PROJECT TITLE: DEVELOPMENT OF GUIDELINES TO ESTABLISH EFFECTIVE AND EFFICIENT TIMELINES AND INCENTIVES FOR ABC

Quarterly Progress Report
For the period ending November 30, 2017

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ACCELERATED BRIDGE CONSTRUCTION
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Submitted to:
ABC-UTC
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1. Background and Introduction

Accelerated Bridge Construction (ABC) techniques have a great potential to minimize the traffic disruptions during the bridge repairs/replacements, promote traffic and worker safety, and improve the overall quality of the built bridges. Despite the major advances in design and construction of ABC techniques, transportation agencies are still hesitant about using ABC techniques largely due to perceived risks during construction and higher initial costs.

ABC techniques are perceived to add a cost premium to replacement of bridges. As such it's important to not only consider the initial costs (cost of material and labor required to design and construct the structure) but also the societal costs associated with the construction activities and attendant traffic disruptions. Many cases of implementation of the ABC techniques show that the time saved due to shorter construction duration in addition to the lower cost and higher quality of the standardized design approaches implemented in bundled designs would make up for the higher initial costs.

In order to find a balance between the additional initial costs and the decreased indirect costs in such a way that the total cost of ABC application is optimized for each specific project or for a bundle of projects, this proposal develops a decision-making framework that accounts for closure time classification (using the FHAW standard of mobility impact time to evaluate the closure time impact state), network reliability, traffic redistribution (re-assigning the daily traffic flow of the network and residual road capacity at retrofit links), direct and indirect cost calculation, and different incentivization mechanisms to balance between different ABC techniques and conventional construction .

2. Problem Statement

It is perceived that the ABC technique results in higher construction costs but because of the reduction on traffic reroutes, on site construction time, and environmental impacts it helps with the total project cost (which includes the indirect costs). Depending on the construction technique adopted under the umbrella of ABC, the duration of the project could vary. There has been numerous efforts that address the prioritization and selection of candidate bridges for ABC application. However, no studies have looked into the effect of the selected ABC technique on duration and total cost of construction. This research aims to address the current gap in selection of a suitable ABC technique depending on the specific characteristics of each site. This project will provide a pathway to analyze the total cost of construction via different strategies and propose a decision making framework to optimize the cost and duration of ABC projects in each site.

3. Research Approach and Methods

To achieve the goals of the project, three major steps will be taken: i) a decision-making framework and system will be developed and used to estimate the cost and time difference among various construction strategies. ii) the decision-making system will be implemented for the state of Iowa bridges as a test-bed and its effectiveness in operational conditions will be evaluated, and iii) the framework and analysis system can be extended when other innovation construction methods are imported into projects. After this project, the whole analysis processes can be improved as a direction tool for the operational construction.

4. Description of Research Project Tasks

The following is a description of tasks carried out to date.

Task 1 – Literature review

The project will start with a thorough literature review on: i) Available ABC techniques and FHWA ABC requirements (2011); ii) the cost and duration of the ABC projects through the FHWA Accelerated Bridge Construction Project Exchange (a database of 100 ABC projects throughout the US), iii) data and experiences from Design-Build (DBE) projects from Missouri "Safe and Sound" and public-private partnership (P3) projects from Pennsylvania , and iv) the best practices for indirect costs analysis.

Progress to date: The literature review is undergoing. Engineers and contractors involved in the Missouri "Safe and Sound" and public-private partnership (P3) projects from Pennsylvania have been identified for the surveys (20%).

Task 2 – Identify different construction techniques and contracting mechanisms

The common approach in ABC is to use various combinations of prefabrication and effective contracting strategies to achieve the accelerated onsite construction timeline and minimize costs. In order to reduce and control the closure time, different bidding strategies and incentive/disincentive strategies such as "A" + "B" (bid items + Critical Duration) and "A"+"B"+"C" (bid items + bridge closures + single lane closures) are utilized. In this project the cost and closure time of each construction technique will be evaluated. Furthermore, useful mechanisms to establish incentives/disincentives will be provided.

Progress to date: N/A

Task 3- Investigate the bridge closure status to estimate the indirect costs

Direct cost is recognized as the sum of construction cost and costs resulted from ABC technique application (mentioned at Task 2). The indirect cost -unit of hours or days- includes the cost caused by traffic delay and changes in travel demand before and after retrofit in addition to the opportunity losses, socio-economic and environmental impacts of the closure. The direct costs are normally straightforward to estimate and are considered as a one-time value. The indirect costs on the other hand are accrued during the full/partial closure of the bridge. The current practice is to only consider the traffic impacted by diversion as the indirect cost, in which case would result in a linearly increasing function overtime. Considering other factors such as the socio-economic impacts of the closure or environmental effects, would result in a nonlinear increase in indirect cost. This project will examine the possibility of using more holistic metrics such as social return on investment (SROI) to estimate the indirect costs.

Progress to date: N/A

Task 4- Optimize the total cost and select the best ABC technique

The cost effective scheduling is one of the most important aspects of the construction project management. The selection of any mode of execution for each project leads to a distinct time and cost for that project. The combination of various possible execution modes produces several project plans where each project plan has a unique duration and cost (Schematic figure below). To find the most optimized approach a linear mathematical optimization model will be developed, which minimizes project total cost and takes into account the project duration. The model guarantees the optimal solution, in which precise discrete activity time-cost function is used. Details of model formulation will be illustrated on an example project.

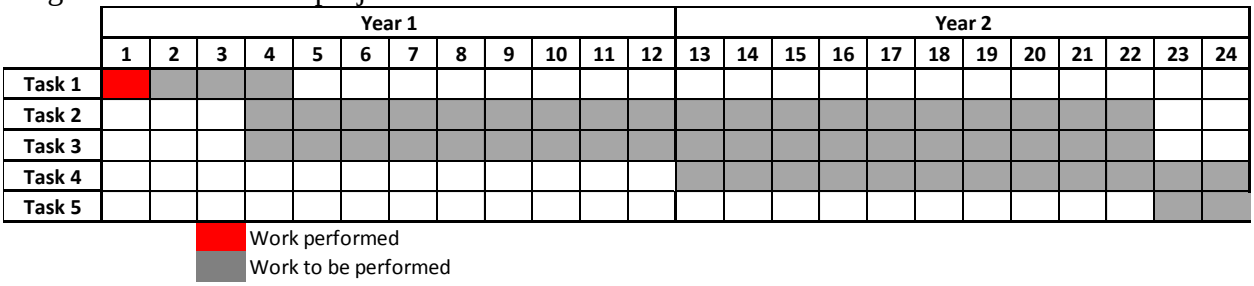
Progress to date: N/A

5. Expected Results and Specific Deliverables

- Quarterly reports
- Final report

6. Schedule

Progress of tasks in this project is shown in the table below.



7. References

N/A