchart and general guidance in the upcoming update to the Department's Bridge Condition Report Procedures and Practices Manual. As additional projects are identified and designed, the guidelines and tools could be refined with the ultimate hope of incorporating the most beneficial ABC technologies into the delivery of their projects. IDOT understands the interview process can consist of many steps and the search can take a while to find the most qualified candidate for the position. However, with the ABC Rating Scorecard, IDOT hopes to find the bridge site that perfectly matches the job requirements, ultimately nailing the interview.

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