

# Plans and progress on "Guidance on the utilization of earthquake-induced GM simulations engineering practice"

Didier Pettinga, Brendon Bradley, Jeff Fraser

QuakeCoRE Flagship 1

# Objectives

The key objectives of this project are to engage leading researchers and practitioners (who represent research developers, users, and early industry adopters of ground motion simulations) over the course of two workshops, and ultimately result in this guidance document associated with the utilization of ground motion simulations in engineering practice (authored by the project team with input from workshop participants).

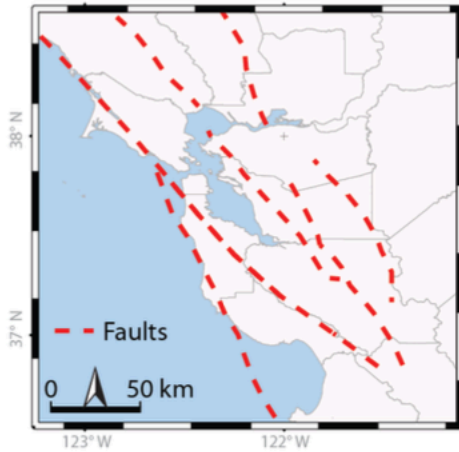
# Current document outline (v3)

## Table of Contents

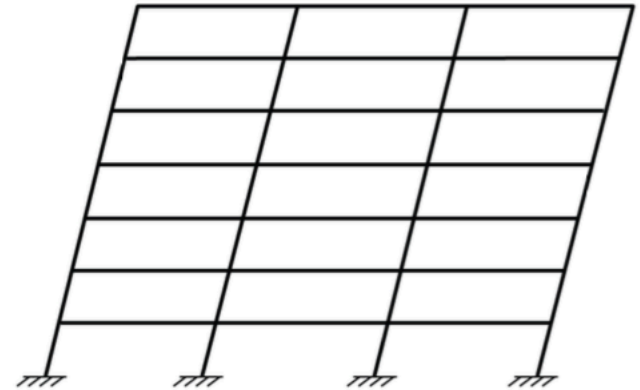
Executive Summary .....	4
1. Motivation, Objectives, Document development .....	5
1.1. Motivation.....	5
1.2. Objective .....	5
1.3. Document development process .....	5
2. Overview of key ground motion simulation ingredients .....	7
2.1. Wave propagation methodology .....	7
2.2. Earthquake source rupture .....	8
2.3. 3D model of the earths crust .....	8
2.4. Near surface site response modelling .....	9
3. Ground motion features of relevance for analysis .....	10
3.1. Use of simulations directly for hazard analysis, or simply design verification .....	10
3.2. Usable frequency range (or “relevant IMs” to be more general?) .....	11
3.3. Ground motion components.....	12

# Section 3.1

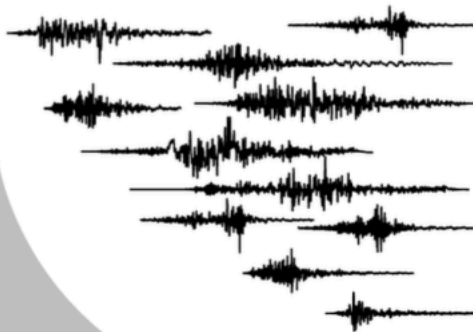
Seismic Sources



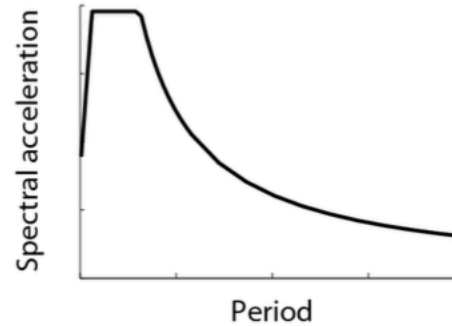
Structural Performance



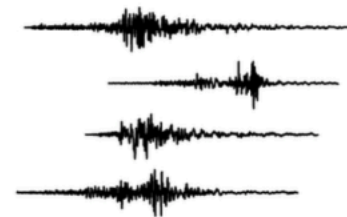
Ground Motions



Target Response Spectrum



Ground Motions



Hazard Analysis

Response History Analysis

4. Expected documentation for the utilization of ground motion simulations in earthquake engineering practice .....	13
4.1. Verification .....	13
4.2. Validation.....	14
4.2.1. What to validate.....	16
4.3. Utilization documentation.....	16
5. Checklist for simulation V&V and utilization documentation .....	17
6. Examples.....	17
6.1. Example 1: Use of the (1D crustal model) SCEC Broadband Platform.....	17
6.2. Example 2: Ground motion simulation of Porters Pass earthquakes on the Canterbury Plains.....	18
7. References.....	19
8. Appendix: Workshop details.....	23

# Validation 'checklist'

In the context of ground motion simulation, the multi-hierarchical nature of validation can be performed in the following contexts:

1. Validation of the 'general' ground motion simulation methodology against relevant worldwide historical earthquakes (validation of the methodology in general)
2. Validation of the methodology for earthquakes of a magnitude similar to that expected from the rupture to be considered (validation of the earthquake rupture generator)
3. For the particular geographical region in question, validation of the simulation method against observations from regional earthquakes (validation of the regional crustal model)
4. For the particular fault rupture considered, validation of the simulation method for small-to-moderate magnitude earthquakes in the vicinity of the fault of interest (validation of the regional crustal model for the specific wave propagation paths from the source to the sites of interest)
5. If explicit site response analyses are utilized, then appropriate validation of the adopted constitutive models should also have been considered (i.e. the equivalent of points 1-4 specifically for site response).
6. Validation metrics by which the simulated and observed ground motions are compared including: elastic response spectral ordinates over a broadband period range, inelastic-to-elastic spectral displacement ratios, significant duration, directionality of orientation-dependent spectra, and inter-period spectral ordinate correlations (validation via metrics which provide insight into the realism of the simulated ground motions for use in nonlinear inelastic response history analyses).

# Updated Timeline

- Project team develops guidance outline [March 2016]
- Workshop 1: (i) Presentations on GM simulation and use of GM time series in engineering practice; and (ii) Socialize initial guidance document concepts and elicit input from workshop participants [~~April 2016~~; **early June 2016**] (**small group ~10 people**)
- Project team develops revised guidance structure and details based on workshop 1 [~~May 2016~~; **late June/early July**]
- Workshop 2: Intention of workshop 2 is to develop wider consensus on the structure and details of the guidance document [July/**Aug** 2016] (**larger group of ~20 people**)
- Guidance document publication [August/Sept 2016]