Holistic Network-level Assessment of Pavement Flood Damages using the FEMA's Hazus Flood Models and Maintenance Cost Prediction

Developing a new method to analyze network-level pavement flood damages with FEMA flooding models

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Tran-SET
Texas A&M University
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$120,000

After recent catastrophic disasters, roadways in the South-Central region suffer not only from the flood inundation, but also from the long-term recovery processes that incur enormous maintenance costs. To assess the impacts of flooding disasters on roadways, various studies have investigated sampled roadway damages with pavement engineering techniques such as a direct damage analysis using cores/bores. However, current methods for evaluating roadway damages are time-consuming and labor-intensive. In addition, even though existing methods provide a detailed damage analysis of pavement in a particular location for a particular time period, there is still a large practical knowledge gap in understanding network-level roadway functional/structural damages before-and-after historic flooding as well as assessing flooding impacts on roadways over time.

The primary objective of this project is to develop a holistic roadway damage assessment method using the FEMA's Hazus flood models and the pavement condition data accumulated over the years. This project also aims to provide a means for Louisiana and Texas to intuitively identify roadway damage patterns at the network level caused by flooding over time as well as accurately predict roadway maintenance cost.

Problem Statement

After recent catastrophic disasters, roadways in Region 6 areas suffer not only from the flood-inundation, but also from the long-term recovery processes that incur enormous maintenance costs. Rebuilding projects in the area affected by Hurricane Katrina in 2005 required $81 billion for completion. In addition, this process can take up to 5 to 10 years, depending on the severity of a disaster and the size of and a damaged realm. Two recent severe flooding events in Texas in August 2017 and Louisiana in August 2016 clearly show how catastrophic events can cause direct damages such as sweeping away roadways systems as well as indirect damage such as deteriorating pavement's long-term performance. To assess the impacts of flooding disasters on roadways, various studies have investigated sampled roadway damages with pavement engineering techniques such as a direct damage analysis using cores/bores. The Louisiana Transportation Research Center (LTRC) conducted two studies regarding the impacts of flooding on roadways. One study defined flood hazard characteristics and compute flood depths over roads to quantify the key factors that affect road flooding. Another LTRC study evaluates historical land elevation and sea level data for forecasting the overall effect on critical transportation infrastructure in southern Louisiana. However, current methods are timeconsuming and labor-intensive because they require visiting a large number of damaged sites and physical analyses. In addition, even though existing methods provide a detailed damage analysis of pavement in a particular location for a particular time period, there is still a large practical knowledge gap in understanding network-level roadway functional/structural damages before-and-after historic flooding as well as assessing flooding impacts on roadways over time.

A holistic assessment of roadway damages after flooding events not only provides regional roadway damage patterns but also facilitates an integrated roadway recovery and maintenance plan. Furthermore, there is no previous effort to evaluate roadway damages by adopting the most accurate FEMA's disaster data and Hazus flood models. In addition, one of the primary challenges in a post-disaster recovery process for decision makers is a lack of a systematical evaluation process of possible recovery plans that can promptly restore normal livelihood. Unfortunately, a lack of holistic perspective and long-term investigation on roadway damages caused by floods has resulted in the absence of accurate maintenance cost prediction. Since each county or perish have to prioritize roadway reconstruction or rehabilitation projects and make a long-term plan for roadway management, the cost prediction process and the life-cycle cost analysis are expected to be imperative resources for decision makers and practitioners.

Objectives

The primary objective of this project is to develop a holistic roadway damage assessment method using the FEMA's Hazus flood models and the pavement condition data accumulated over the years. This project also aims to provide a means for Louisiana and Texas (ultimately to all Region 6's States) to intuitively identify roadway damage patterns at the network level caused by flooding over time as well as accurately predict roadway maintenance cost.

Intended Implementation of Research

Workforce Development: The major deliverables from this project include the intuitive implementation guidebook for educating and assisting practitioners in DOTs in Region 6's States. This guidebook and its education materials will be used for workforce development in post-flood roadway damage assessment and maintenance including district engineers, planners, and decision-makers in Region 6's State transportation agencies. In addition, the PIs will closely work together with Christophe Fillastre, who is PMS and Data Collection Pavement Management Engineer in LaDoTD, with the already archived Pavement Analytics data in order to integrate our holistic assessment approach into existing pavement management systems. Furthermore, the PIs will offer one-day tech-transfer workshops to deploy research results to the State professionals. For local districts in suburban areas in Region 6, the PIs will provide a webinar or a virtual education session. This will also be uploaded to a designated YouTube channel for engineers to view, ask questions, or make comments. The research team will curate the comment section on the channel and respond to questions or comments. The main concept behind the online model is to actively utilize social media to engage suburban area engineers for a more effective dissemination of research results

Outreach: The PIs will actively present the research outcomes at regional meetings of Parishes in Louisiana as well as quarterly meetings of the Construction Industry Advisory Council, industry support groups of the LSU Construction Management department and TAMU Construction Science Department. In addition to presentations at reputable conferences, the research team will disseminate the research results through publications in prominent professional journals and diverse media. This project should result in a minimum of five top-tier peer-reviewed publications.

Education: The findings and methods of this project are highly interrelated with the PIs' educational activities. The research results will be used to create educational material in the Dr. Lee's graduate course, Construction Data Modeling and Analysis, as well as the Dr. Choi's graduate course, Civil Infrastructure Informatics (CII). In addition, the project will incorporate its knowledge and research findings into a comprehensive educational plan for underclassmen, underrepresented and community college students, through the following three programs: (i) A hands-on Summer School of the LSU Cain Center, (ii) A LSU ENGage program for teaching middle school students, and (iii) A regional science fair. In TAMU, the PIs will present this project to K-12 teachers at an annual teacher summit, and they will disseminate their learned knowledge to K- 12 students.

Anticipated Impacts/Benefits of Implementation

The practitioners can identify holistic flood impacts on road ways over time and predict its long-term maintenance cost.

Web links

- TranSET's website (https://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1642185)

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 Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.