Research Project Highlight

Accounting for Earthquake Duration in Performance-Based Evaluation and Design of Bridges (UNR-Stanford Collaboration)

Project # 1143-NCTRDS

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Start-End Dates:
4/1/2018-6/30/2020

Abstract
Previous studies have shown that earthquake duration can have a significant effect on structural performance, decreasing displacement capacity on the order of 25% and increasing the risk of structural collapse, compared to shorter-duration motions upon which most design models and criteria are based. In addition to concerns related to long-duration motions from large magnitude (M8 and M9) earthquakes, duration effects are also important for evaluating structural performance under aftershocks and multiple earthquake events.

The overall goal of this project is to develop models and recommendations for considering earthquake duration in the performance assessment and design of bridges. Related objectives are (1) to develop improved design details to mitigate the effect of duration on reinforced concrete bridge piers; and (2) to leverage research on cyclic deterioration to help qualify the use of high-strength reinforcement in the seismic design of bridges. Four shake table column experiments will be conducted at the University of Nevada, Reno that will be extended through the use of analytical modelling. The test results and analyses will be integrated through the PEER performance-based framework to consider the combined effects of ground-motion intensity, spectral shape, and duration on structural response. The framework will be applied to develop and calibrate performance-based design requirements that account for earthquake duration. The proposed research will be conducted through two companion projects at the University of Nevada, Reno and Stanford University.

Deliverables
- Four shake-table bridge column tests that extend previous experimental research on duration effects. The proposed tests will examine how high-strength reinforcement and different detailing

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configurations (transverse steel ratio and debonding details) impact column performance under long-duration motions.

- Analytical studies that utilize the new and existing experimental results to relate the damage, deformations, and collapse safety of bridges to design parameters and earthquake ground-motion duration.
- Develop recommendations for design and performance assessment of concrete bridges that utilize the experimental and analytical results.

Research Impact

This project will develop seismic design provisions that account for earthquake duration effects, which are especially for Northern California, Oregon, and Washington where large subduction earthquakes are expected to occur. The project will also contribute to the reliable use of high-strength reinforcement for bridges in high seismic regions and develop details for mitigating duration impact. The PI's will work with Caltrans, AASHTO, ACI, and other organizations to implement the research findings into design standards.

Project Images

(a) Shake table experiments

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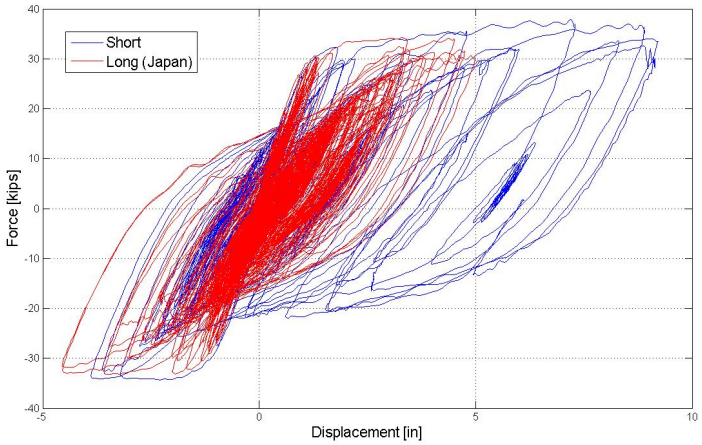

(b) Impact of duration of bridge performance

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