ASSESSING TRANSPORTATION INFRASTRUCTURE RISK

A report by Portland State University (PSU) researchers offers an improved framework for assessing the seismic risk of transportation structures. Earthquake preparedness is a high priority for the Pacific Northwest, and cities and state agencies will benefit from having a more accurate and consistent way to prepare.

In collaboration with the Oregon Department of Transportation (ODOT) and the Federal Highway Administration (FHWA), the researchers developed a method to manage bridges and tunnels using various data sources and rigorous risk definitions.

Traditionally, decisions about retrofitting existing structures have been based on expert opinion, past experience, or limited data, which can be subjective and incomplete for the estimation of seismic risk. This new research developed an automated method, underpinned by scientific understanding on seismic hazard and structural fragility, to make risk assessments more accurate, consistent, and helpful for choosing which retrofitting interventions should be a priority.

The research was sponsored by the FHWA Office of Bridges and Structures, and conducted by David Yang, Arash Khosravifar, and Diane Moug of PSU's Maseeh College of Engineering and Computer Science and Avinash Unnikrishnan at University of Alabama, Birmingham (former faculty at PSU).

"Previously a lot of risk assessments were based on empirical assumptions or panel sessions where engineers sit together and try to evaluate what will be the hazard scenarios for our region, what are their frequencies, and what are the damage likelihood and extent to our transportation structures. While this is useful, latest advances on earthquake engineering and performance-based engineering can offer more reliable ways to assess risk," Yang said.

> **"The challenge is how these latest advances can be incorporated into the asset management practice and bridge management systems (BMSs) used by transportation agencies. Our research aims to fill in this research gap."**

Existing BMSs use a table of expert-elicited hazard scenarios. Keeping the format of a risk table, the new method selects scenarios, evaluates likelihoods and consequences of scenarios, and weights their importance to overall risks, all based on well established information on hazard and structural characteristics. This makes it more consistent and objective.

WHO CAN USE THIS RESEARCH?

Who are the stakeholders for accurate seismic risk assessment? It encompasses many: communities at risk, structural engineers, insurance and reinsurance industries, and various federal, state,

and local agencies, such as the Federal Emergency Management Agency (FEMA), ODOT, Portland Bureau of Transportation (PBOT), and state and local emergency management offices.

The framework developed by the team accounts for direct monetary impacts due to both deterioration and natural disasters, as well as for indirect impacts on the functionality of highway networks. This lets various stakeholders identify which bridges, tunnels, or routes pose the greatest risk to the system performance — and make smarter, more cost-effective decisions to keep people and transportation networks safe.

The methods developed by the research team can handle large, complex networks and account for low-probability but high-impact events, and they outperform previous, more subjective approaches in both accuracy and robustness.

To facilitate application, the model's source code is shared with FHWA and is accessible by agencies who wish to use it. While this report focuses on earthquakes, the general theory can be adapted for other hazards as well, making it potentially useful for a wide variety of resilience efforts.

The report, "Framework and Methodology for Risk-Based Bridge and Tunnel Asset Management: Objective Risk Assessment and Network Level Evaluation," represents the first of a two-phase research project aimed at assessing and managing the condition and risk of bridges and tunnels.

In the second phase, the research team will prepare a repository of risk tables for all the bridges in Oregon, creating a case study for the new method and helping ODOT to prioritize retrofits and repairs.

THE RESEARCH TEAM

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MORE ABOUT THIS STUDY

The complete report can be found at:
https://trec.pdx.edu/research/project/1557