Little Ivy Creek Bridge Replacement using Accelerated Bridge Construction Methods

(Technical Paper)

Investigating the Organizational Relationships Governing the Research and Implementation of Accelerated Bridge Construction

(STS Paper)

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Introduction – The Need to Address the Urgent Infrastructure Problem

In April 2019, President Donald Trump and Democratic congressional leaders came to a verbal agreement to pursue and implement a $2 trillion infrastructure plan to improve the United States' highways, railroads, bridges, and broadband (Karni, Cochrane, & Rappeport, 2019, p. 1). While the infrastructure bill ultimately fell apart and was not signed, the discussion that this bill instigated came at a pivotal time, as it was recently identified by the Federal Department of Transportation in 2016 that out of the approximately 614,000 public road bridges in the US, about 56,000 (just over 9%) were considered structurally deficient (Kirk & Mallet, 2018, p. 2). For a bridge to be deemed structurally deficient, its elements, such as the foundation, piers, or deck slabs, require monitorization and ultimately renovation, but its structure can maintain its daily traffic and will not collapse. In addition, as seen in Figure 1 below, almost four out of every ten (39%) of all bridges in the United States are 50 years or older, the majority of which are only designed to have a lifespan of 50 years (ASCE, 2016, p. 2). In order to address the urgent issue of these structurally deficient bridges in a faster and safer manner than traditional construction, the method of accelerated bridge construction was introduced by Federal Government-run transportation programs.

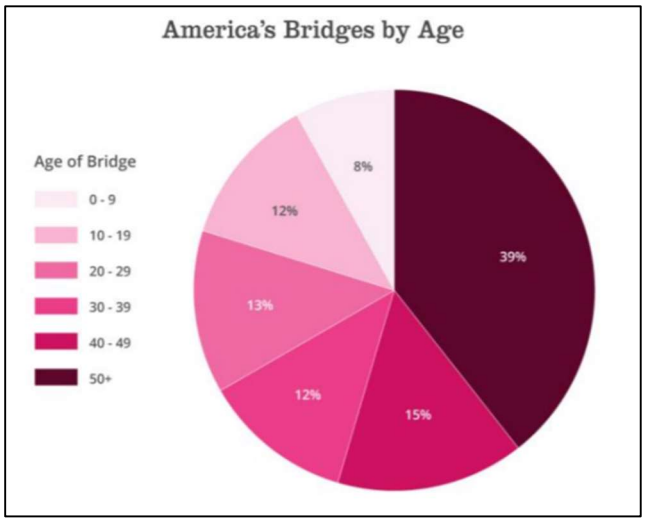

Figure 1: America's Bridges by Age. The majority of the bridges in 2016 are 40 years or older with a design lifespan of 50 years (ASCE, 2016, p. 2).

Accelerated Bridge Construction (ABC) is a method for rapidly replacing bridges using prefabricated elements or systems and then moving them into position, instead of assembling the bridge components on site. This methodology allows for a shorter construction period, which decreases the number of lane closures and detours, in a manner that is safer for pedestrians and laborers, and more cost-effective (Federal Highway Administration, 2019, p. 1). In 2003, the National Cooperative Highway Research Program (NCHRP) published a synthesis report on prefabricated bridge elements and systems (PBES), the concept behind ABC techniques, but the use of traditional bridge construction did not waver (Ralls, 2014, p. 2). Despite Accelerated Bridge Construction first emerging in the 1980's, its implementation in the construction industry has been very gradual.

Since the introduction of Accelerated Bridge Construction in the 1980's, State Departments of Transportation (DOTs) have requested research projects for specific ABC technologies in an effort to "advance nationwide ABC implementation" (Ralls, 2014, p. 2). However, the growth in popularity of ABC methods in the United States did not fluctuate as a result, and the relationships between state and federal DOTs, the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), construction and engineering industry partners, and academic research institutions may be at the root of this delayed procedural uptake. A sociotechnical analysis into the organizational and cultural interactions impacting the research and utilization of ABC technologies is necessary to further understand the underwhelming industry implementation in the US.

Supporting Argument 1: ABC Technology is Being Under-Utilized as a Result of a Lack of Organizational Clarity

As referenced earlier, it has become clear that the United States has a vested interest in improving the nation's infrastructure. At the current rate of inspection and repair being done by both public and private entities, the task of fixing the over 56,000 structurally deficient bridges would take approximately 80 years (American Road & Transportation Builders Association, 2019, p. 1). Therefore, it should be clear that Accelerated Bridge Construction has great potential to not only limit future project traffic delays, but to make it far more realistic to repair and genuinely improve the state of our current infrastructure. If the network of organizations responsible for the research and implementation of the ABC methodology could be clarified, the goal of fixing all the structurally deficient bridges in the US would be more attainable.

In terms of research, several state DOTs, the FHWA, and many academic and industry organizations have sponsored ABC-related research. The Oregon DOT led a pooled-fund project to "develop a decision tool to help determine whether a project is a good candidate for ABC," which is now being used in a number of states (Ralls, 2014, p. 3). Also, the FHWA has completed several years of extensive research on ultra-high performance concrete for its use in prefabricated concrete elements in ABC (Lysett, 2018, p. 1). In 2013, the Research and Innovative Technology Administration, under the U.S. Department of Transportation, funded the establishment and operation of the ABC University Transportation Center (ABCUTC) at Florida International University, along with Iowa State University and the University of Nevada at Reno (Ralls, 2014, p. 7). This research project continues to investigate a variety of sub-fields in ABC, such as pre-cast bridge railing, seismic connection details, and "compiling ABC projects and research into databases for ready access by bridge professionals in their work" to aid industry

implementation (Ralls, 2014, p. 4). While it is clear that there is currently a significant effort in academia and government entities to expand our knowledge of Accelerated Bridge Construction, this promising technique has still not been used more commonly.

One possible explanation for this discrepancy may be due to several unlikely but notable catastrophic accidents that have occurred during ABC projects, causing traffic delays, construction delays, and injuries or fatalities. On one specific project at Florida International University, a newly installed pedestrian bridge constructed with ABC techniques collapsed, killing 6 people in March of 2018. Shortly after, the National Safety Transportation Board conducted an investigated into the cause of the collapse, and determined that it originated from a design error that overestimated the capacity and underestimated the expected loads at a point where two truss members were connected to the bridge deck (O'Neil, 2018, p. 1). This pedestrian bridge, which should have been able to withstand a Category 5 hurricane and last 100 years, was supposed to be a representation of the innovative ABC work that has taking place at Florida International University. Instead, following the collapse, a media frenzy took place in which Accelerated Bridge Construction was portrayed in a very negative light.

Alternatively, the reason why Accelerated Bridge Construction is not used in more bridge rehabilitation or replacement projects may be due to the Federal Highway Administration's *Every Day Counts* (EDC) initiative established in 2009. The EDC movement is a state-based model used "to identify and rapidly deploy proven but underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce congestion and improve environmental sustainability (Zicko, 2015, p. 1). While ABC is a significant aspect of the innovative implementations of the EDC initiative and the number of ABC projects has gradually increased as a result, the initiative may not be adequately identifying the appropriate circumstances for

these techniques. After three years, in 2012, the EDC reported that only approximately 1,000 bridge projects were built “in an accelerated manner using some form of PBES technology” (Ralls, 2014, p. 6). If the emphasis on utilizing ABC in more bridge construction projects is increased, and initiatives originating from construction and engineering industry partners are implemented, the use of Accelerated Bridge Construction could be more broadly applied, and the state of our nation’s infrastructure could be drastically improved.

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