Research Project Highlight

Probabilistic Regional Seismic Risk Assessment of a Los Angeles Bridge Network Using a New Generation of Fragility Functions

TSRP Topic 2: Forward Uncertainty Quantification

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Start-End Dates:
8/1/2023 – 7/31/2025

Abstract
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The Pacific Earthquake Engineering Research (PEER) Center's performance-based earthquake engineering (PBEE) framework provides an effective convolutional integral to incorporate different stochastic processes into evaluating the performance of bridges at the demand, damage, and risk levels. As an essential element in the seismic risk assessment workflow, fragility models predict the damage probabilities of bridge components and systems conditioned on the ground shaking intensity. The primary goal of the proposed project is to integrate the new-generation bridge fragility (g2F) models into the stochastic event-based regional seismic risk assessment of the bridge network in the city of Los Angeles (LA). This testbed high-resolution risk assessment aims to enhance Caltrans' situational awareness of its bridge infrastructure to facilitate planning, management, and emergency response. While regional risk assessment of building assets has seen considerable progress, there is a significant gap in the state of research and practice to conduct such high-resolution assessment for bridge infrastructure at a regional scale. It is the goal of this project to address this gap by developing the required analysis models to extend the PBEE framework and equip the research community with adequate and timely tools towards end-to-end seismic risk simulations of bridge networks.

Deliverables
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Deliverables include a PEER report and a top-tier journal paper. The developed analysis tools and data inputs/outputs will be made open-source and provided to the PEER community for related studies. Research outcomes will be presented at the PEER Annual Meeting and PEER Researcher's Workshop.

Research Impact

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The developed bridge risk map can be used by decision-makers to identify emergency routes for first responders to better prepare, plan for, and react to the forthcoming strong earthquake. It can also help Caltrans to assess high-risk areas and prioritize critical bridges for seismic retrofits. In the long term, resilience metrics such as restoration trajectories of traffic capacity and speed limit against each bridge damage state can be added to the analysis workflow to assess to what degree individual bridge performance would affect the resilience of the transportation network, which will improve policy makers' capability towards more effective resilience planning for the city of LA. Moreover, the existing simulation software tools developed by the SimCenter are mostly customized for building assets. Its simulation capacity will be significantly enhanced by incorporating some of the models developed from the proposed project. This effort will pave the path for engaging the research community worldwide to initiate relevant risk assessment studies for bridge infrastructure.
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Project Image

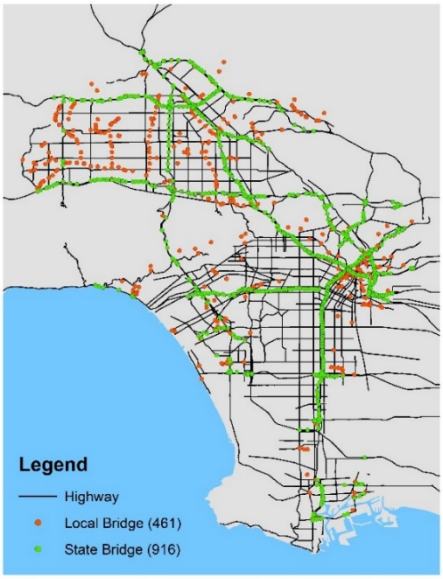

Figure 1. Los Angeles highway network showing all state and local bridges.

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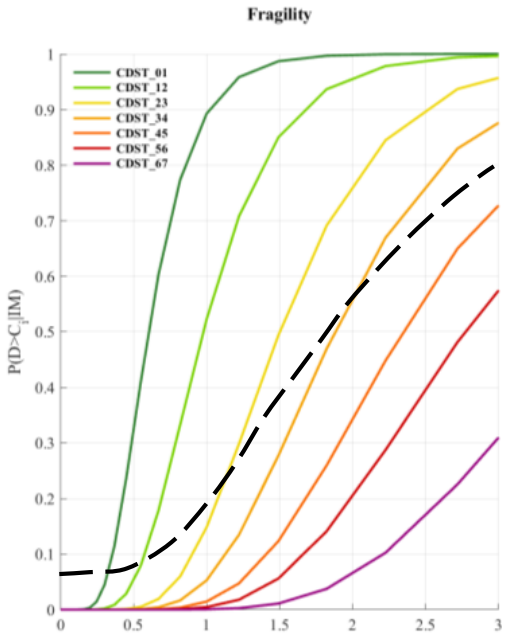

Figure 2. Preliminary fragility model comparisons between the g2F fragility models (colorful lines) and HAZUS models (black lines) for transverse column responses in an Era 3 bridge with flexural failure

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