DRISI

Caltrans Division of Research, Innovation and System Information

Research Notes

Generation-2 Seismic Bridge Fragility Models - Production Analytical Components

This research extends the initiative to complete models for other concrete bridge classes and initial scoping studies for steel bridges for implementation into ShakeCast.

Geotechnical/ Structures

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Project Title:
Generation-2 Bridge Fragility Models - Production Analytical Components

Task Number: 1780

Start Date: January 1, 2023

Completion Date: June 30, 2024

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WHAT IS THE NEED?

Major earthquakes can severely disrupt transportation networks. Immediately after an earthquake, the California Department of Transportation (Caltrans) emergency managers and decision-makers need to understand field conditions to coordinate the response and to dispatch bridge inspection resources. Since 2008, Caltrans has used the ShakeCast alerting system to provide early situational awareness to emergency managers. ShakeCast uses a combination of ground-shaking maps developed in near-real time by the United States Geological Survey, coupled with pre-calculated bridge fragility relationships, to rapidly estimate the bridge damage. Fragility relationships are statistical models describing the probability that a specific level of shaking will induce varying degrees of bridge damage, ranging from minor spalling of concrete to complete bridge collapse.

The first-generation fragility models, developed in the early 1990s, have several limitations that affect their usefulness for emergency response and planning applications. Most importantly, the models do not address substantial variations in bridge performance associated with the full range of bridge types, configurations, and design eras existing in California. In addition, the bridge damage-state definitions are not clearly associated with the identification of post-earthquake emergency repair needs and available traffic capacity, and they provide only a qualitative sense of damage for the entire bridge, with minimal details about quantitative engineering metrics or where the damage might be located.

Task 1780 is the second phase of Project P266 that builds upon the knowledge and experience gained through an initial end-to-end application of the methodology completed under the phase-one feasibility studies (Task 1755). This new phase will develop and optimize a set of generation-2 fragility models for most concrete bridge classes in California.

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WHAT ARE WE DOING?

This new work extends prior research on the development of a new generation of more accurate and more useful seismic fragility models for California bridges. The prior work provided models for concrete box-girder bridge types. This contract extends the initiative to complete models for other concrete bridge classes and initial scoping studies for steel bridges using the same, now proven, methodology and research team. Fragility models are statistical equations that describe the probability that a specific level of earthquake shaking will induce varying degrees of bridge damage. The new fragility models will be incorporated into Caltrans' ShakeCast earthquake alerting system to support emergency response, risk mitigation planning, and seismic reliability evaluations of the state bridge inventory.

WHAT IS OUR GOAL?

Improve Caltrans' ShakeCast earthquake alerting system to support emergency response, risk mitigation planning, and seismic reliability evaluations of the state bridge inventory.

WHAT IS THE BENEFIT?

A more effective post-earthquake emergency response where incident commanders, decision makers, and field inspectors have excellent situational awareness early in the response-operations timeline. Additionally, these same tools will improve transportation-system planning by providing a uniform basis to assess the seismic reliability of California's bridge inventory over a full range of hazard levels. Both applications will preserve and protect human life and safety as well as achieve significant long-term cost savings by reducing manageable earthquake-related fatalities, facility damage and transportation-network downtime along with associated liabilities.

WHAT IS THE PROGRESS TO DATE?

Proposed.