

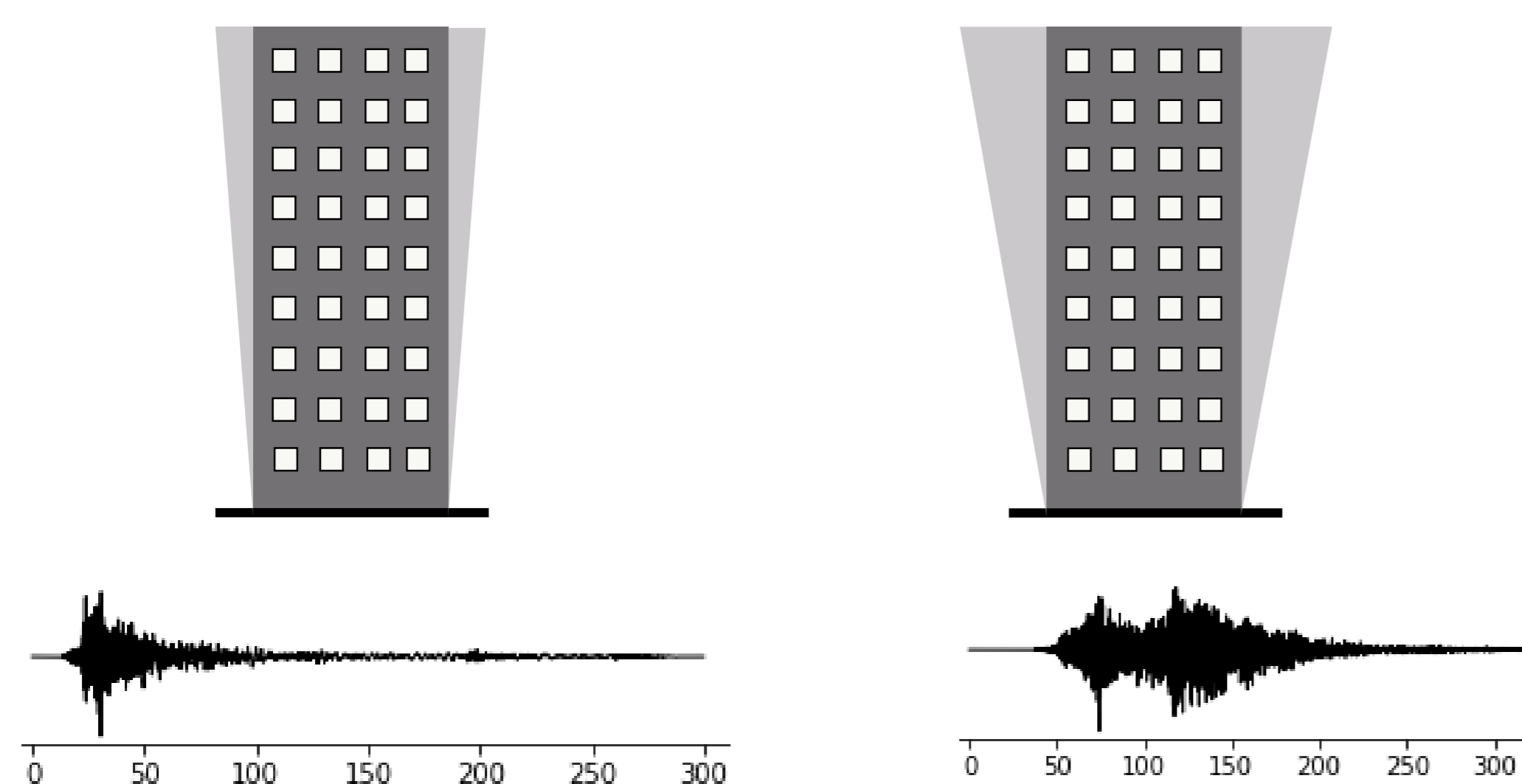
Effect of Ground Motion Duration and Response Spectral Shape on Seismic Performance of Steel Moment Resisting Frame Buildings

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Background and Motivation

- ▶ Relying only on peak amplitude of ground motion is not sufficient to predict the seismic response of structures



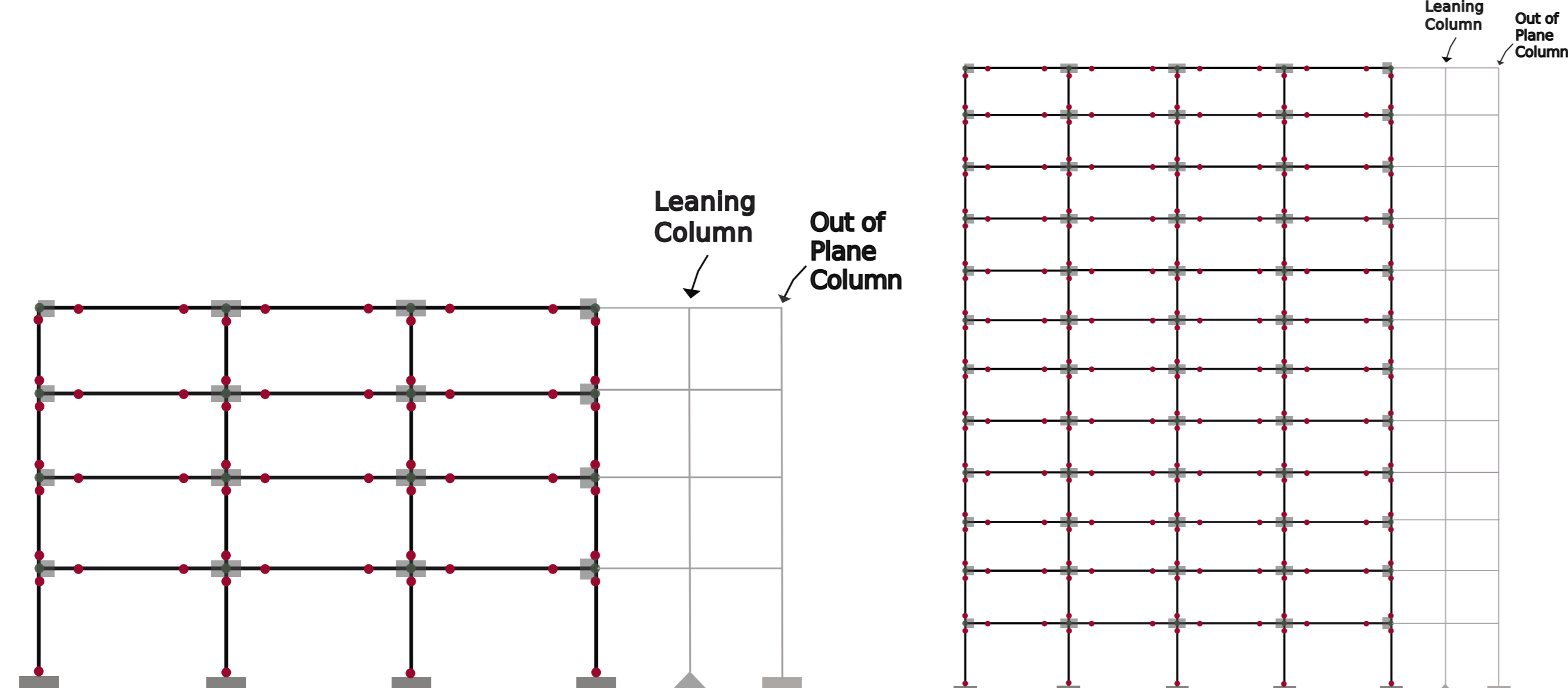
- ▶ Ignoring duration of ground motion may overestimate the collapse capacity of structures located on sites susceptible to long duration earthquakes.
- ▶ Another important characteristics of ground motion is its response spectral shape. Shape of Uniform Hazard Spectrum can be very different from the shape of response spectrum of a real ground motion of equivalent peak amplitude.
- ▶ FEMA P695 shows that neglecting the effect of spectral shape can lead to underestimation of collapse capacity of structures up to 60

Objectives

- ▶ To implement the recently developed framework in the US structural design practice for consideration of ground motion characteristics in the context of New Zealand buildings
- ▶ To observe the effect of duration of ground motion on low and high rise steel moment resisting frame building
- ▶ To observe the influence of response spectral shape on response of the building

Numerical Model

- ▶ Structural models selected for the study
 - ▶ Low rise(4 story) and high rise(12 story) typical office building designed for Wellington
 - ▶ 2D perimeter frame modeled in OpenSees platform
 - ▶ Beam hinges are assigned at the location of reduced section of the beam



- ▶ Hysteretic response of the concentrated plastic hinge at beam and column follows the Modified Ibarra Krawinkler Deterioration Model calibrated for steel components [2011].

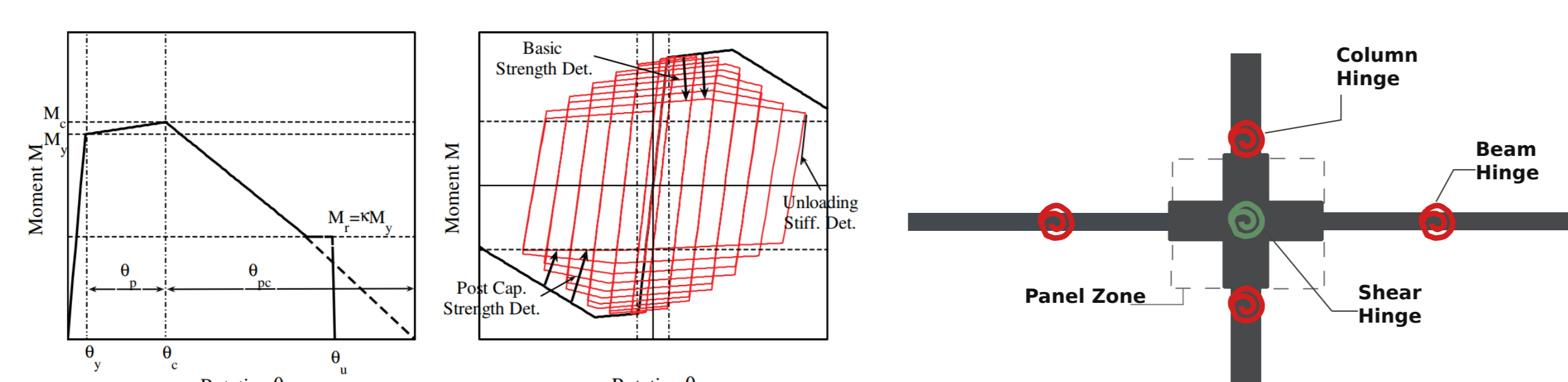


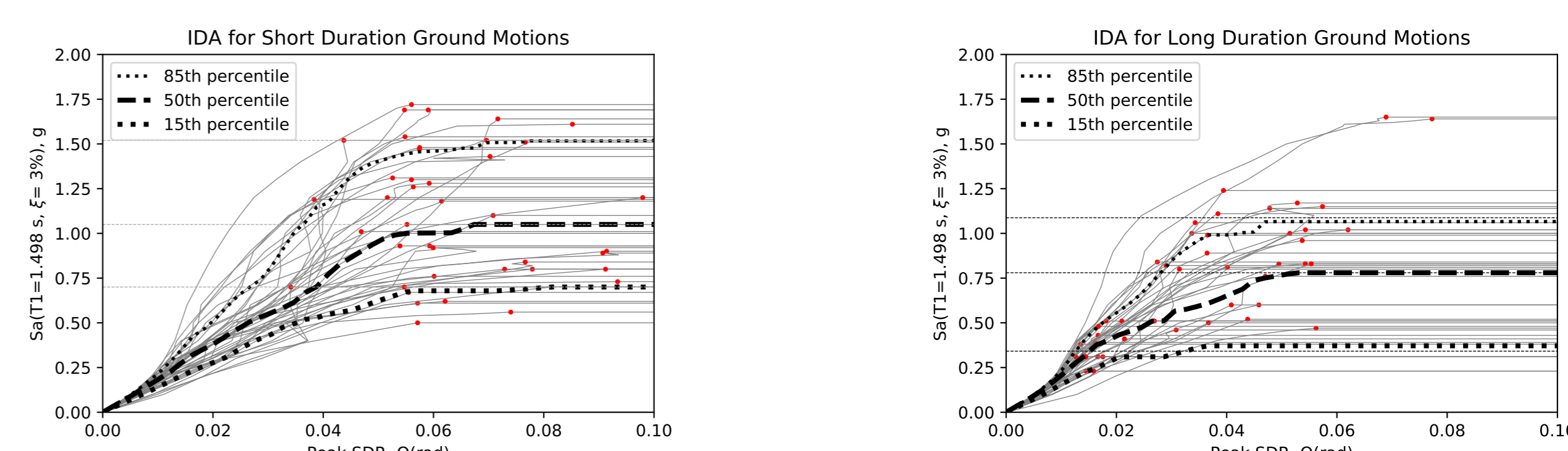
Image source:Lignos and Krawinkler(2011)

Incremental Dynamic Analysis

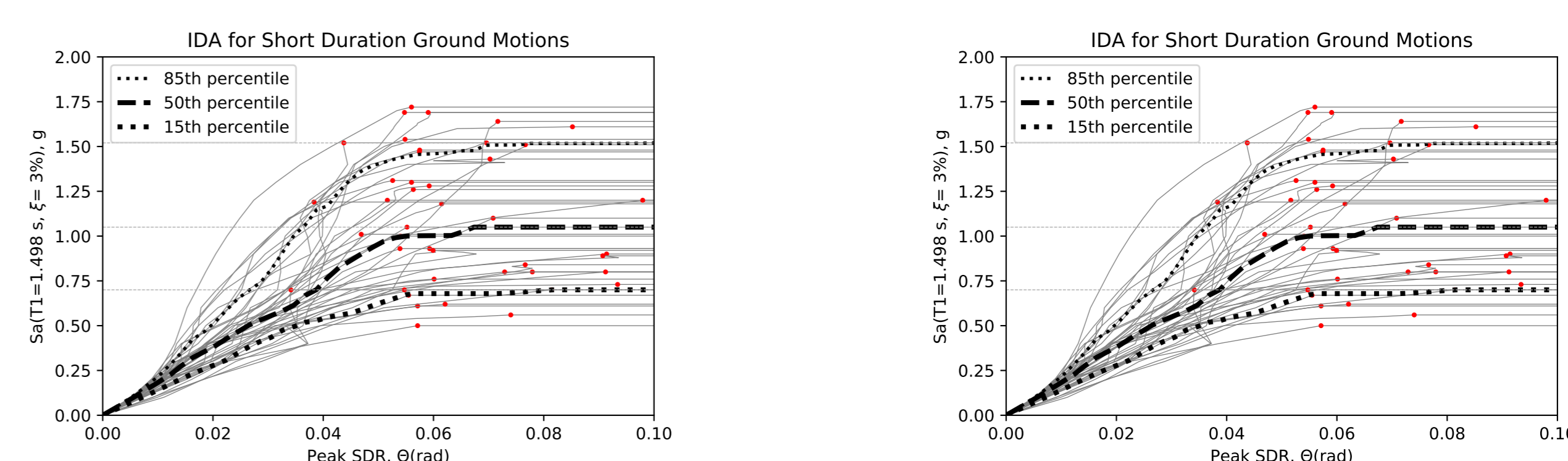
- ▶ 2 spectrally equivalent sets of 44 far field ground motion records from FEMA P695, each set representing long and short duration ground motions.
- ▶ Implementation of automated algorithm and parallel computing

IDA Curves

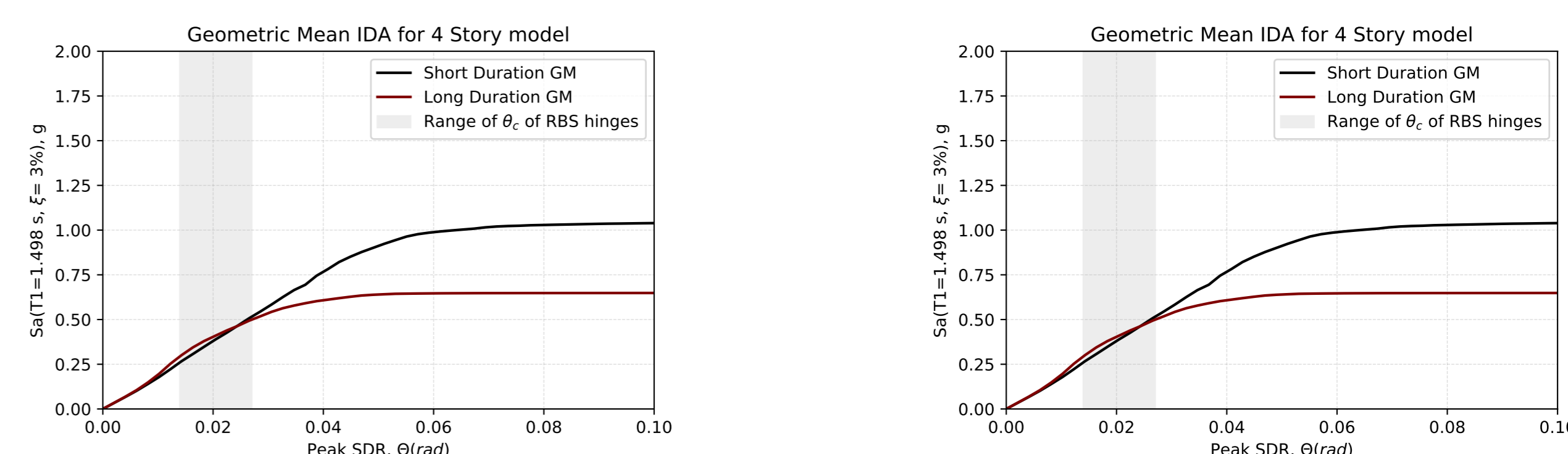
- ▶ IDA curves for all records along with percentiles for 4 story model



- ▶ IDA curves for all records along with percentiles for 12 story model

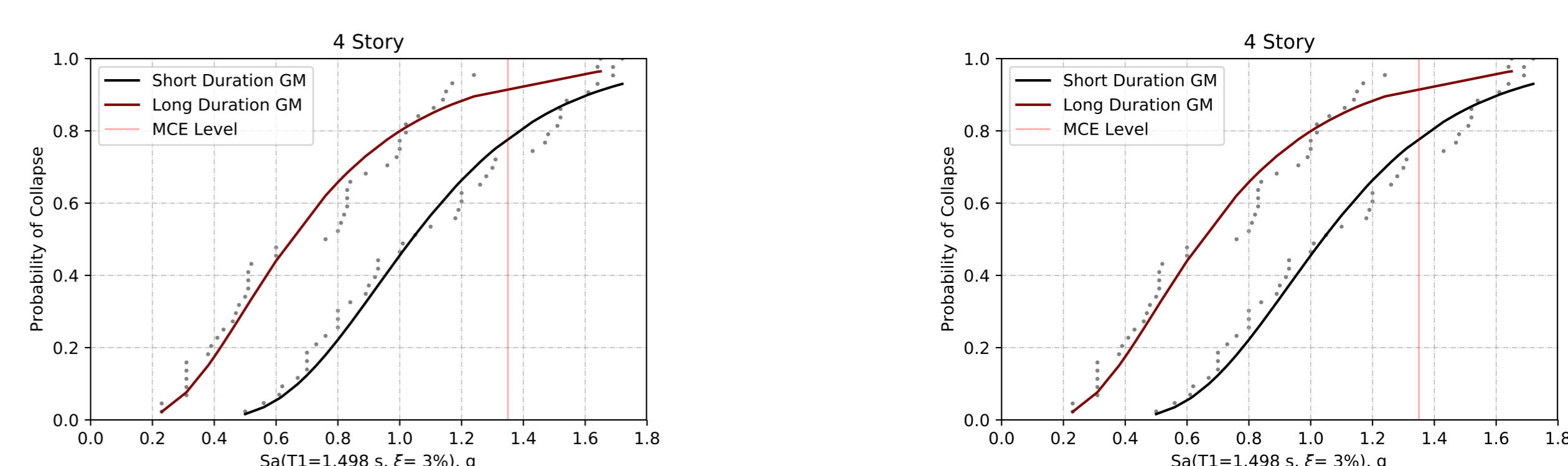


Geometric Mean of IDA curves



- ▶ The gap between mean collapse capacities of long and short duration ground motions at higher intensity is up to 37 percent for 4 story model

Collapse Fragility Curves



- ▶ 13 percent difference in collapse probability due to duration of ground motion at MCE level(1.35g) of Wellington for 4 story model

Conclusions

- ▶ Divergence of mean collapse capacities shows that duration of ground motion makes significant difference when structure is responding in nonlinear range of deformation.
- ▶ Comparison of collapse fragilities illustrates that the probability of failure is higher for long duration ground motions at a specific intensity level which is relevant to the studies conducted on influence of ground motion duration

Future Works

- ▶ Study the effects of response spectral shape of ground motions
- ▶ Develop hazard consistent collapse fragility curve through post processing of results from IDA