Background and Motivation

- Although ground motion duration is widely believed to be important in structural performance assessment, results from prior research have been mixed and inconclusive.
- The numerical models used in these studies did not capture in-cycle and cyclic deterioration of strength and stiffness, and the effect of duration on collapse capacity has not been previously studied.
- Current design provisions, performance assessment studies and cyclic loading protocols do not explicitly consider ground motion duration.
- Recent large magnitude earthquakes like the 2008 Wenchuan, 2010 Chile and 2011 Tohoku earthquakes reinforce the importance of duration while providing useful new data.

Objectives

- To assess the effects of ground motion duration on structural performance and collapse capacity using realistic models that incorporate in-cycle and cyclic deterioration.
- To determine which duration metric is best suited for use within the PBEE framework.
- To create a benchmark long duration record set that can be used in performance assessment studies.
- To identify types of structures, regions and situations where ground motion duration is expected to be important.
- To evaluate and propose how to incorporate the effects of duration into the PBEE framework (in hazard characterization and ground motion selection), design codes and cyclic loading protocols.

Analysis of Ground Motion Duration Metrics

- Arias Intensity $A_I = \frac{\pi}{2g} \int_{0}^{t_{\text{max}}} a(t) dt$
- Cumulative Absolute Velocity $C AV = \int_{0}^{t_{\text{max}}} \left| a(t) \right| dt$
- Significant duration $(5-95\%, 5-75\%$ and $2.5-97.5\%$ ranges)

5-95\% Significant duration ($t_{95-5}$) also found to best capture the expected decreasing trend in collapse capacity with duration in the structures analyzed and thus identified as most suitable duration metric.

Long duration record set

- 4200 records obtained from the following events:
  - 1974 Lima, Peru
  - 2004 Niigata, Japan
  - 1979 Imperial Valley, USA
  - 2007 Chiangri, Japan
  - 1985 Sylpho, Chile
  - 2001 Ino, Japan
  - 1985 Michoacan, Mexico
  - 2008 Wenchuan, China
  - 1995 Kobe, Japan
  - 2010 Maule, Chile
  - 1999 Chi-Chi, Taiwan
  - 2003 Hokkaido, Japan
  - 2011 Tohoku, Japan

Spectrally equivalent short duration record set

- For every long duration record, a corresponding short duration record with similar spectral shape was chosen, to serve as a control for the effect of spectral shape.

Concrete Bridge Pier Model

- Concrete column tested by PEER and NEES at UC San Diego
- Modeled as an SDOF system

Rotational Spring

- Modified Biarre-Medina-Krawinkler peak-oriented model with in-cycle and cyclic deterioration

Effect of Ground Motion Duration on Structural Collapse Risk

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