Strategies for Prioritizing Needs for Accelerated Construction after Hazard Events

Developing a multi-criteria decision making tool for prioritizing accelerated construction needs after a natural disaster

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There is a need for rapid and responsive infrastructure repair and construction after natural disaster events such as hurricanes, wildfires, and tornadoes. These natural disasters often shut down basic infrastructure systems, including roads, bridges, water supply, and power supply, as experienced recently in states around the country. Accelerated construction practices are often used in these situations to speed up the traditional, and often slow, project delivery process. However, after a natural disaster, several and different types of transportation infrastructure components are in need of inspection, rehabilitation or reconstruction, and transportation agencies are challenged with the task of prioritizing these accelerated projects. This project studies the current practices and institutional barriers to identify the critical decision criteria and to develop a conceptual model for prioritizing needs for accelerated construction after disaster events, specifically hurricanes and flooding.

Background

Transportation infrastructure in the South-Cetnral region has been severely affected by recent hurricanes and flooding. For example, after historic flooding in the state of Louisiana in 2016, the LaDOTD reported the closure of approximately 200 roads, including more than 30 washouts of state highways. Another 1,400 critical bridges needed to be inspected before they could be opened to traffic. Harvey floodwaters in Houston, TX collapsed bridges and also washed away roads by eroding their foundations (Figure 1). Highway traffic was disrupted by severe and prolonged inundation.

Accelerated construction practices are often used in these situations to speed up the traditional, and often slow, project delivery process. However, after a natural disaster, several and different types of transportation infrastructure components are in need of inspection, rehabilitation or reconstruction, and transportation agencies are challenged with the task of prioritizing which projects should be tackled first considering resource constraints.

Figure 1. Bridge collapse near Rosenberg, TX as a result of Hurricane Harvey (Photo: Rick Jervis, USA TODAY 2017).

The lack of a plan for accelerated transportation projects in response to disaster events increases the recovery time of the transportation network. Consequently, not only the efficiency of disaster response operations is affected, but also the reestablishment of the local economy is delayed. Malfunctioning infrastructure might also impose additional safety issues to the community exposed to disaster induced safety hazards (e.g., collapsed bridge, lack of traffic lights, dangerous routes, etc.) that could result in accidents and fatalities.

Project Summary

Even though the current body of knowledge has investigated accelerated construction and post-disaster project prioritization for transportation infrastructure, the studies do not overlap between accelerated construction, emergency operations, and prioritization of infrastructure projects at a programmatic level for post disaster recovery. Also, prior studies have not focused on a diverse portfolio of projects and have mostly concentrated in projects with similar characteristics. There is a need for further research and guidance to assist state DOTs in identifying and prioritizing needs for accelerated construction after hazard events. This study will investigate current practices and institutional barriers to identify and quantify important decision criteria and to develop a decision support tool for prioritizing needs for accelerated construction after disaster events, specifically hurricanes and flooding which commonly affect the South-Central region. The proposed framework for this research project includes: a literature review, conceptual prioritization model, data gather, and validating/calibrating the final prioritization model.

Status Update

The conceptual prioritization model was developed with five questions in mind: (1) Why do we need to accelerate the construction projects after a hazard event?, (2) How do we define the re-establishment of the condition of the affected place?, (3) How do we define the "recovery index"?, (4) What are the variables that influence the decision to accelerate a construction project?, and (5) What is the final objective of the strategy for prioritizing needs for accelerated construction? The proposed structure for the conceptual prioritization model is shown in Figure 2. The model was developed considering four main block components: the projects' prioritization criteria, the accelerated methods available, the projects' alternatives, and the scheduling of the project alternatives.

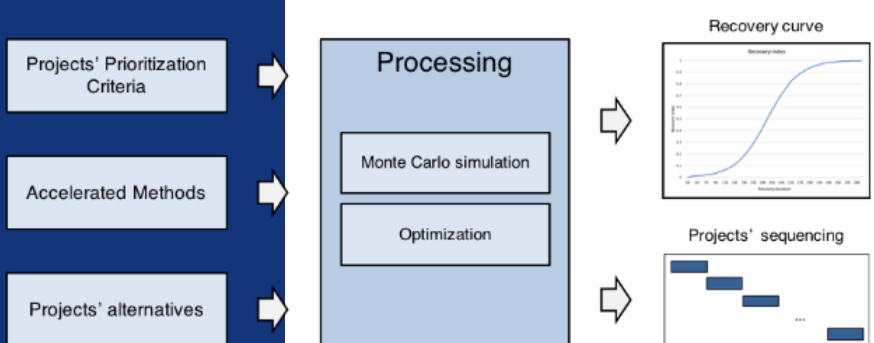

Figure 2. Conceptual prioritization model diagram.

A demonstration of the model was created using synthetic data. The hypothetical scenario included 5 (five) projects, 5 (five) prioritization criteria, 4 (four) acceleration methods plus the option without acceleration. Therefore, a total of 25 different alternatives were used for prioritization. Each alternative had also a cost and a duration associated. Additionally, the model was subjected to 3 (three) constraints: total investment less than $ 25,000,000, recovery index equal to or higher than 80%, and no repetition of projects. The goal was to find the minimum duration, sequencing 5 possible projects. The model was set to run using Latin Hypercube and to stop running after 100 trials or when the progress maximum change reached 0.05%. The run stopped after reach the maximum number of trials and one best trial was found. The best result can be achieved with only one project being accelerated (project 4) and the other four projects without acceleration (projects 3, 1, 5, and 2), attaining a total duration of 2325 days, a total investment of $ 24,630,000, and an accumulated recovery index of 1.00 in the end. This was the case that attended all the conditions of the problem. If constraints are relaxed, more alternatives can be part of the solution. For example, if the limit of the total investment increases to $ 28,000,000, more 5 (five) project combinations can be part in the solution universe.

Impacts

The expected deliverables from this study include a decision support tool, best practices and recommendations for prioritizing needs post disaster and applying accelerated construction strategies to multiple projects concurrently. The research team will work closely with all of the DOTs within Region 6, particularly the Louisiana Department of Transportation and Development (LaDOTD) and the New Mexico Department of Transportation (NMDOT) as these are the states represented by the research team. While the focus will be on Region 6, it is expected that the research results will be relevant to other DOTs outside of Region 6 and will provide an overview for the methods used for prioritizing post-disaster infrastructure repair nationwide.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

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