Research Project Highlight

Uncertainty Quantification for Meeting Bridge Design Objectives

PEER-Bridge 2024

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Abstract
Caltrans Seismic Design Criteria requires that all ground motions are matched to the site's design spectrum using the time domain method (i.e. amplitude scaling); thus, the practice of spectral matching is not permitted. Often, engineers believe that amplitude scaling is necessary to maintain variability between ground motions that is not represented by a response spectrum; however, the practice of spectral matching has improved, and many practitioners are performing spectral matching such that component-to-component variability is maintained as opposed to being suppressed during tight spectral matching. There is currently no consensus on the presence of a systematic difference between spectrally matched motions and amplitude scaled motions. Thus, this project will use non-linear models of two Caltrans bridges to compare how the different scaling methodologies estimate means and distributions of bridge response parameters. The study will make use of the conditional scenario spectrum method to develop a ground truth for the bridge response.

Deliverables
The outcome of the study will be recommendations on best practices for modifying ground motions to determine a suite of records for use in bridge design. Finalized work will be presented in a Caltrans report, PEER report, a journal paper, and presentations at the PEER annual meeting. All data including the modified ground motions will be made publicly available as a supplement to the PEER report.

Research Impact
There is still considerable debate on the appropriate and best methods to select ground motions for time series analysis of structures. Furthermore, there is a large disconnect in thought between seismologists and structural engineers which has resulted in codes that have (1) multiple accepted methodologies for including uncertainty from seismic input and (2) express the need for consideration of uncertainty without providing direct guidance. By comparing the resulting statistics of engineering demand parameters and

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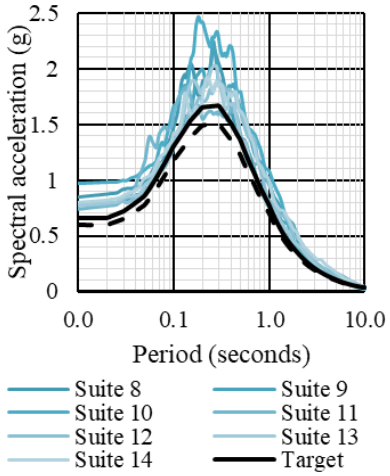
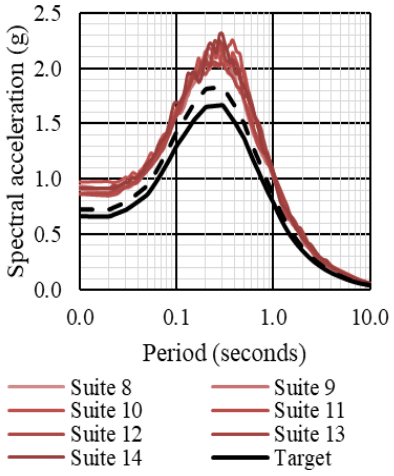
damage states arising from suites of different ground motion selection and scaling methods and comparing the resulting uncertainties against that from the original seismic hazard analysis as well as the structural model and material uncertainties, we will build a strong basis to (1) give explicit recommendations on the effect of ground motion selection methodologies that should be used for design, and (2) provide clear guidance on how practitioners can maintain means and uncertainties. As a result, this work will facilitate procedures for bridges requiring nonlinear dynamic analysis, reducing design costs, and bolster confidence in the seismic performance of these structures. Furthermore, through understanding the uncertainty in the analysis, stakeholders can be given more power to select beyond-code-conforming behavior. Thus, the research is of strong interest to Caltrans structural and geotechnical engineers, structural engineering firms, geotechnical engineering firms, and code committees.

Project Image

Suite median values of amplitude scaled motions



Suite median values of spectrally matched motions



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