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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

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Research Notes

Geotechnical /Structures

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Project Title:

New Near-Fault Adjustment Factors for Caltrans Seismic Design Criteria (SDC)

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New Near-Fault Adjustment Factors for Caltrans Seismic Design Criteria (SDC)

This research will update near-fault adjustment factors for use in bridge design.

WHAT IS THE NEED?

Recordings from past earthquakes reveal that ground shaking near a rupturing fault can cause significantly more damage than shaking at greater distances. Since 1992, the California Department of Transportation (Caltrans) has increased the design response spectrum at locations within 15 km of a fault to account for the potential severity of shaking. Caltrans has made only minor modifications to these near-fault increases using period-dependent adjustment factors since their inception.

Additionally, under severe earthquake ground motions, structures go to the inelastic range. Therefore, further refinement of the near-fault adjustment factors is necessary, based on recent earthquake events, to better account for the effects of inelastic response.

WHAT ARE WE DOING?

The research will use the Directivity-Based Intensity Measure Interactive Maps available from the Natural Hazards Risk and Resiliency Research Center (NHR3) at the University of California, Los Angeles (UCLA) to assess directivity effects and determine if a simpler distance-from-fault parameterization can capture the effects. The research team will randomly select twenty locations and compare design spectral acceleration with and without directivity. Based on these comparisons, they will decide whether a distance-dependent model sufficiently captures the directivity effects or if mapped values should be used directly for adjustment factors.

The team will develop adjustment factors for modal analysis that account for the inelastic response to near-fault motion. They will calculate these factors for two selected ductility

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demand levels, considering a full range of pulse periods. The team will create target response spectra for two return periods (975 and 5000 years) and use scaled ground motions to develop adjustment factors for nonlinear time history analysis. This will account for bridge orientation, pulse period, and peak ground velocity. They will test at least two simple bridge models with a wide range of pulse-type input motions, including various pulse periods, peak ground velocities, and orientations.

WHAT IS OUR GOAL?

The research aims to update near-fault adjustment factors based on recent findings from a statewide seismic hazard model that includes near-fault effects and a study on the inelastic structural response resulting from near-fault input motions. This research will update near-fault adjustment factors for use in bridge design.

WHAT IS THE BENEFIT?

This research will refine the near-fault adjustment factors used in bridge design, incorporating the latest findings from seismic hazard models and studies on inelastic structural response to near-fault motion. By improving the accuracy of these factors, the research will enhance the safety and performance of bridges near faults, better accounting for the potential severity of ground shaking.

WHAT IS THE PROGRESS TO DATE?

The research comprises of a total of 3 tasks:

- Task 1: Use of of the NHR3 Directivity-Based Intensity Measure Interactive Maps to assess directivity effects;
- Task 2: Consideration of inelastic response; and
- Task 3: Development of near-fault adjustment factors applicable to nonlinear time history analysis.

These tasks are currently in progress, primarily focusing on determining the threshold distance for directivity and developing two directivity-amplification models based on return periods, magnitudes, and spectral periods. The next step will involve performing numerical simulation of bridges and comparing the results to those obtained using the current Caltrans near-fault factors.