4th International Conference on Rehabilitation and Maintenance in Civil Engineering

Building evaluation using two components of acceleration time histories causes by shallow crustal fault earthquakes with maximum magnitude 7 Mw

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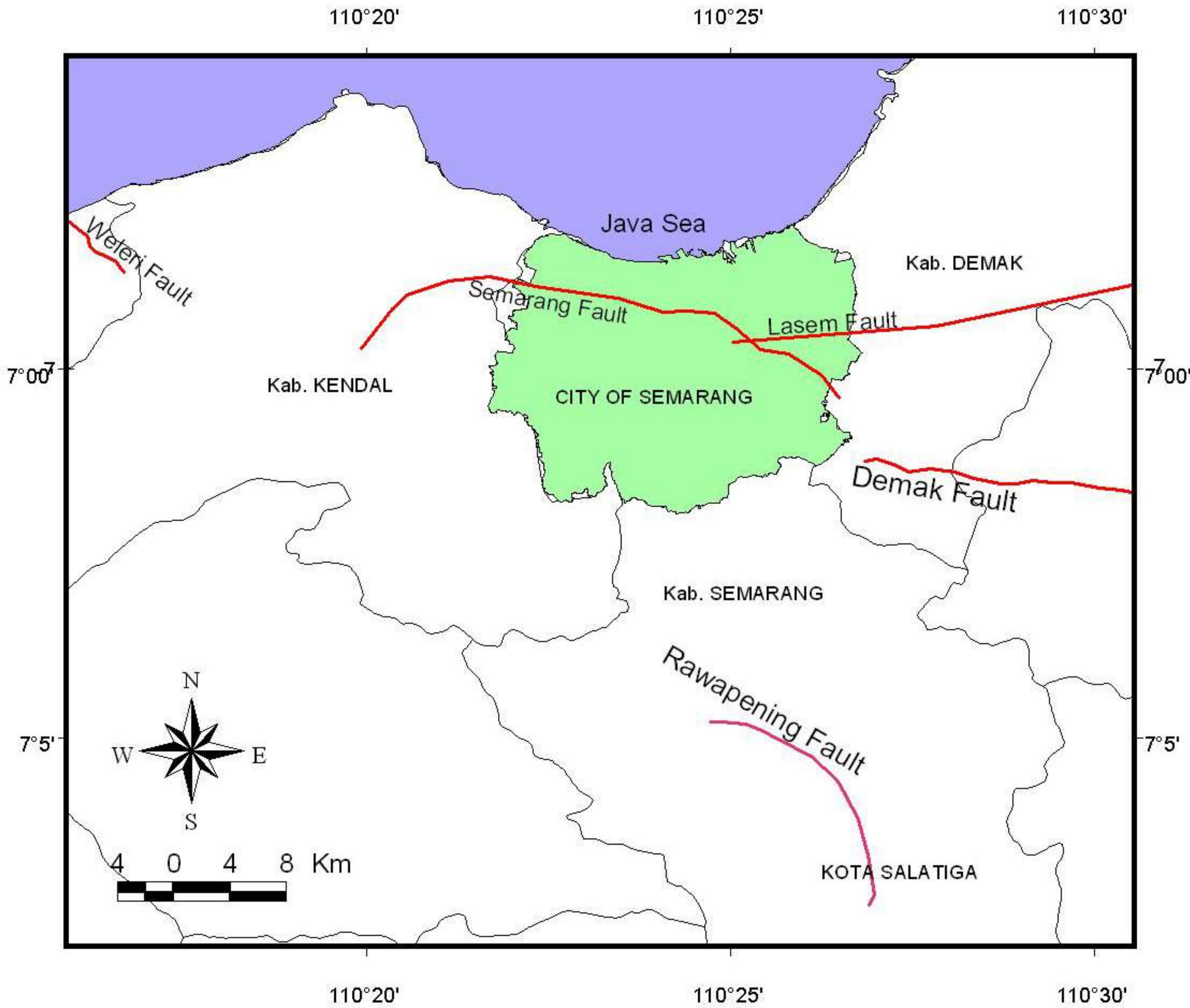
Introduction

- Fault is one of the dangerous earthquake sources that can cause building failure. A lot of buildings were collapsed caused by Yogyakarta fault (2006) and Pidie fault (2016) source earthquakes with maximum magnitude 6.4 Mw.
- Based on the research conducted by Team for Revision of Seismic Hazard Maps of Indonesia 2010 and National Center for Earthquake Studies (PUSGEN) 2017, Lasem fault and Semarang fault are two earthquake sources crosses Semarang.

Introduction



Introduction

- Stability analysis of a structure can be evaluated by conducting seismic loads. The objective of the analysis is to get the information of maximum loads that can be applied to a structure.
- The stability analysis in this study were implemented for 3 buildings (minimum 40 m height) at Semarang by conducting dynamic structural analysis and applying modified acceleration time histories.
- The modified acceleration time histories were developed from earthquake scenarios caused by Semarang fault earthquakes with magnitude 6 -7 Mw.

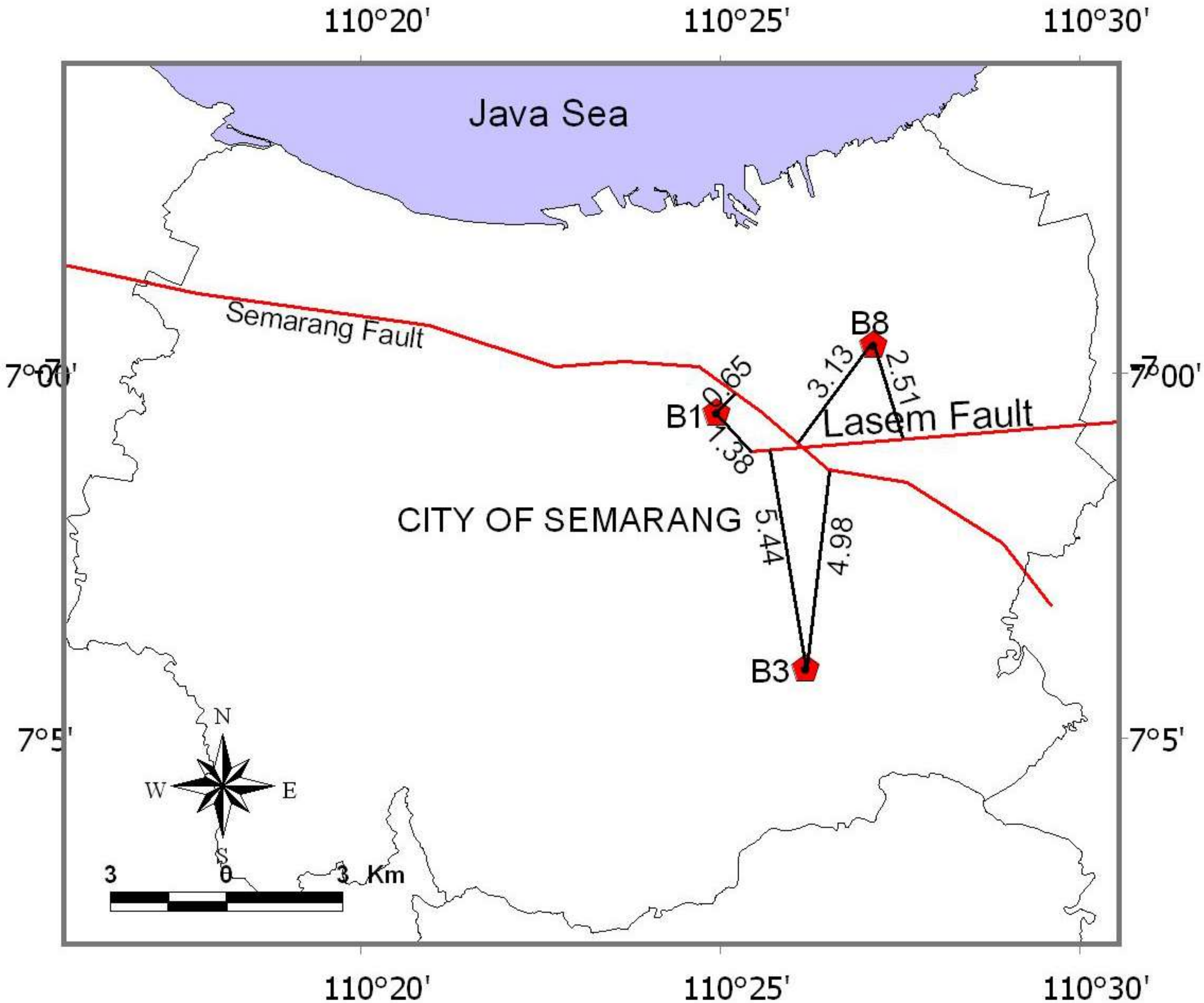
Research Methodology

1. Collecting **information and data** related with
   - structural details
   - geological and geotechnical data
   - positions of each building against seismic source
   - acceleration time histories due to shallow crustal fault sources with magnitude 6–7 Mw and maximum distance 30 km.
2. Developing modified acceleration time histories by conducting **response spectral matching analysis**.
3. Conducting **shear wave propagation analysis** using modified time histories for developing surface acceleration time histories
4. Performing **dynamic structural analysis** to get the deformation and drift ratio of buildings due to acceleration time histories and surface spectra developed from SNI:1726-2012.

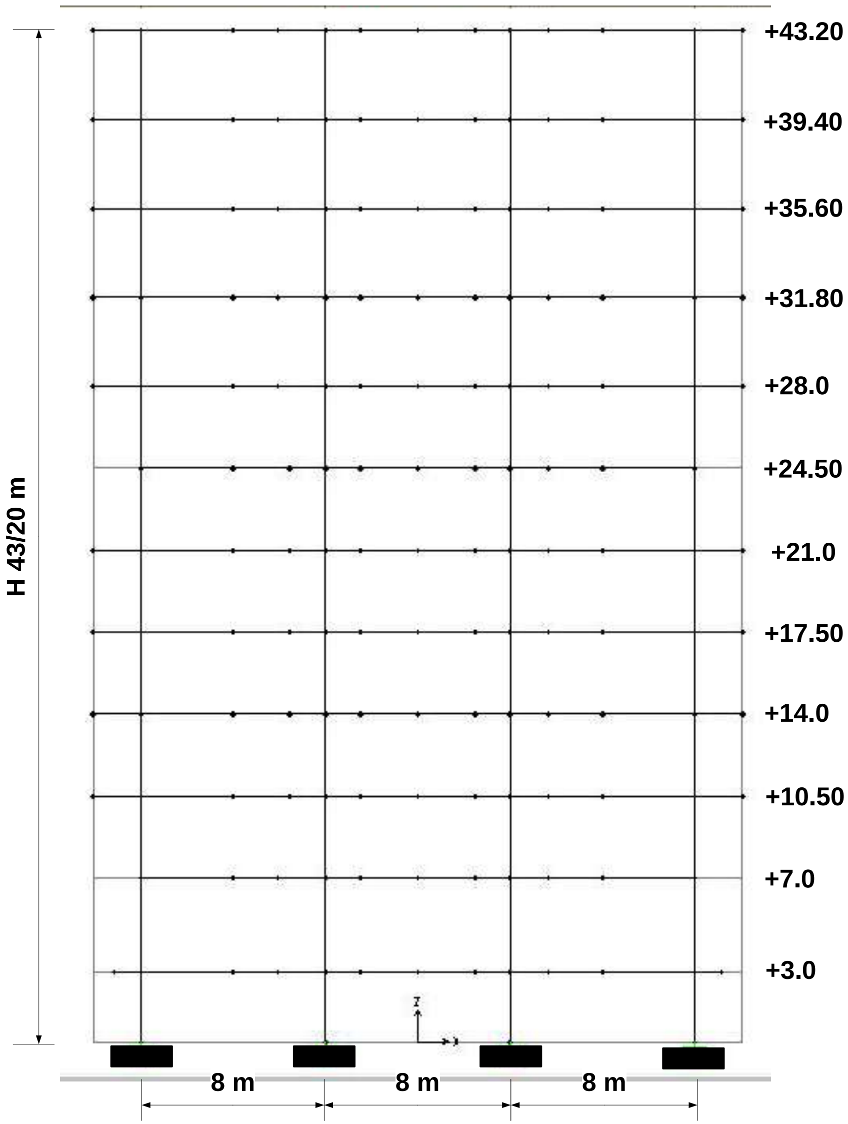
Data Requirements (building information)

Building Number	Dimension Plans (m)	Height of Building (m)	Site Class	Depth of Bedrock (m)	Distance to Seismic Source (Km)
B1 (Hospital)	22x78	48.73	SE	165	3.13
B3 (Hotel)	28.8x19.75	41.2	SC	40	0.65
B8 (University Building)	40.75x16.2	43.2	SD	60	4.98

Data Requirements (building position)

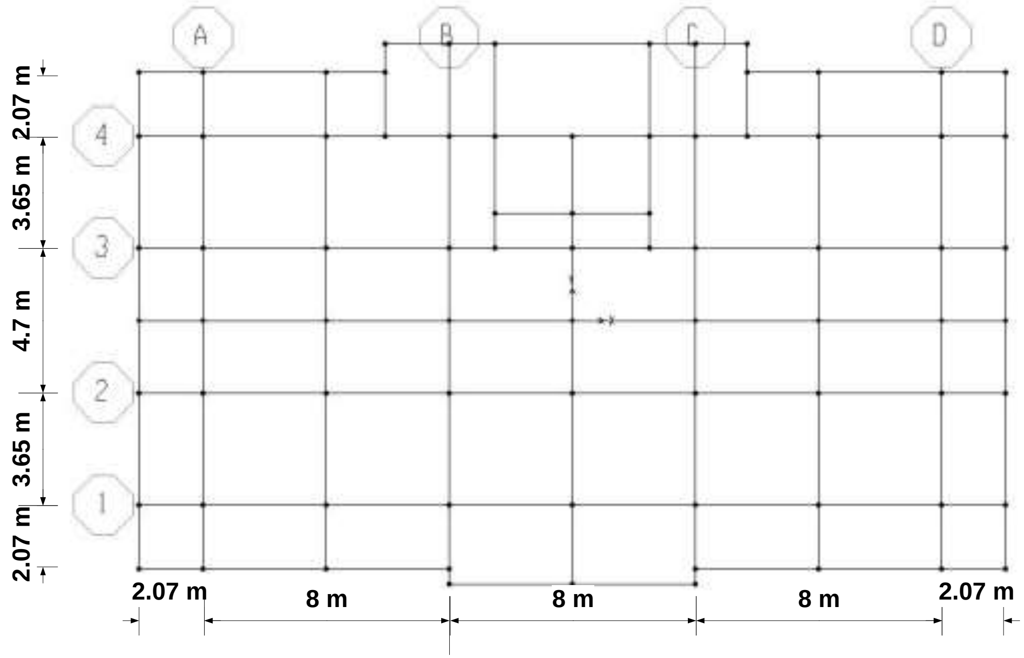


Data Requirements (structural details)

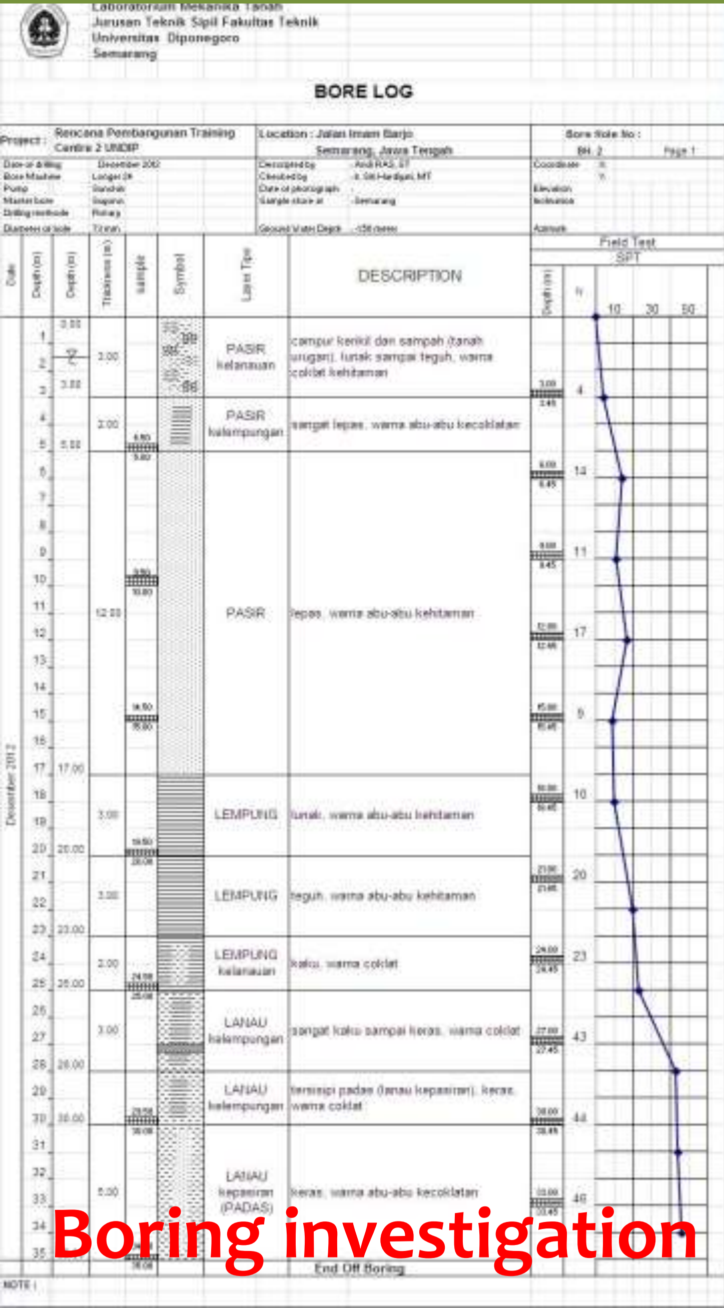


Building B3

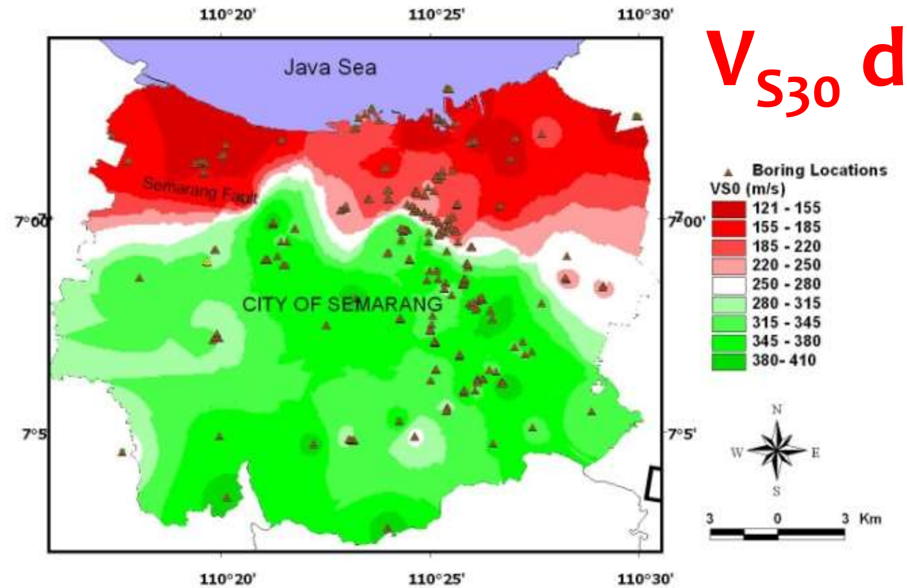
Plan, elevation, materials and detail of element structure



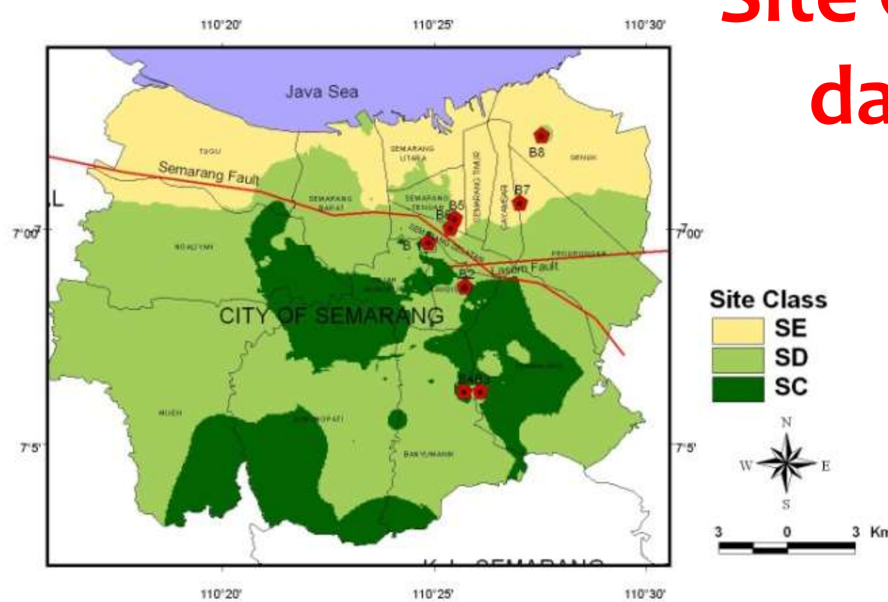
Data Requirements (geotechnical data)



Boring investigation

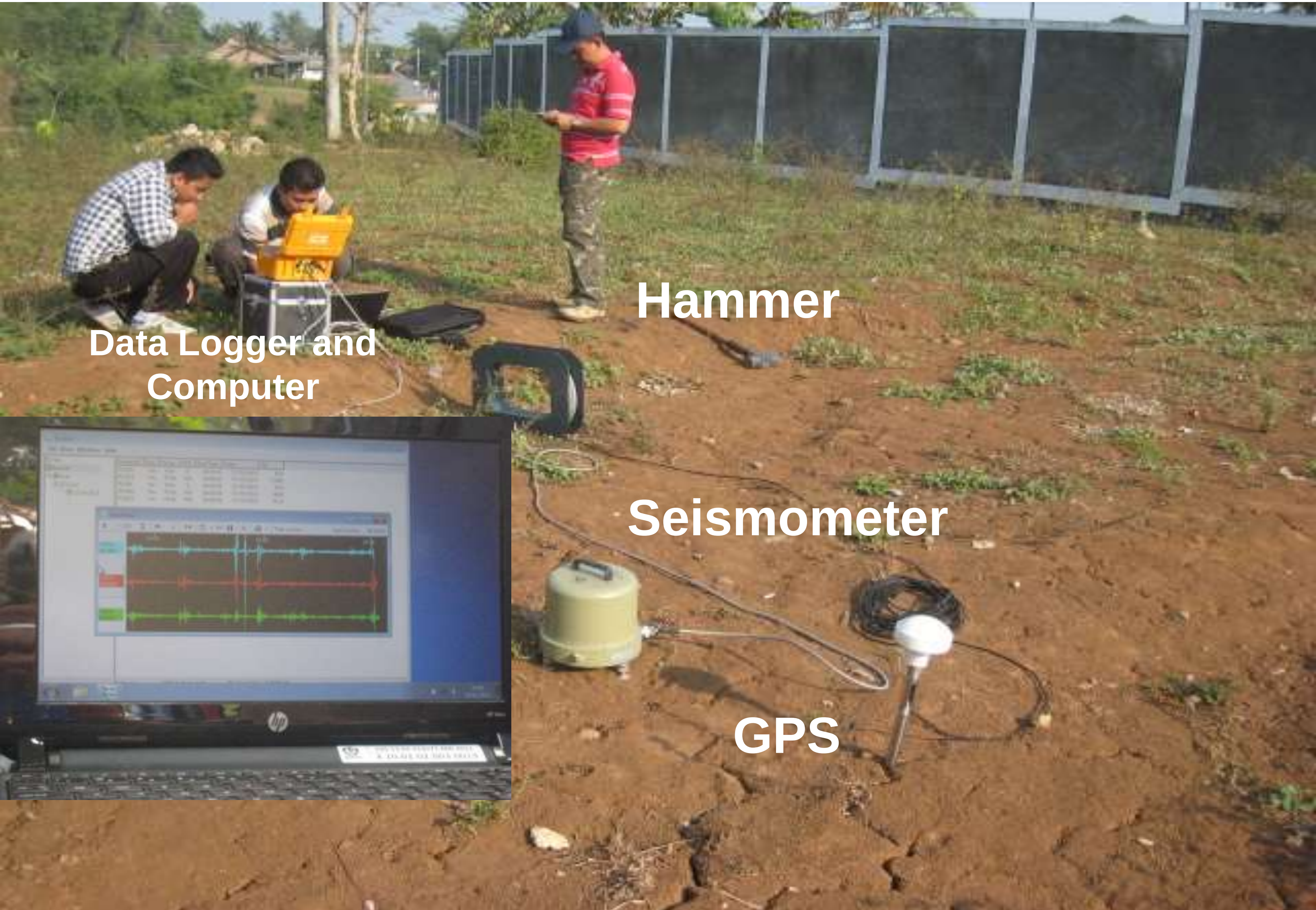


V_{S30} data



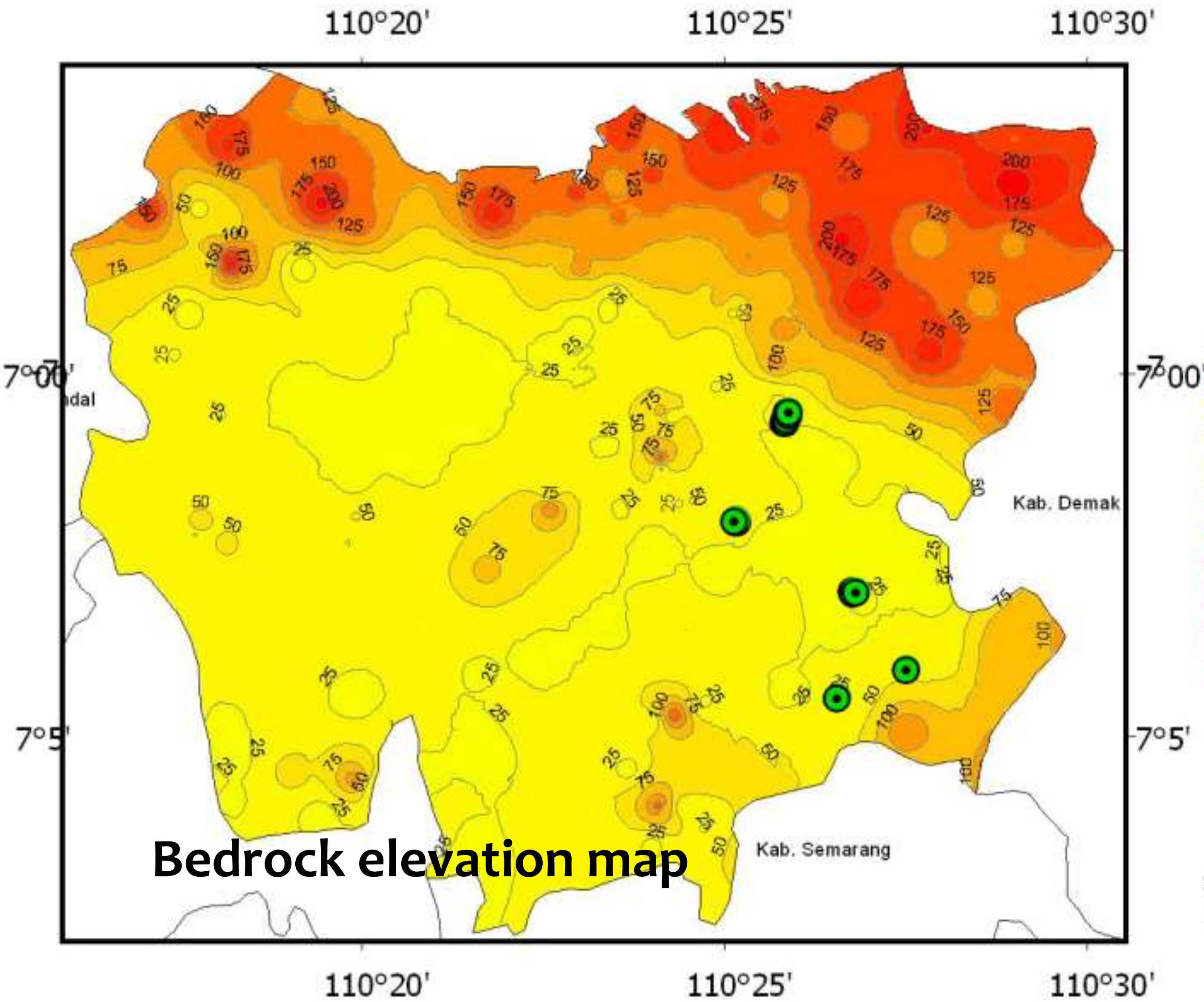
Site Class data

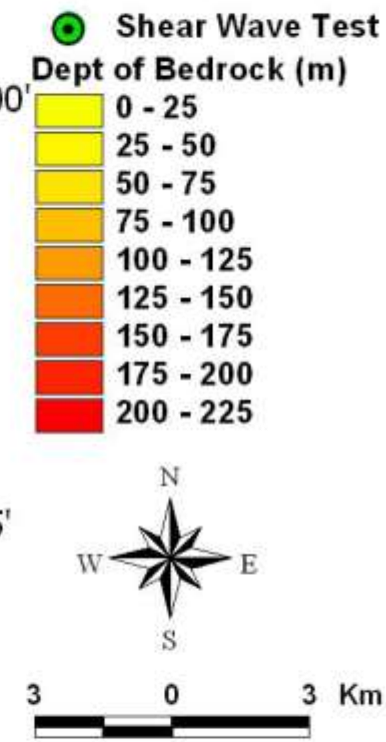
Data Requirements (Bedrock Measurement)



Data Requirements (Bedrock Measurement)

Bedrock Elevation





Bedrock elevation map

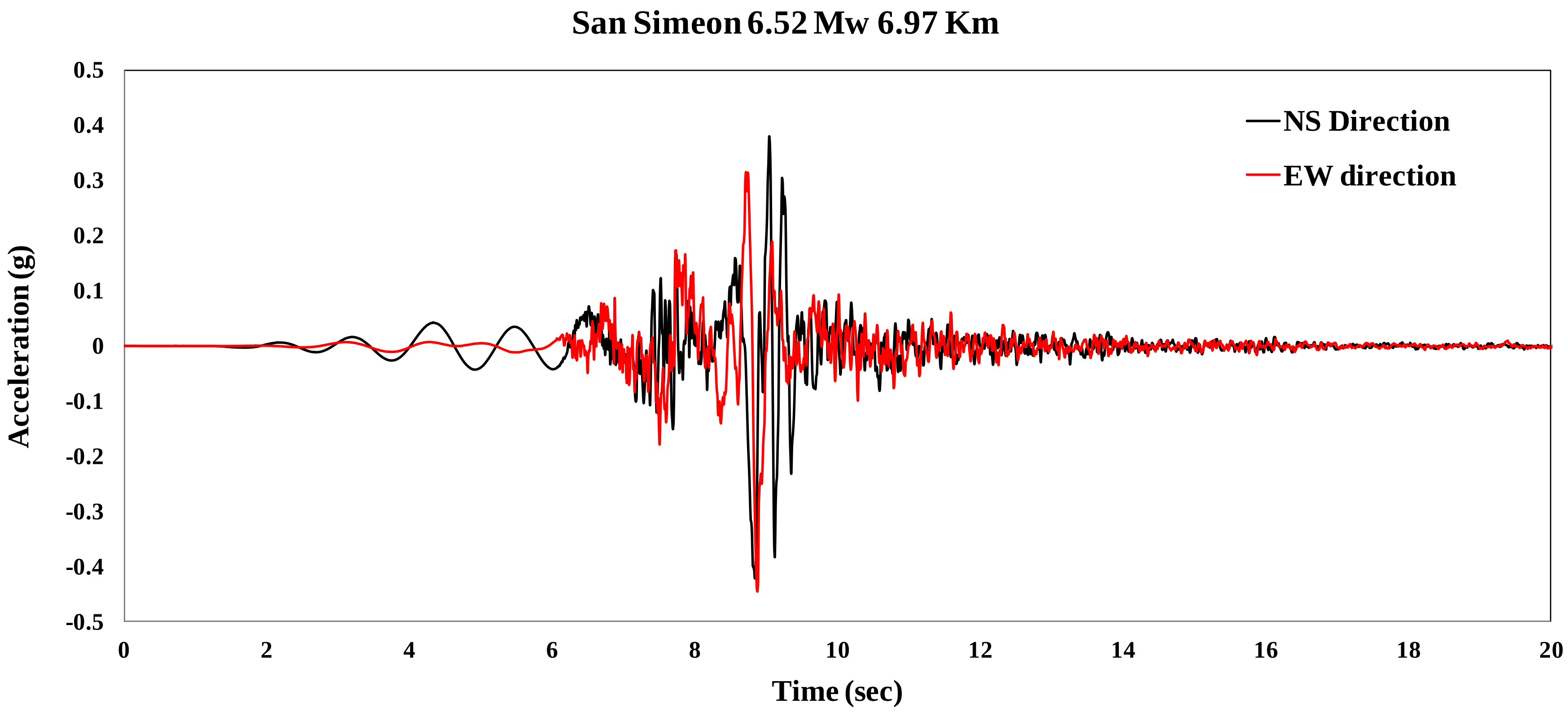
Data Requirements (acceleration time histories)

Earthquake Events	Station and Epicentre Distance (km)	Magnitude (Mw)
Chuetsu-oki Japan	Nagaoka (3.98) and Joetsu Kakizakiku Kakizaki (9.43)	6.8
Iwate_ Japan	IWTH24 (3.1), Mizusawaku Interior O Ganecho (7.82) and IWTH24 (11.68)	6.9
San Simeon_ CA	Cambria - Hwy 1 Caltrans Bridge (5.07) and Templeton - 1-story Hospital (6.97)	6.52
Northridge-02 California	Newhall - Fire Sta (7.36) and Pacoima Kagel Canyon (6.61)	6.05

All acceleration time histories (reverse mechanism earthquake) were collected from PEER NGA-West 2 Databases

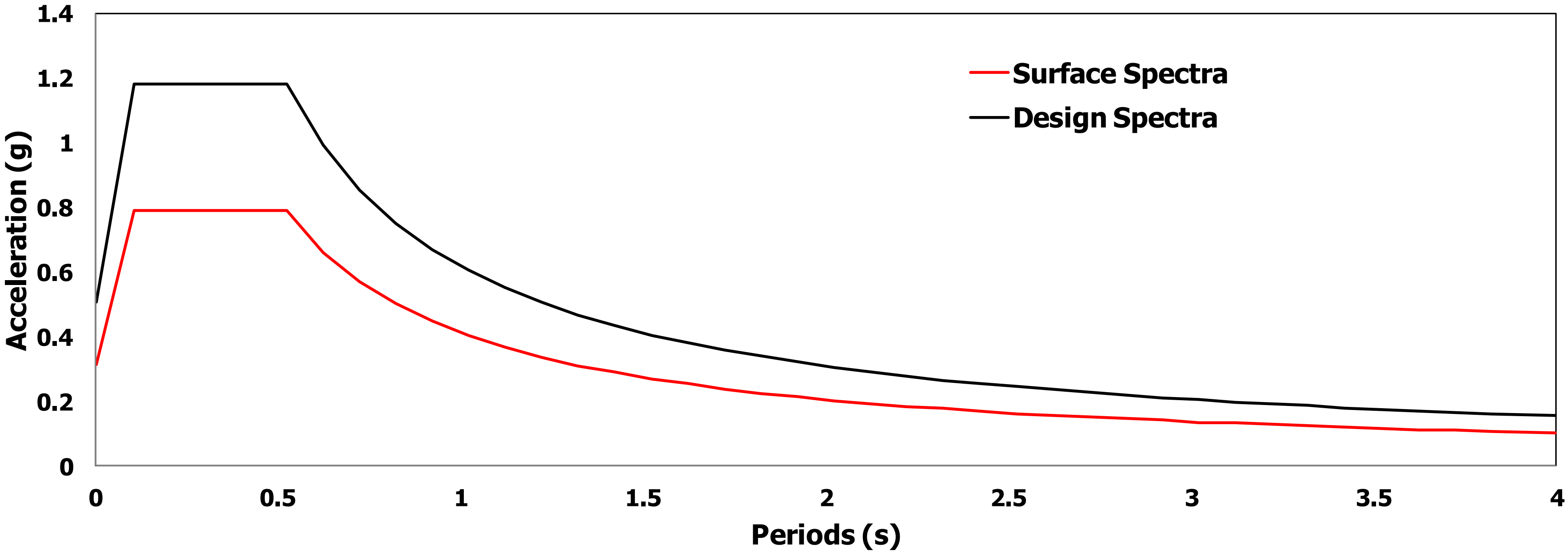
Data Requirements (acceleration time histories)

Original Acceleration Time Histories of San Simeon earthquake 6.52 Mw with epicentre distance 6.97 Km collected from PEER NGA-West 2 Databases



Data Requirements (surface spectra SNI:1726-2012)

Surface spectra and design spectra from SNI-2012 at building B3 location (SD site class)

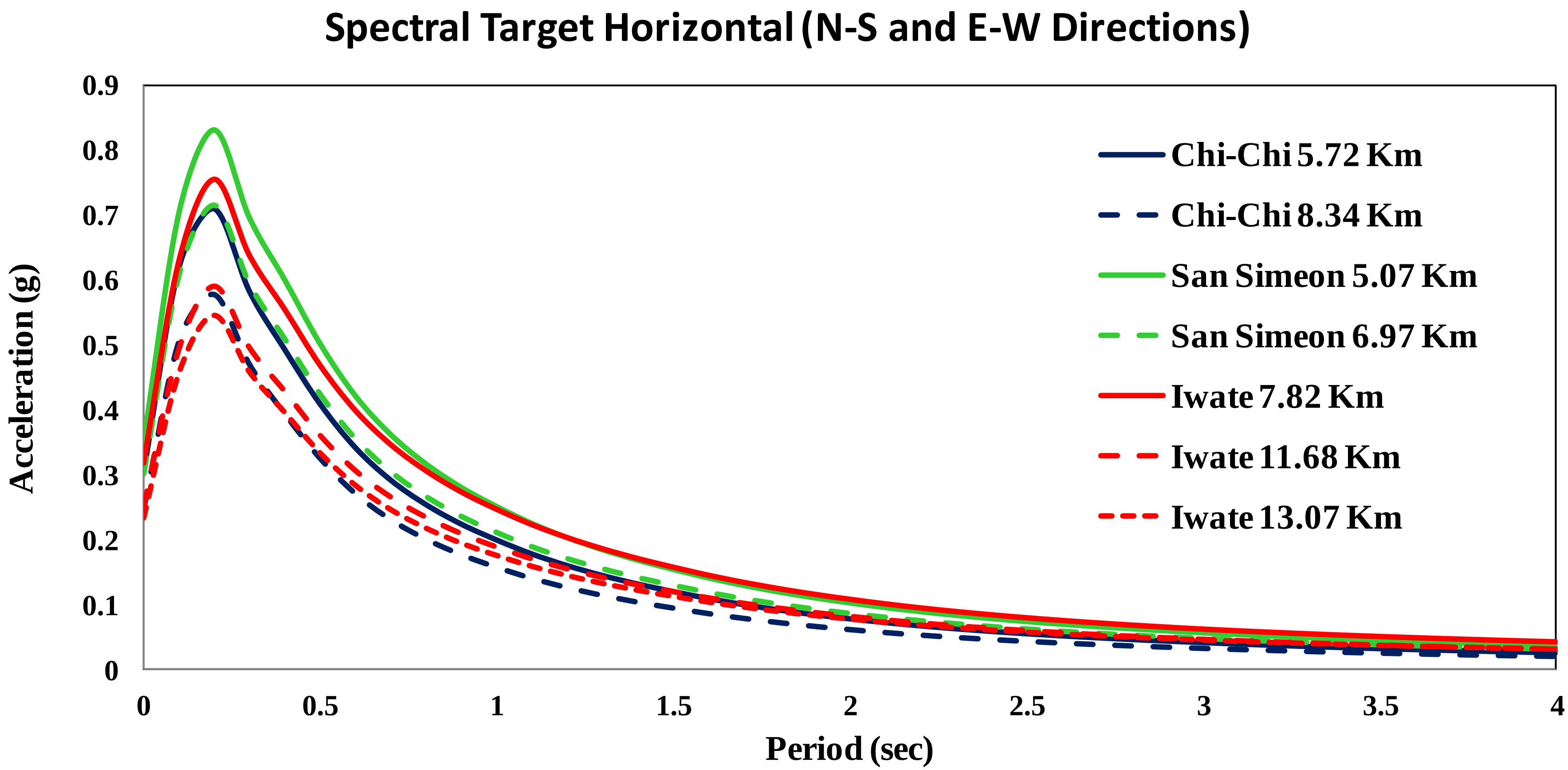


Data Analysis (Response Spectral Matching)

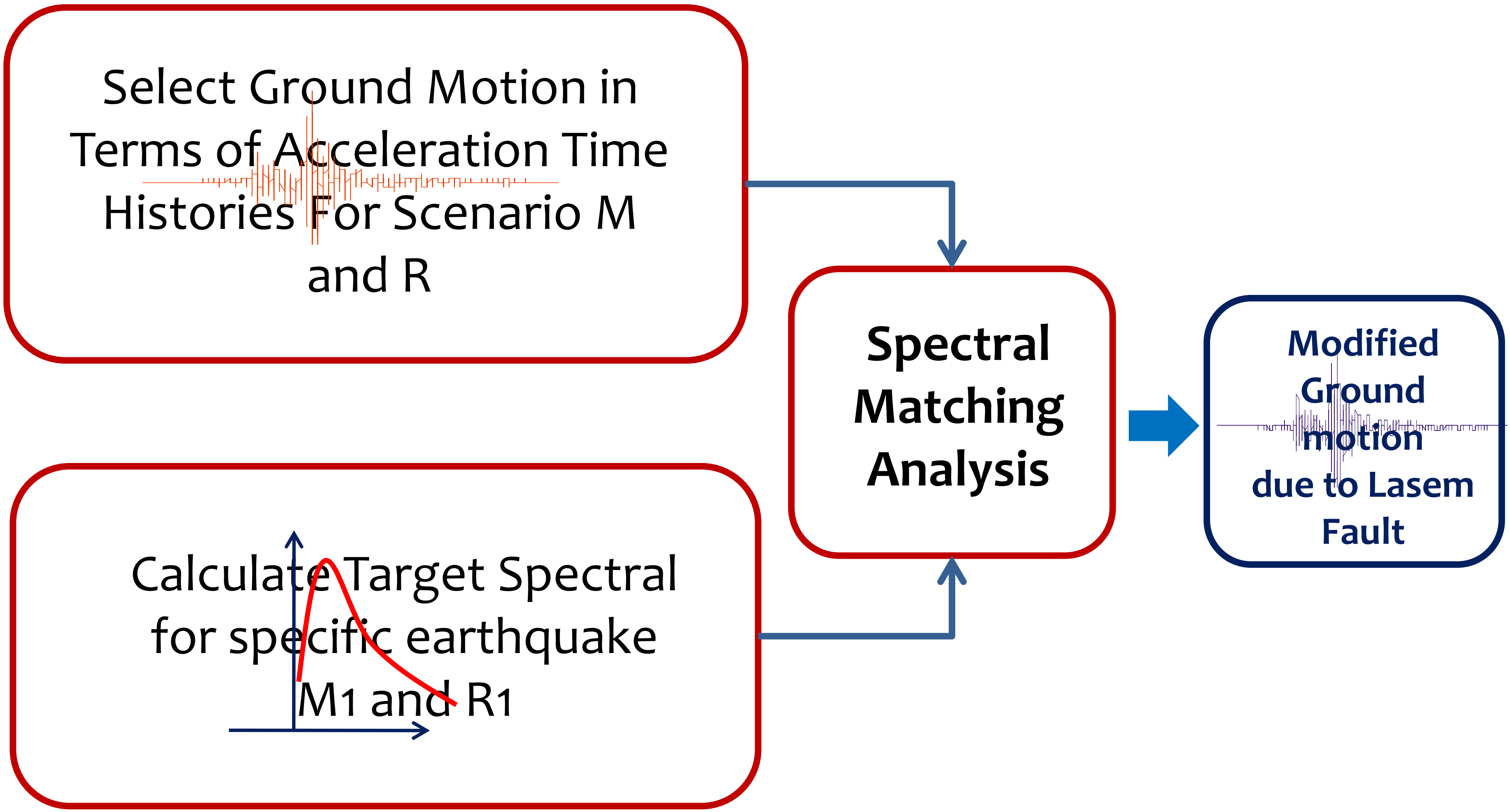
Response Spectra Target (Deterministic Seismic Hazard Analysis)

Spectral Target for building B3 (SD site class)

Three atenuation functions for deterministic seismic hazard analysis (Boore and Atkinson , 2008, Campbell and Bozorgnia, 2008 and Chiou, and Youngs, 2008)

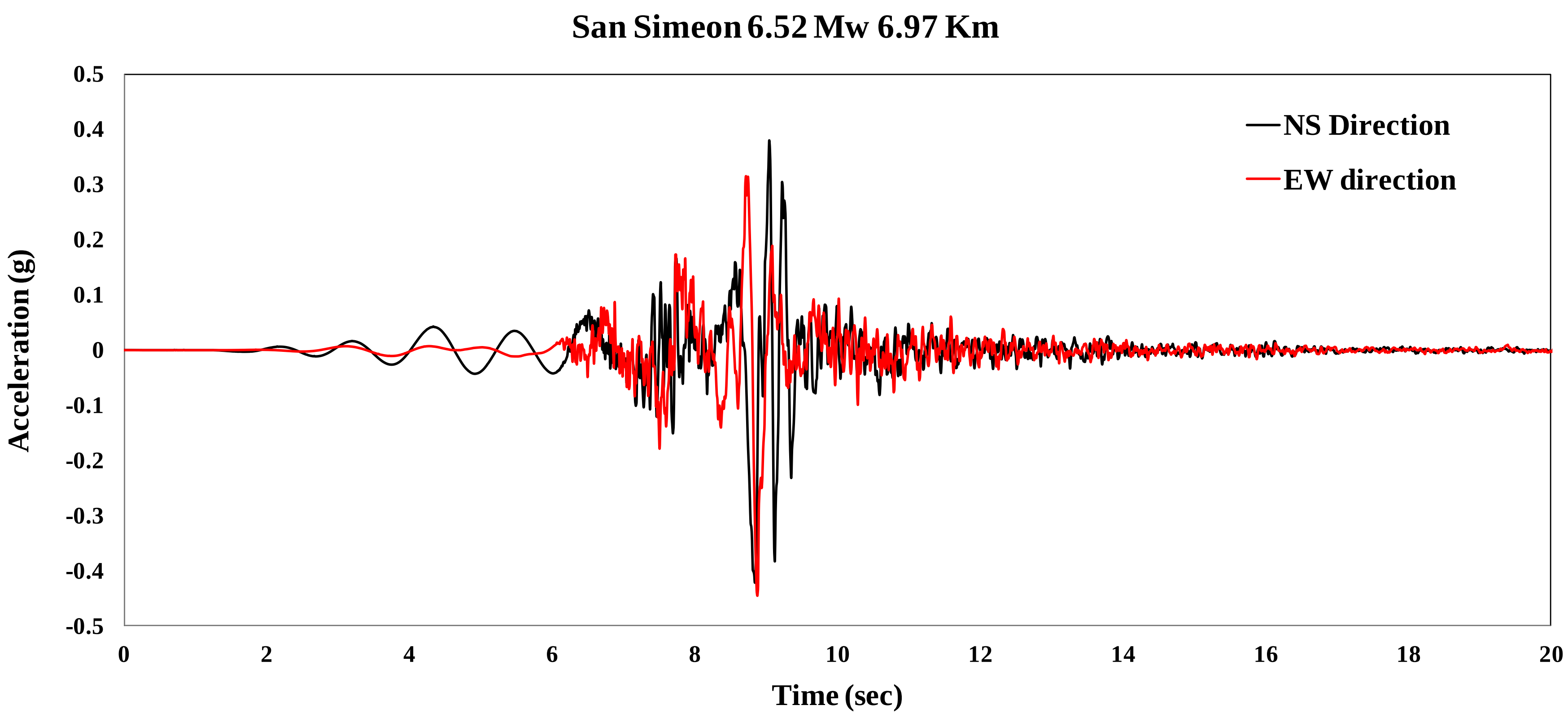


Data Analysis (Response Spectral Matching)



Data Analysis (Response Spectral Matching)

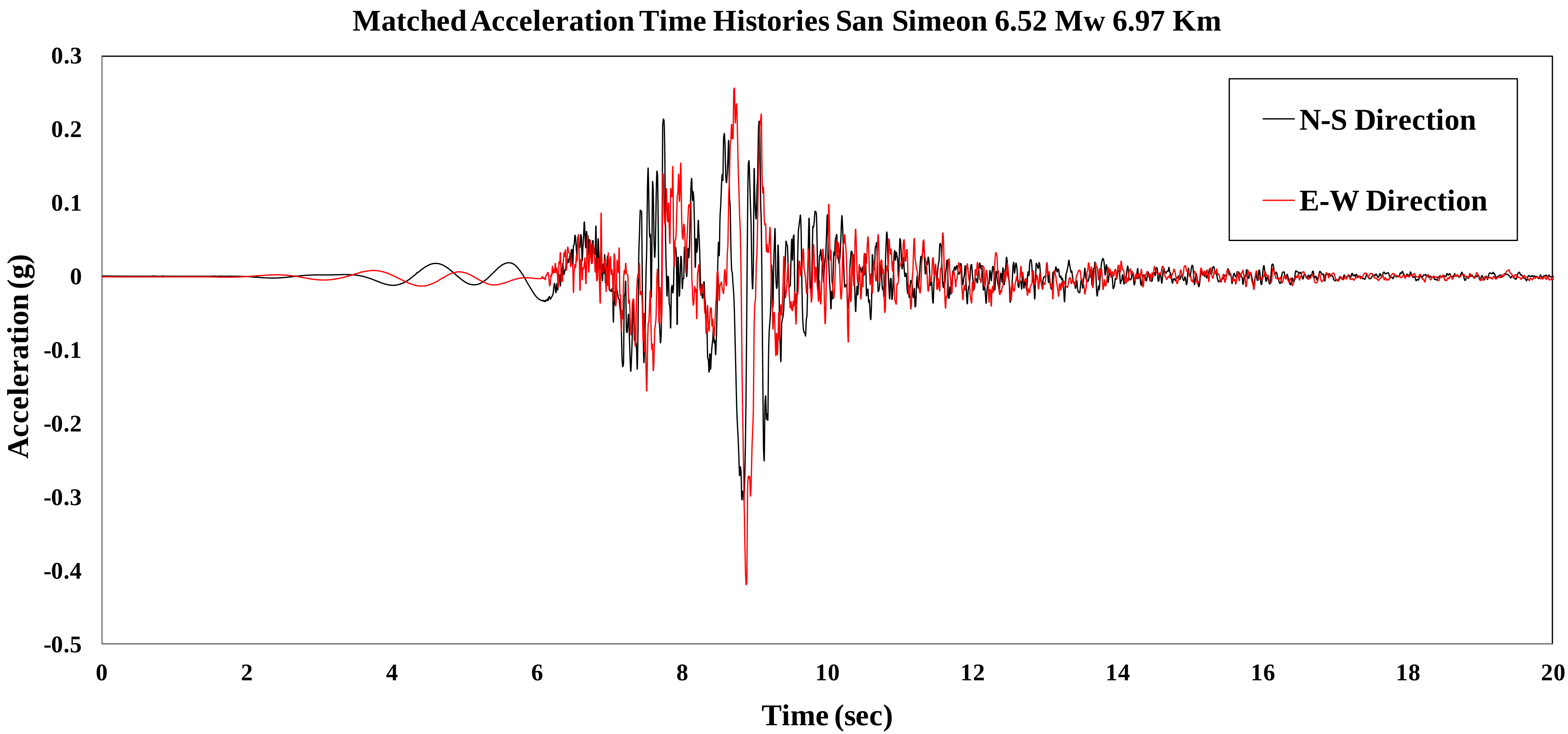
Response Spectral Matching San Simeon 6.52 Mw, 6.97 Km



Original acceleration time histories

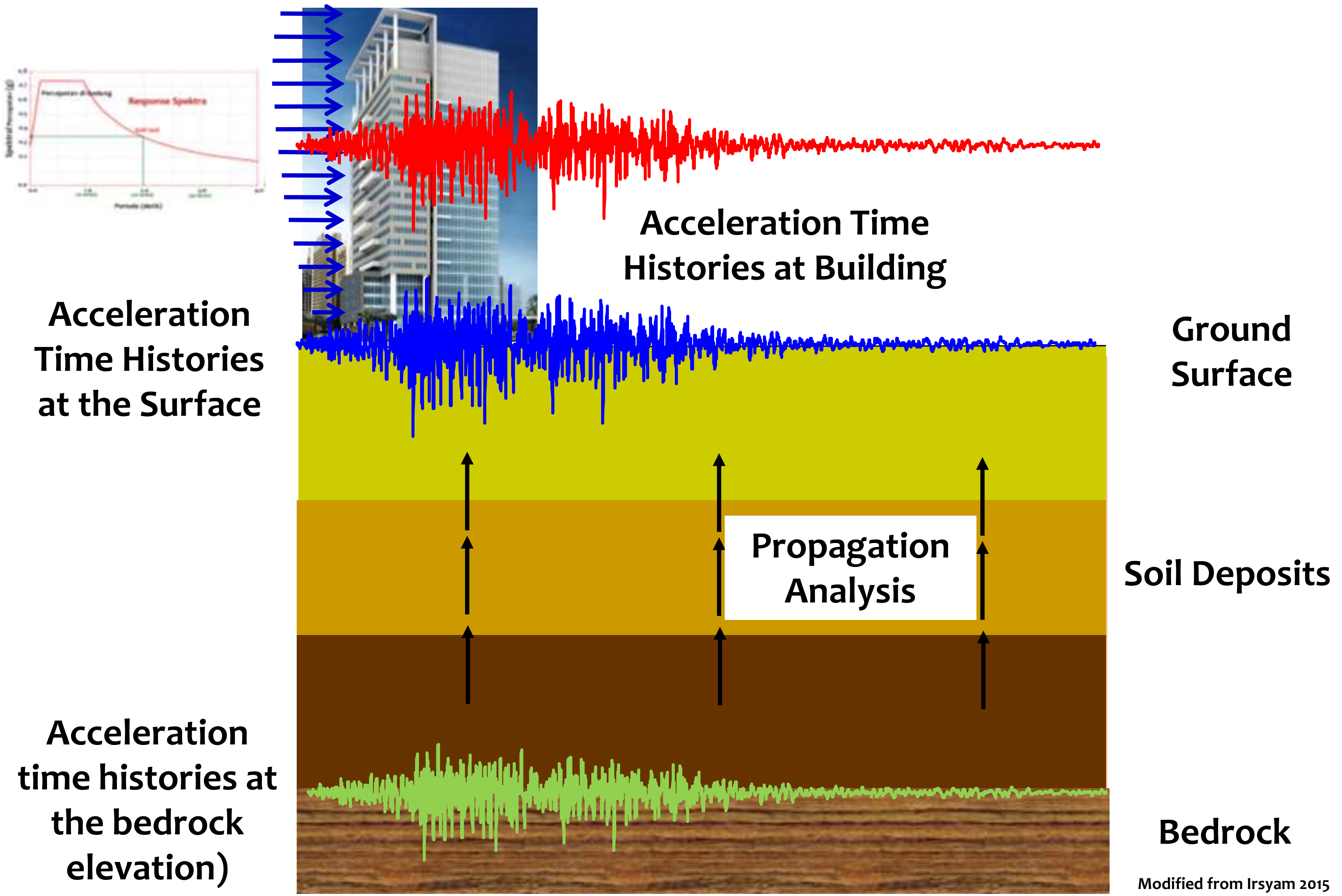
Data Analysis (Response Spectral Matching)

Response Spectral Matching San Simeon 6.52 Mw, 6.97 Km



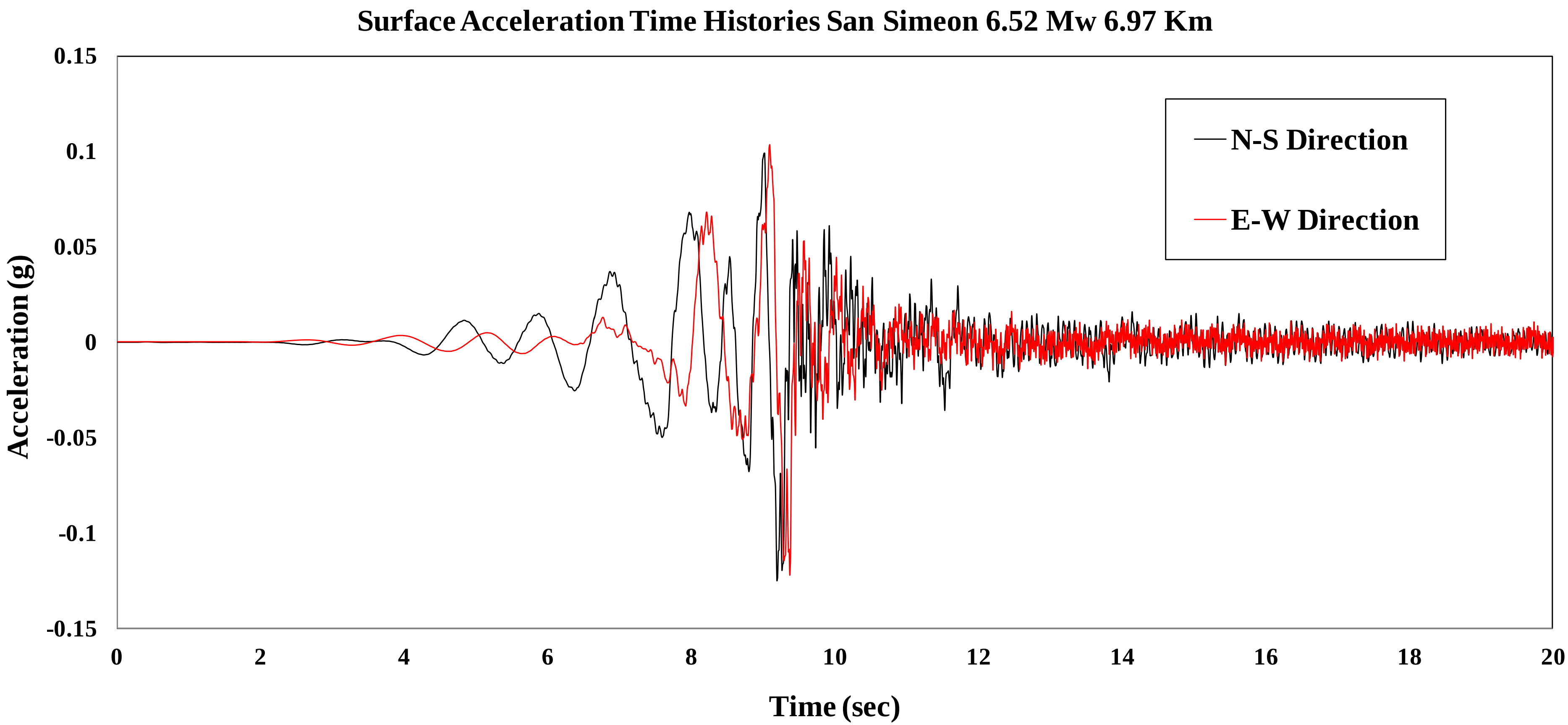
Matched / modified acceleration time histories

Data Analysis (Site Response/Propagation Analysis)



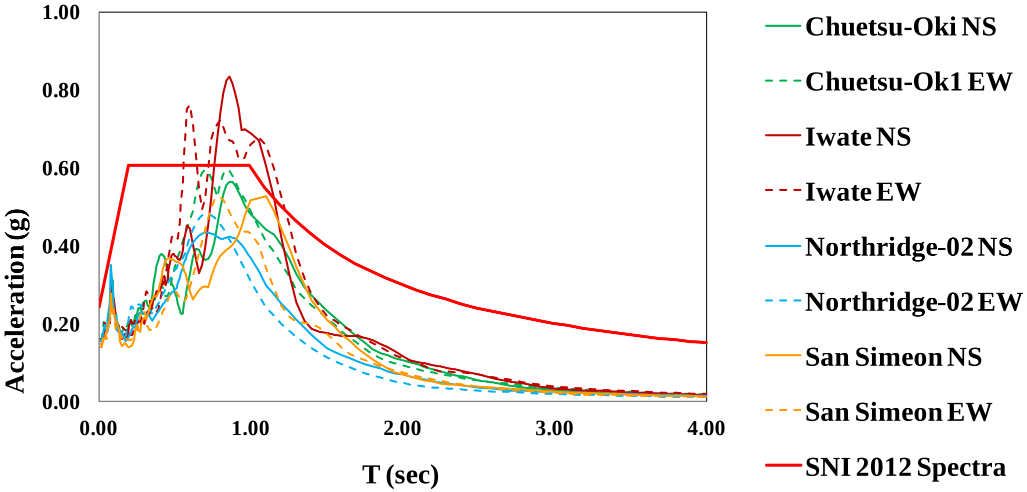
Data Analysis (Response Spectral Matching)

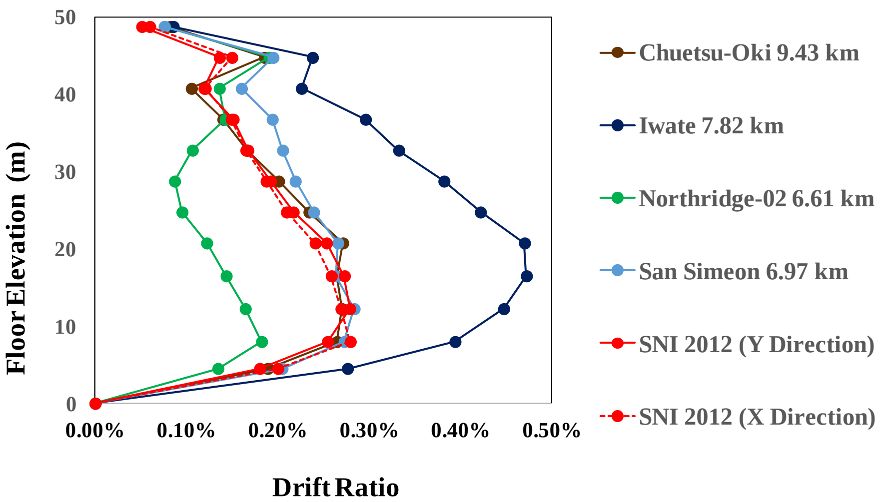
Response Spectral Matching San Simeon 6.52 Mw, 6.97 Km



Propagating of modified acceleration time histories for producing surface acceleration time histories

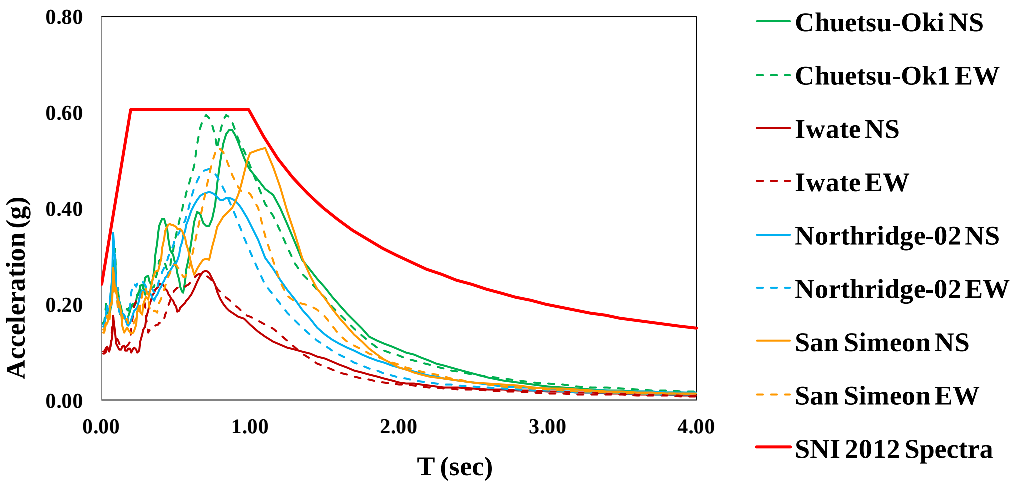
Structural Analysis

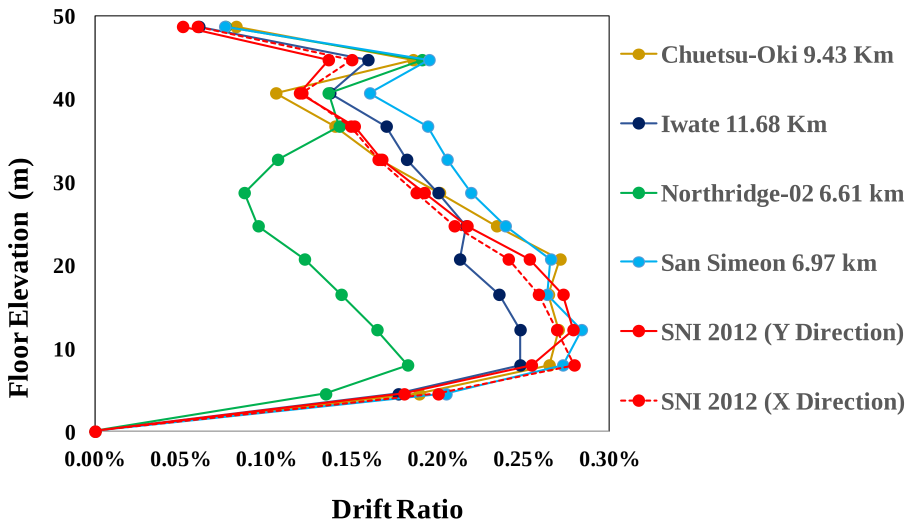




Comparison of spectral acceleration calculated from SNI-03-1726-2012 and two components acceleration time histories of four earthquake events (a) and drift ratio of building B1 when subjected to SNI-03-1726-2012 spectral acceleration and acceleration time histories of four earthquake events

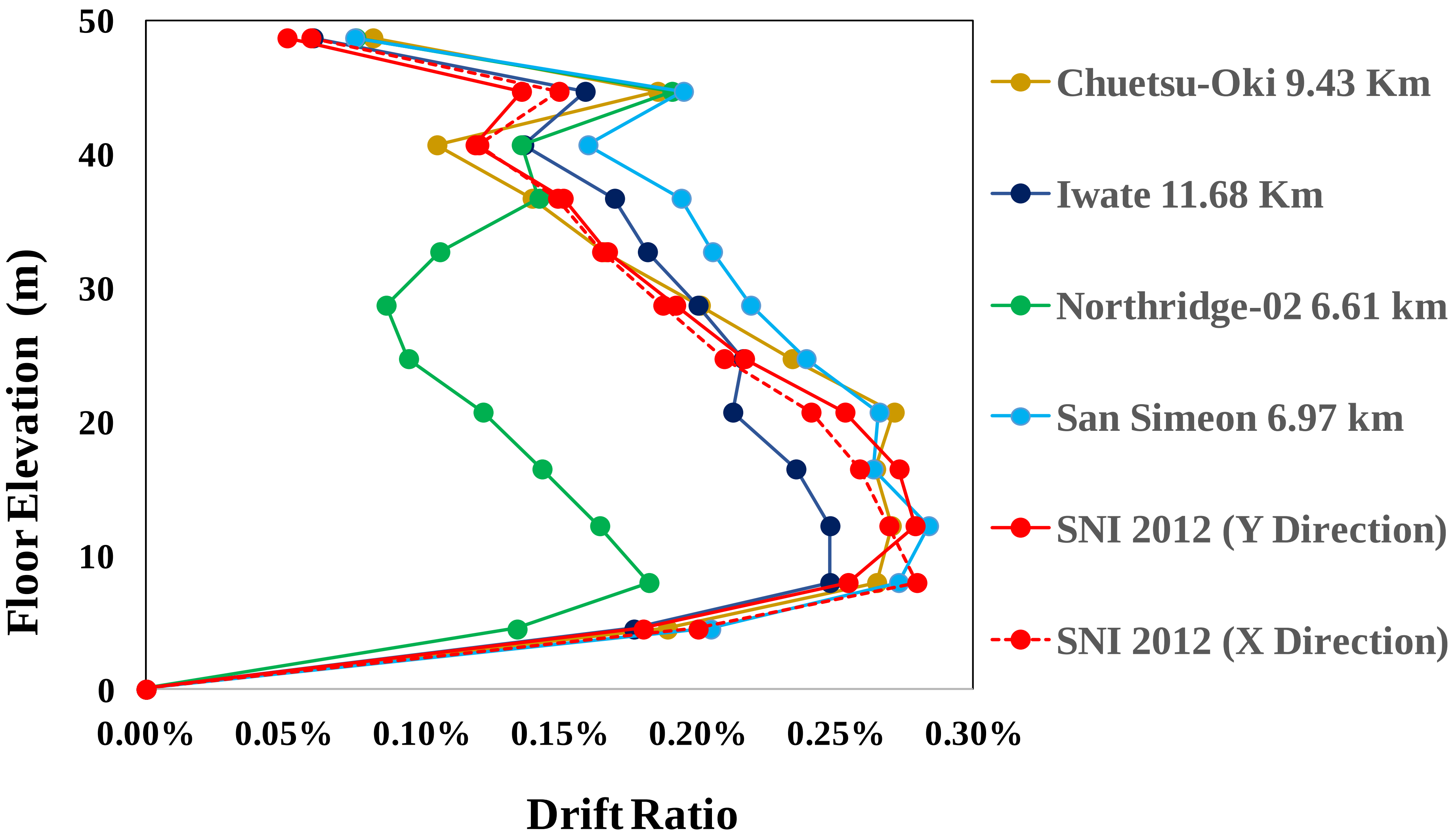
Structural Analysis





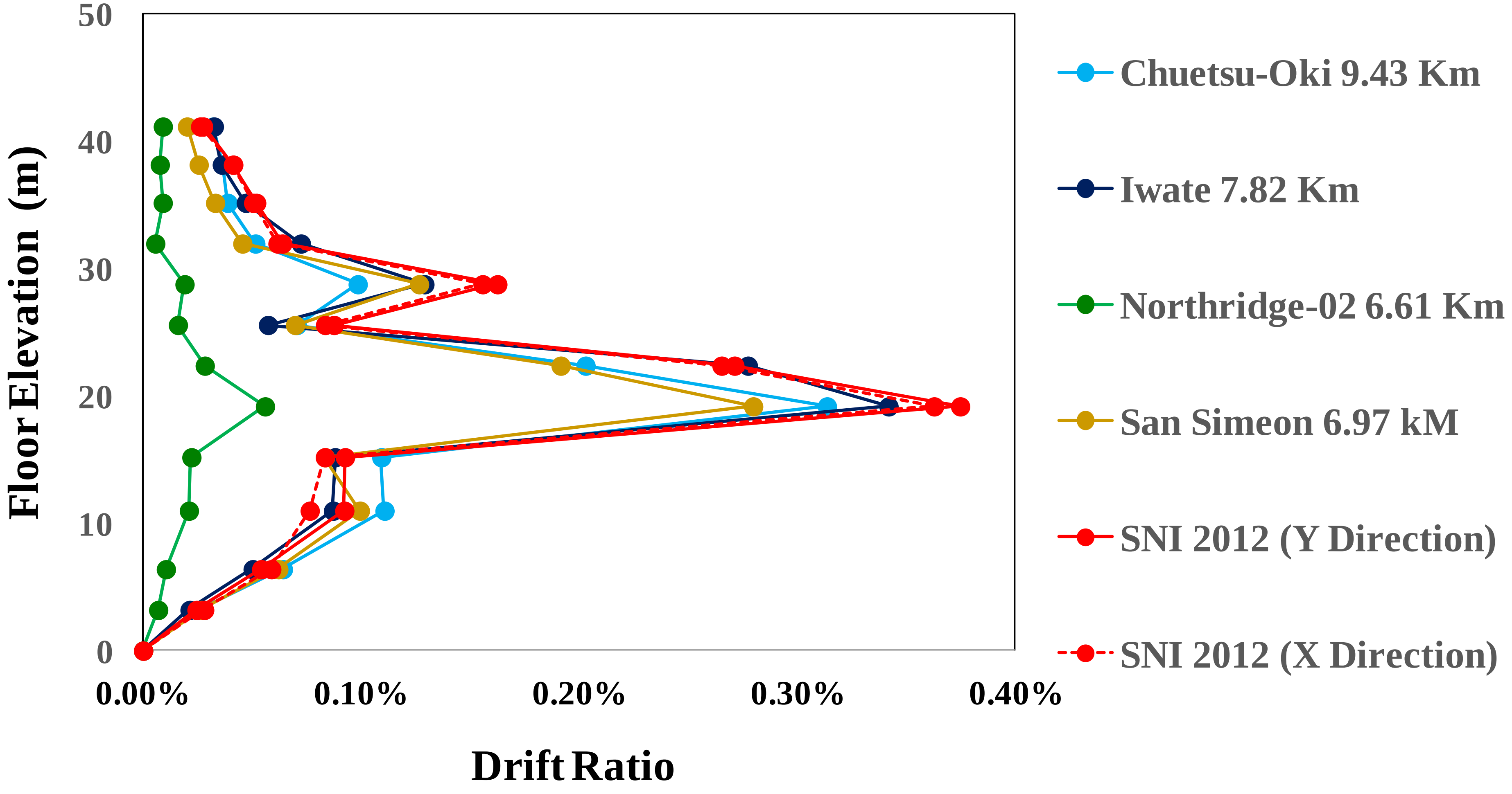
Comparison of spectral acceleration calculated from SNI-03-1726-2012 and two components acceleration time histories of four earthquake events (a) and drift ratio of building B1 when subjected to SNI-03-1726-2012 spectral acceleration and acceleration time histories of four earthquake events

Structural Analysis Results



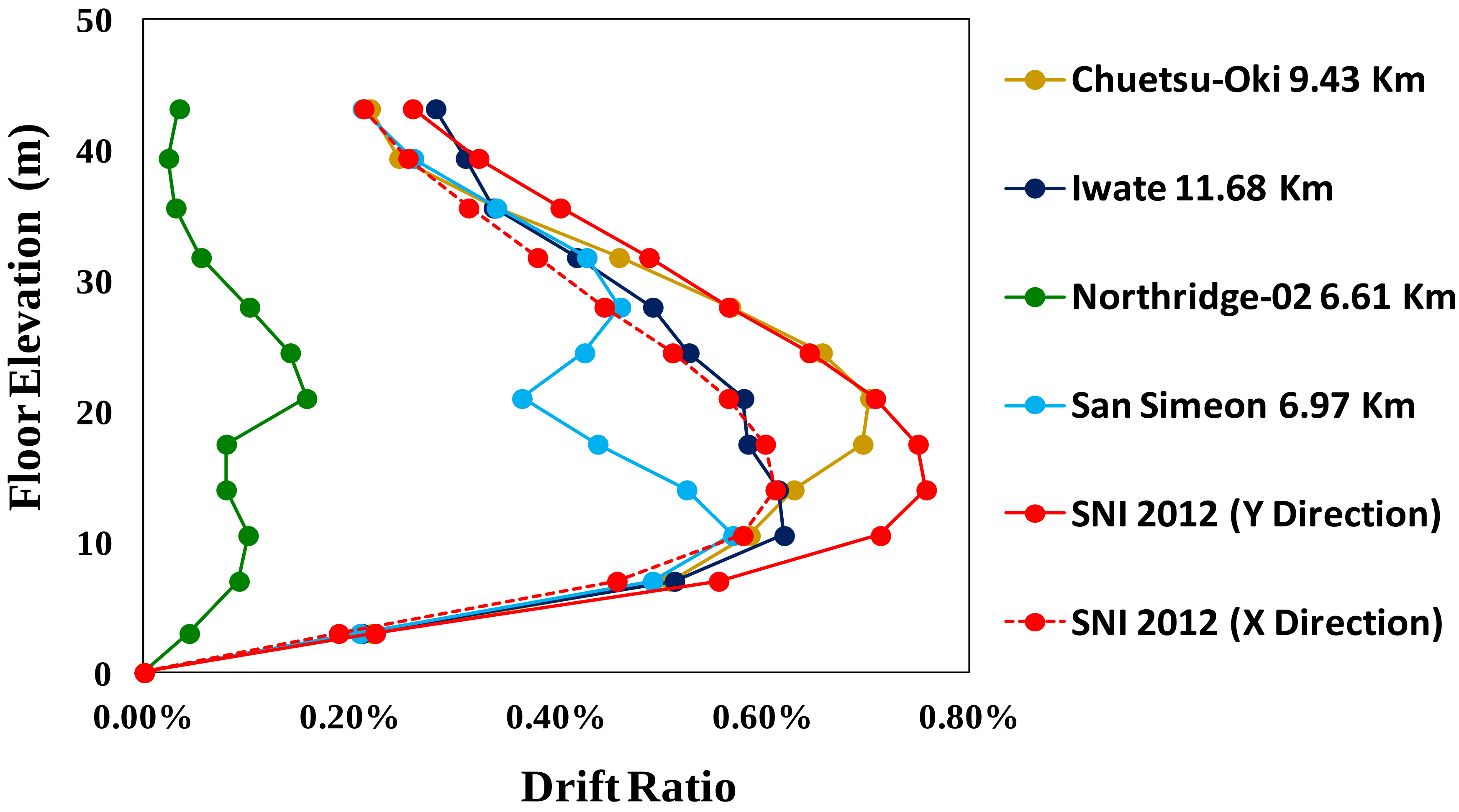
Drift ratio of building B1

Structural Analysis Results



Drift ratio for building B2

Structural Analysis Results



Drift ratio for building B3

CONCLUSIONS

1. Stability performance of buildings can be predicted by evaluating surface response spectra calculated using seismic code and surface response spectra calculated from acceleration time histories from a specific earthquake event. If the surface response spectra calculated using seismic code is greater than the surface response spectra calculated from acceleration time histories the structure will strong enough to resist the earthquake force.

CONCLUSIONS

2. Based on the deformation and drift ratio results, all buildings were predicted are strong enough to resist earthquake force produced by earthquake with maximum magnitude 6.5 Mw and minimum 5 Km distance to earthquake source. However if the earthquake magnitude is greater than 6.5 Mw, all structures are predicted strong enough to resist an earthquake with minimum epicenter distance 10 km.

Windu Partono et al., 2018