Development of a Multi-Level Dynamic Model to Measure the Resilience Level of Transportation Infrastructure Networks

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$112,235

Developing a thorough and efficient method to measure resilience levels of transportation networks following natural disasters

Natural disasters often cause a massive loss of resources in communities due to destruction of the built environment and interruption of normal human activities. Over the last few decades, resilience has been studied diligently to evaluate damages and performance of infrastructures suffered by natural and/or man-made hazards. Researchers, governments, and agencies are harboring interest over infrastructure resilience. Critical infrastructure resilience is a major objective that is being carried out by Department of Homeland Security (DHS) for more than a decade. However, few transportation resilience projects has been considered as an independent focus of study. In this regard, many models and frameworks related transportation resilience has already been developed. However, a comprehensive model to measure organizational, economic, social, as well as the technical aspects of the transportation infrastructures considering all dimension of resiliency is yet to be developed. Most public agencies do not have any decision-making tool to measure the resilience level of their transportation infrastructures; hence, they do not implement resilience enhancement strategies in a timely manner. This causes costly damages to the infrastructures which could be avoided. Thus, this study aims to develop a decision-support tool and quantitative model which measures the resilience level of transportation infrastructures and suggest the best resilience enhancement strategies.

Problem Statement

In short, a system's resilience is its ability to return to the predetermined level of performance after a disaster in the shortest possible time. Hence, the definition of resilience has a static aspect which deals with the desired level of performance and a dynamic aspect which focuses on the speed to achieve said level. However, for a system to be resilient, it must be technically, organizationally, economically, and socially resilient. Technical resilience denotes the soundness of the physical properties of the system under disruption. Organizational resilience indicates the competence of the persons making the decisions under the crisis. Economic resilience indicates the availability of monetary resources needed to face and recover from the disaster. Social resilience indicates the ability of the surrounding society to provide help to those in need. These four subsections of resilience are collectively known as TOSE. Based on this classification, this study mainly focuses on technical resilience aspect. However, current literature does not provide a consistent definition of resilience for transportation systems. For this study, resilience of transportation infrastructures is defined as the ability to tolerate disturbance while maintaining the basic structure and function and to recover performance deviation after the disaster within reasonable cost and time constraints.

Objectives

This project identifies technologies that could enhance the resilience level of infrastructure projects, reducing the probability of failures from natural disasters. In response to the aforementioned issue, this research project aims to accomplish the following objectives:

- To identify the resilience dimensions of transportation infrastructures.
- To draft a model to measure the resilience of transportation infrastructure networks.
- To establish resilience enhancement strategies for transportation infrastructures.

Intended Implementation of Research

Education, Workforce Development and Outreach: The project will employ one Ph.D. Student and one Masters Student who will contribute to the study and learn valuable skills. The PI's will increase participation among women and underrepresented minorities through campus K-12 programs.

Figure 1: Natural-disaster effect on infrastructure

Anticipated Impacts/Benefits of Implementation

The main deliverables from this study are:

1) A technical report containing the feasibility of the use of high RAP along with suitable softening agents in preparing durable asphalt mixes. The report will also contain recommendation(s) the mixing and compaction temperatures asphalt mixes containing high RAP.

2) The findings of the study will be showcased at symposia such as the ArDOT Annual Technical Research Committee (TRC) Conference and at the Tran-SET Annual Conference.

3) Technical articles (scientific journal and conference proceedings) will be published.

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

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".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.