

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

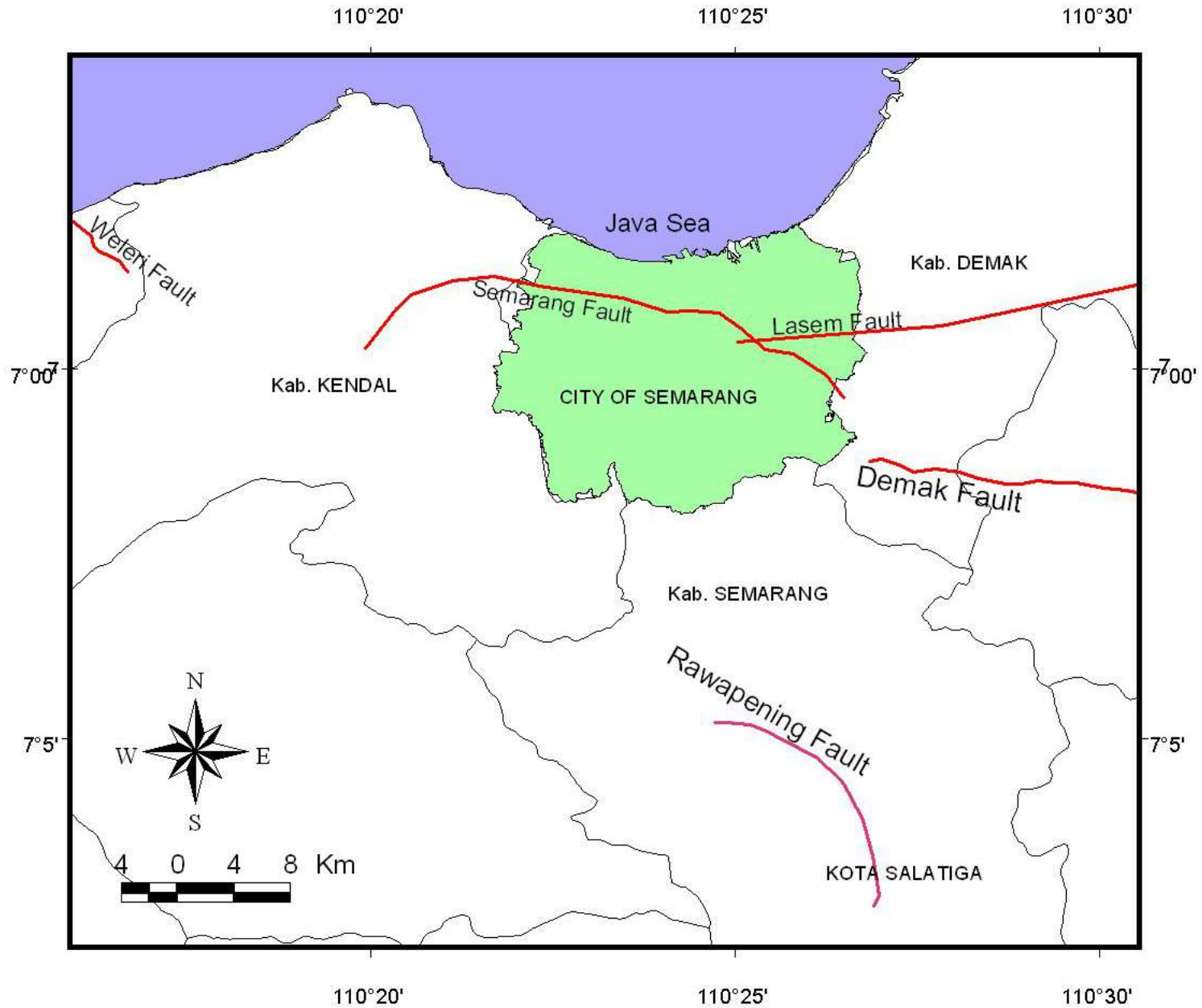


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and Robby Yanuar Setiawan

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.

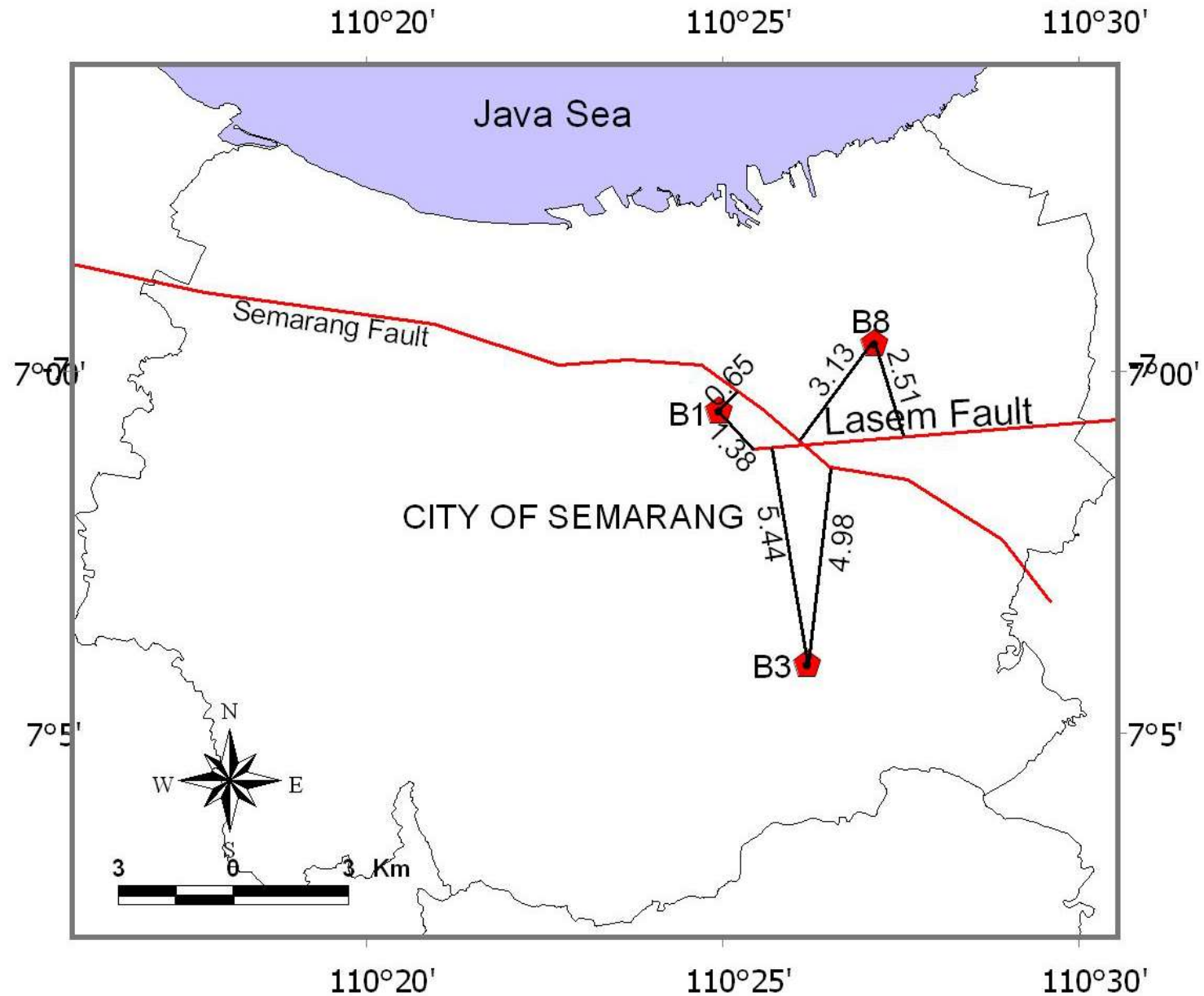
Research Methodology

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.

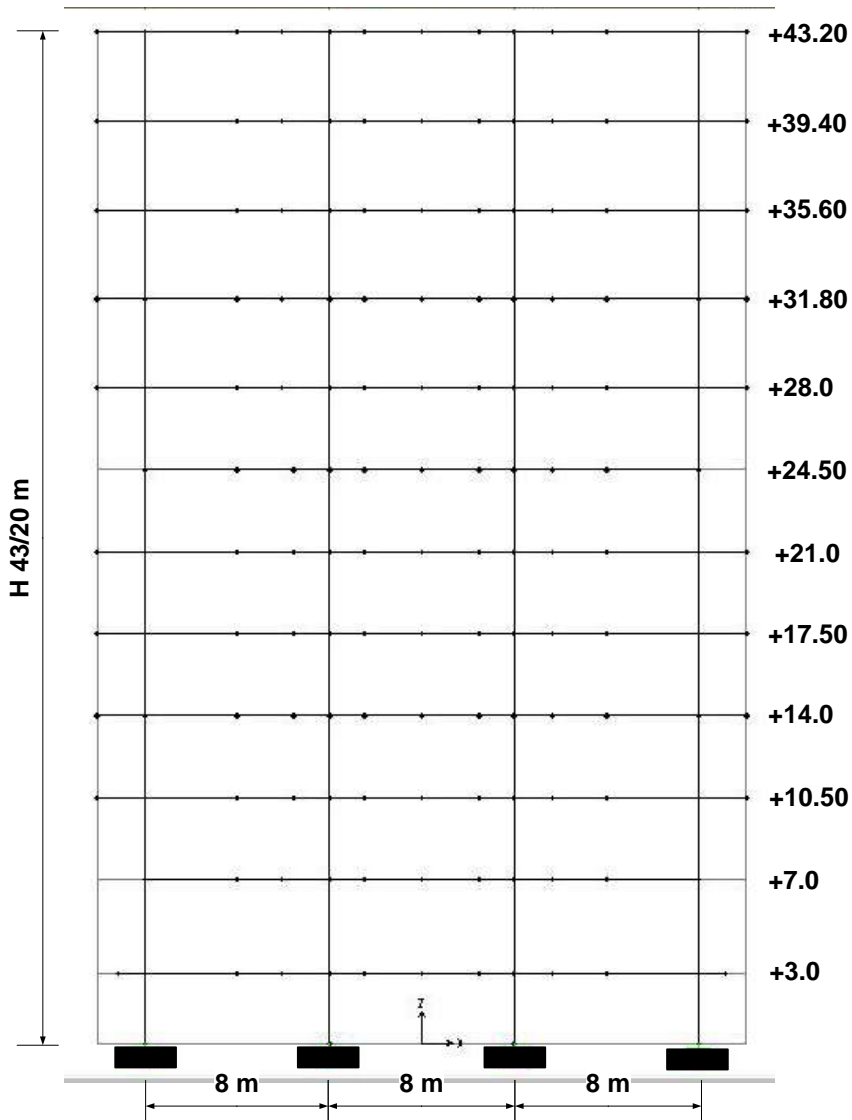
Data Requirements (building information)

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)

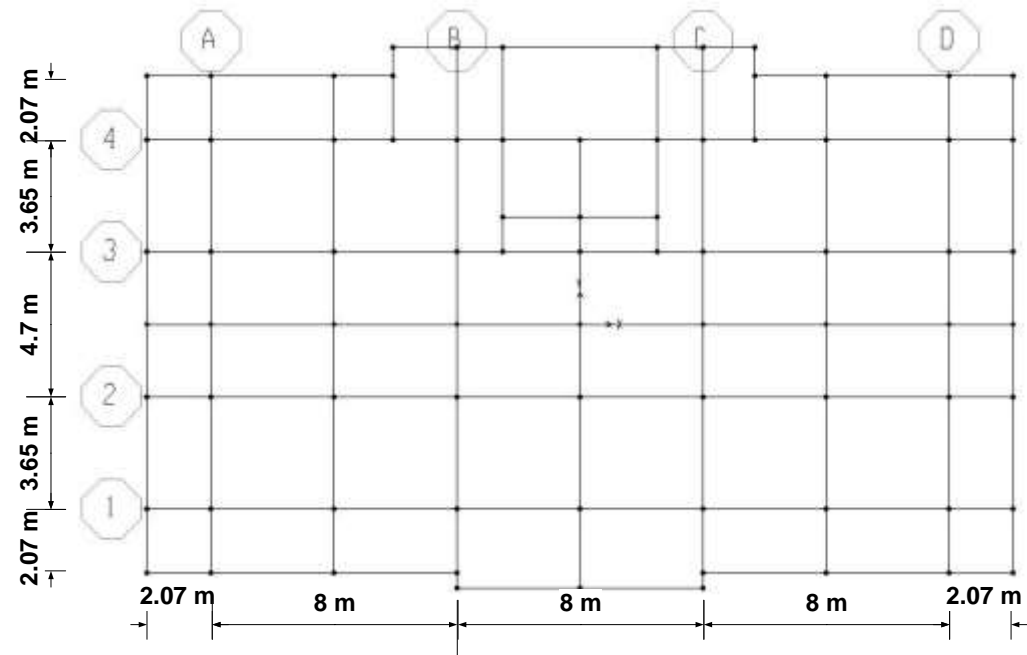


Data Requirements (structural details)



Building B3

Plan, elevation, materials and detail of element structure

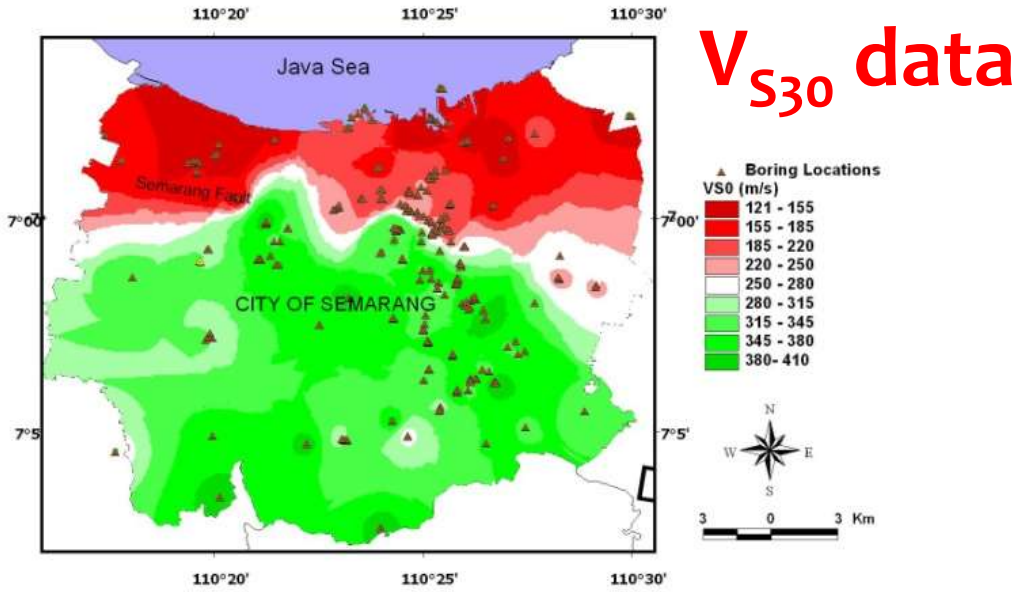


Data Requirements (geotechnical data)

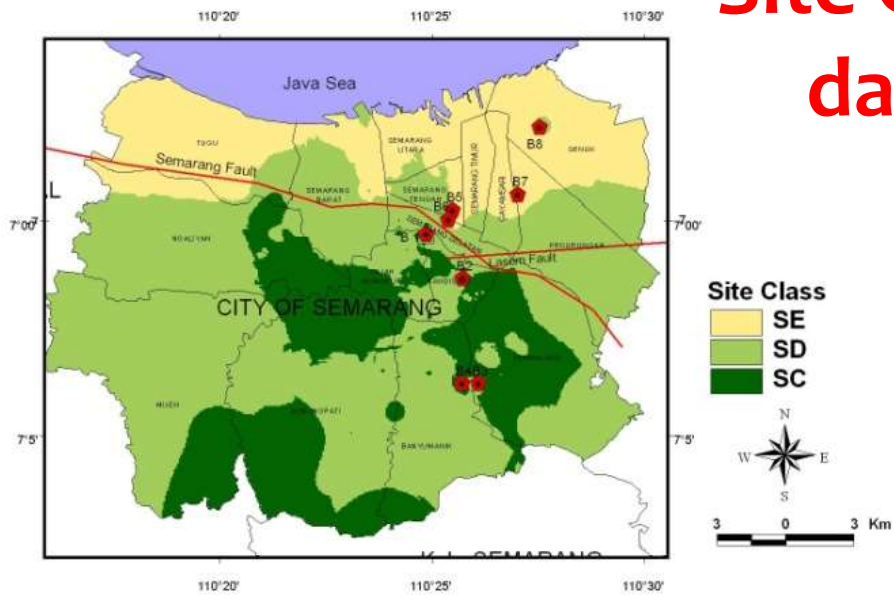
BORE LOG

Project		Location		Bore Hole No.		
Rencana Pembangunan Training Candra 2 UMOP		Jalan Imam Barjo Semarang, Jawa Tengah		BH 2 Page 1		
Date	Depth (m)	Thickness (m)	Symbol	Lapis Type	DESCRIPTION	Depth (m)
1	0.00		BB	PASIR kelanauan	campur kecil dan sampah (tanah lunak), lunak sampai teguh, warna coklat kehitaman	0
2	2.00		BB	PASIR kelampungan	sangat lepas, warna abu-abu kecoklatan	2.00
3	3.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	3.00
4	4.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	4.00
5	5.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	5.00
6	6.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	6.00
7	7.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	7.00
8	8.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	8.00
9	9.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	9.00
10	10.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	10.00
11	11.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	11.00
12	12.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	12.00
13	13.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	13.00
14	14.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	14.00
15	15.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	15.00
16	16.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	16.00
17	17.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	17.00
18	18.00		BB	PASIR kelampungan	lepas, warna abu-abu kehitaman	18.00
19	19.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		19.00
20	20.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		20.00
21	21.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		21.00
22	22.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		22.00
23	23.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		23.00
24	24.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		24.00
25	25.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		25.00
26	26.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		26.00
27	27.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		27.00
28	28.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		28.00
29	29.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		29.00
30	30.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		30.00
31	31.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		31.00
32	32.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		32.00
33	33.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		33.00
34	34.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		34.00
35	35.00		BB	LEMPUNG lunak, warna abu-abu kehitaman		35.00

Boring investigation

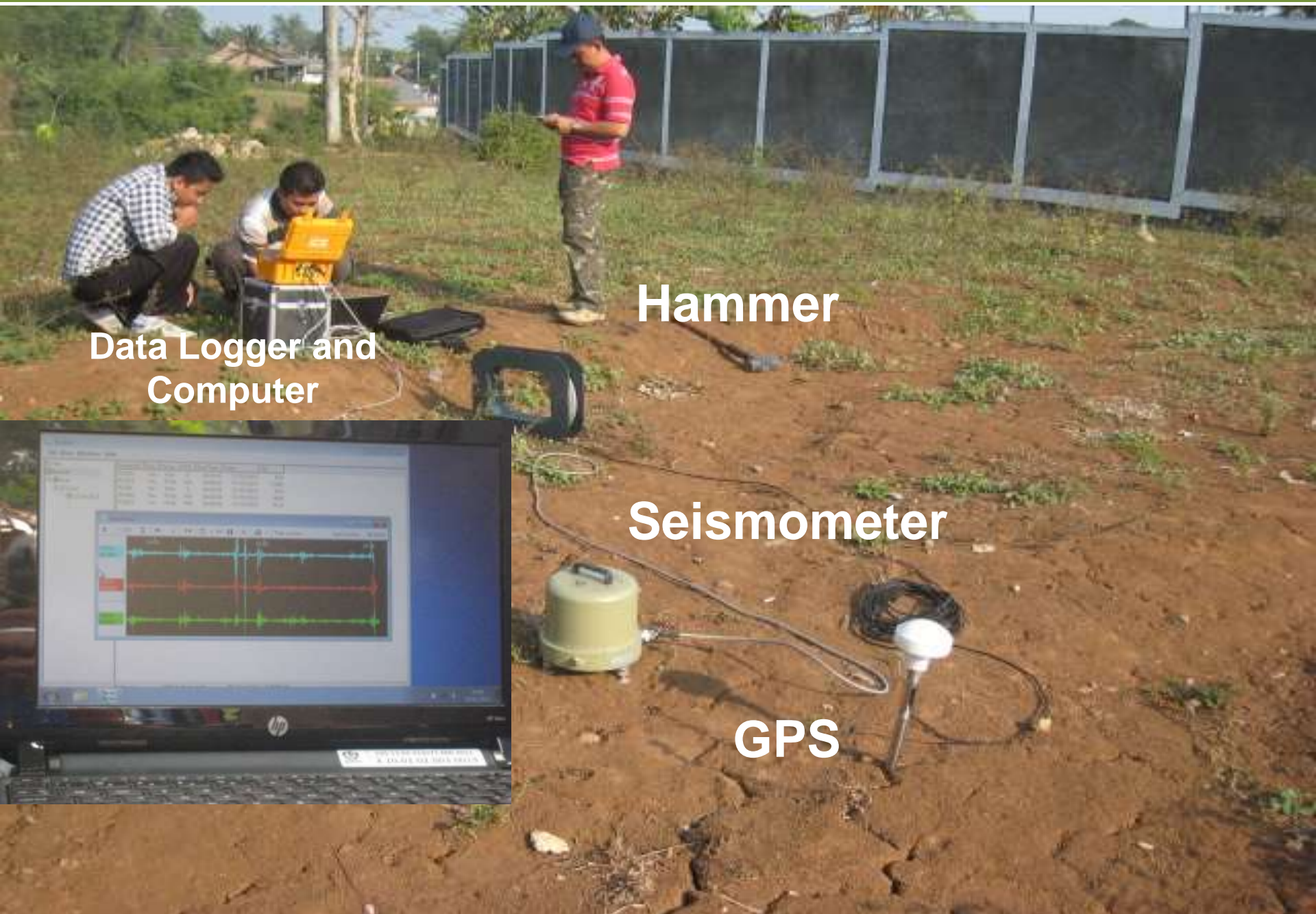


V_{S30} data



Site Class data

Data Requirements (Bedrock Measurement)

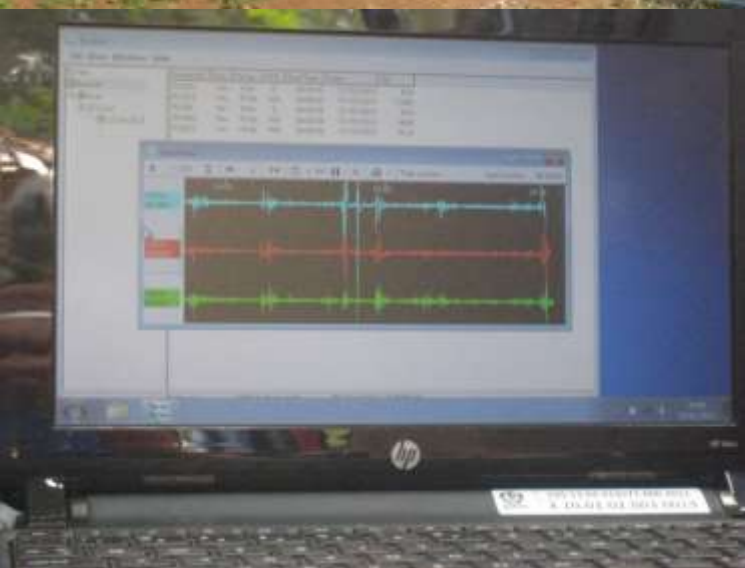


**Data Logger and
Computer**

Hammer

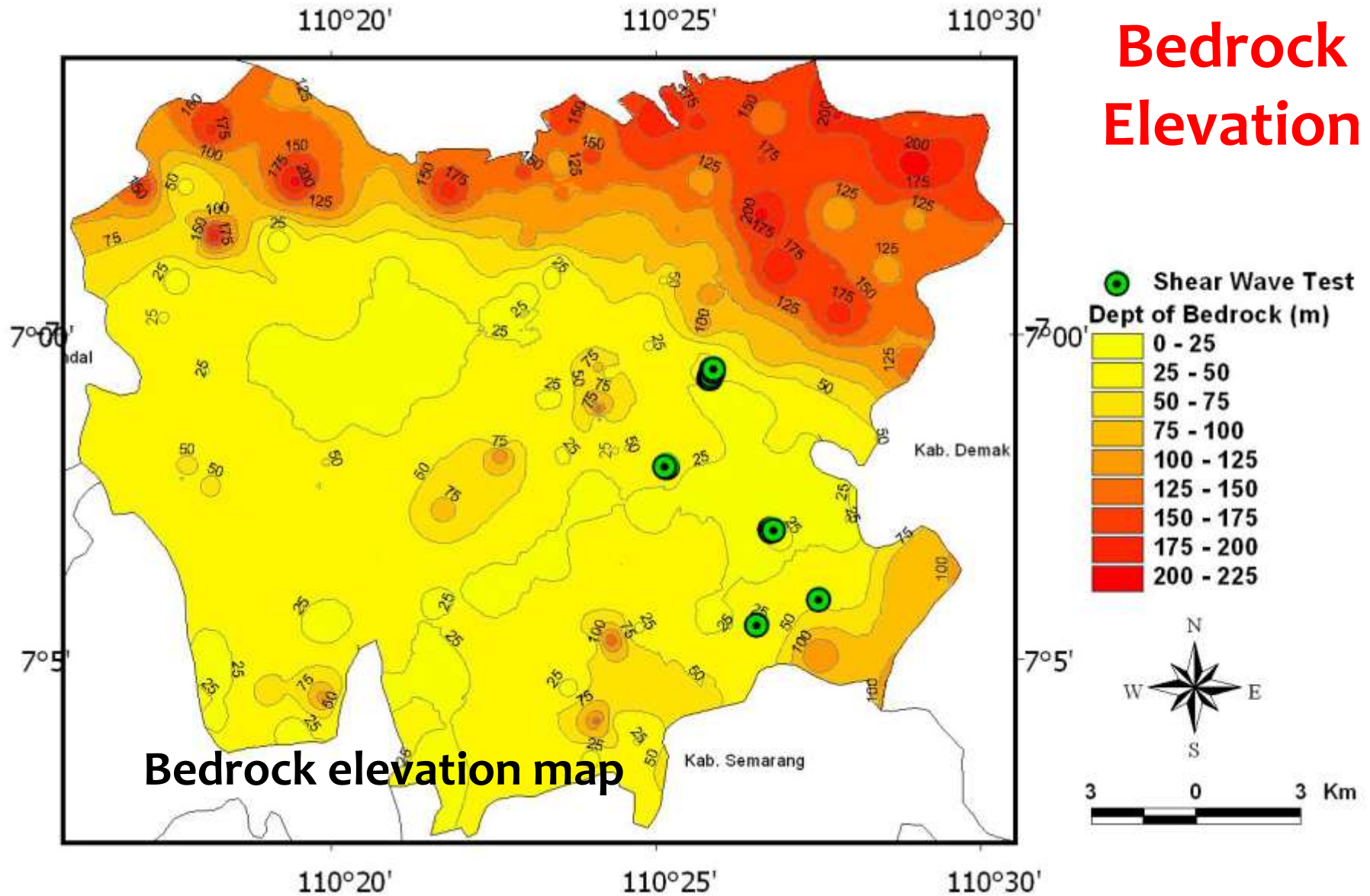
Seismometer

GPS



Data Requirements (Bedrock Measurement)

Bedrock Elevation



Data Requirements (acceleration time histories)

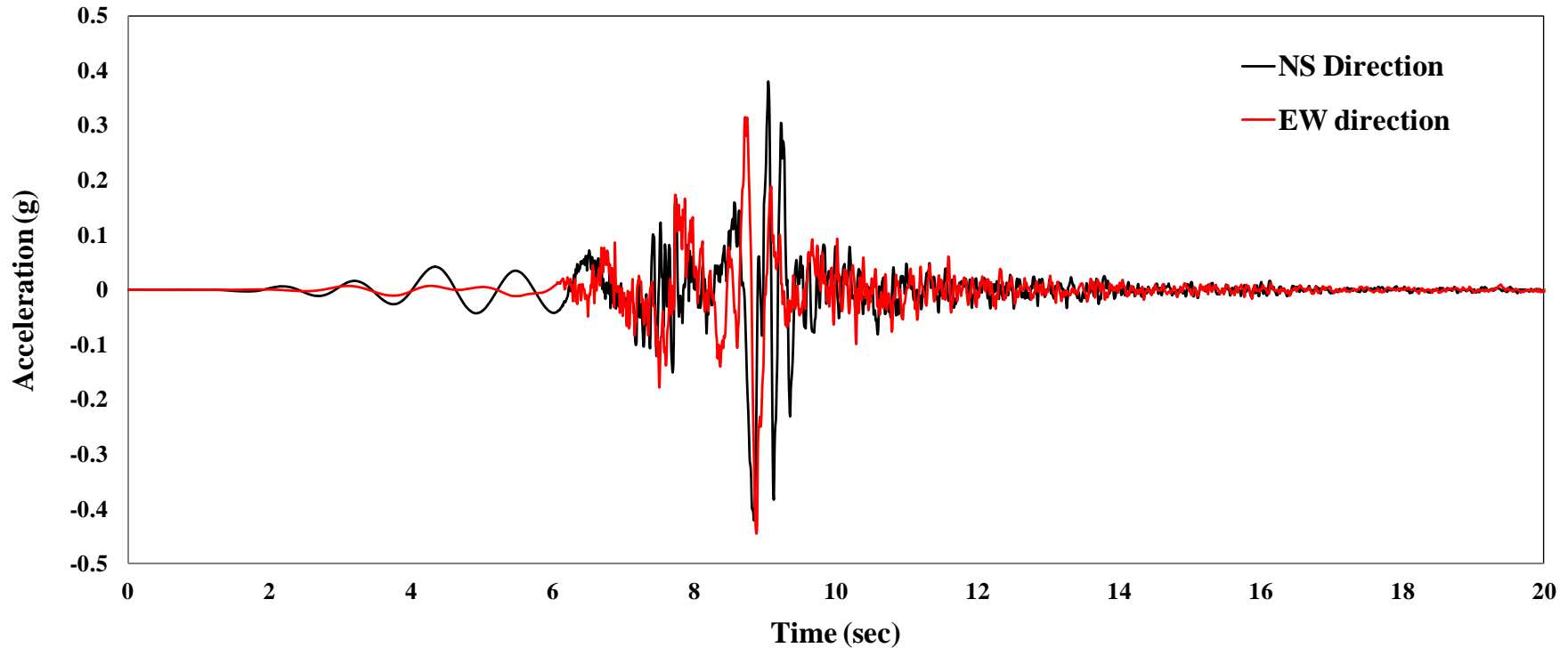
Earthquake Events	Station and Epicentre Distance (km)	Magnitude (Mw)
Chuetsu-oki Japan	Nagaoka (3.98) and Joetsu Kakizakiku Kakizaki (9.43)	6.8
Iwate_ Japan	IWTH24 (3.1), Mizusawaku Interior O Ganecho (7.82) and IWTH24 (11.68)	6.9
San Simeon_ CA	Cambria - Hwy 1 Caltrans Bridge (5.07) and Templeton - 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)

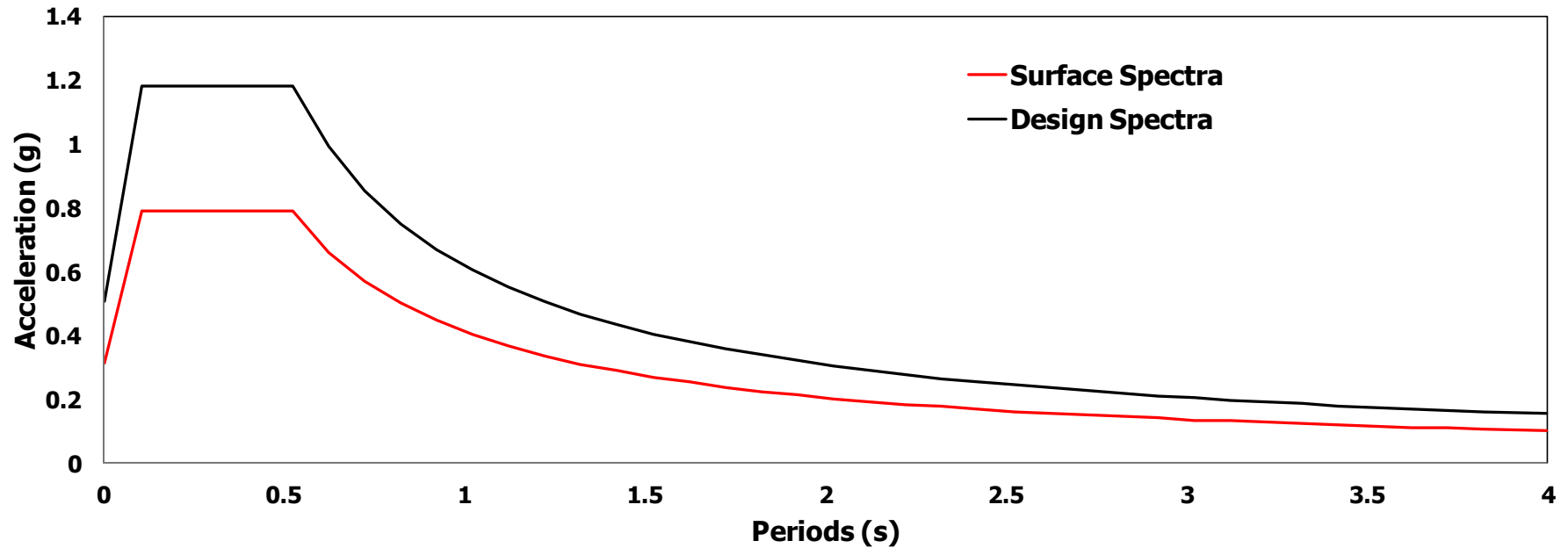
Original Acceleration Time Histories of San Simeon earthquake 6.52 Mw with epicentre distance 6.97 Km collected from PEER NGA-West 2 Databases

San Simeon 6.52 Mw 6.97 Km



Data Requirements (surface spectra SNI:1726-2012)

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



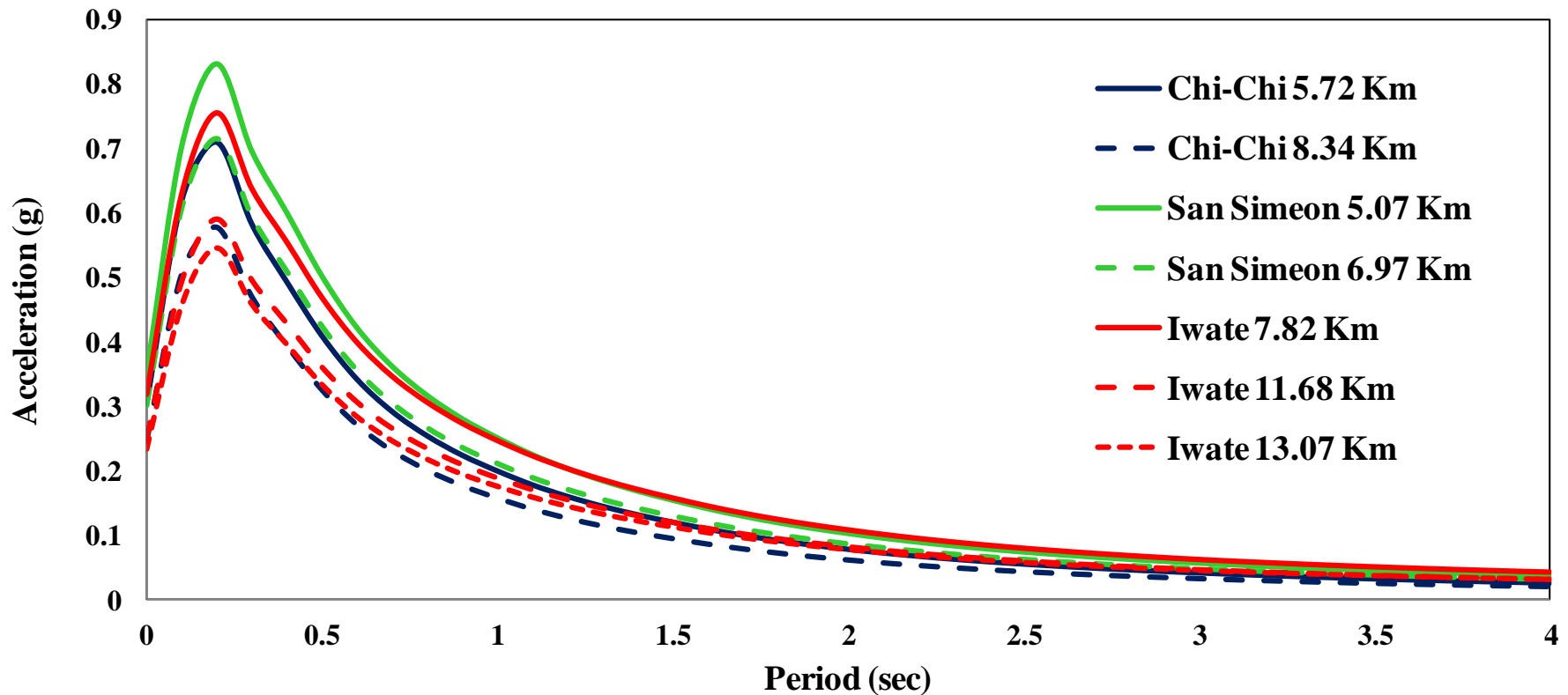
Data Analysis (Response Spectral Matching)

Response Spectra Target (Deterministic Seismic Hazard Analysis)

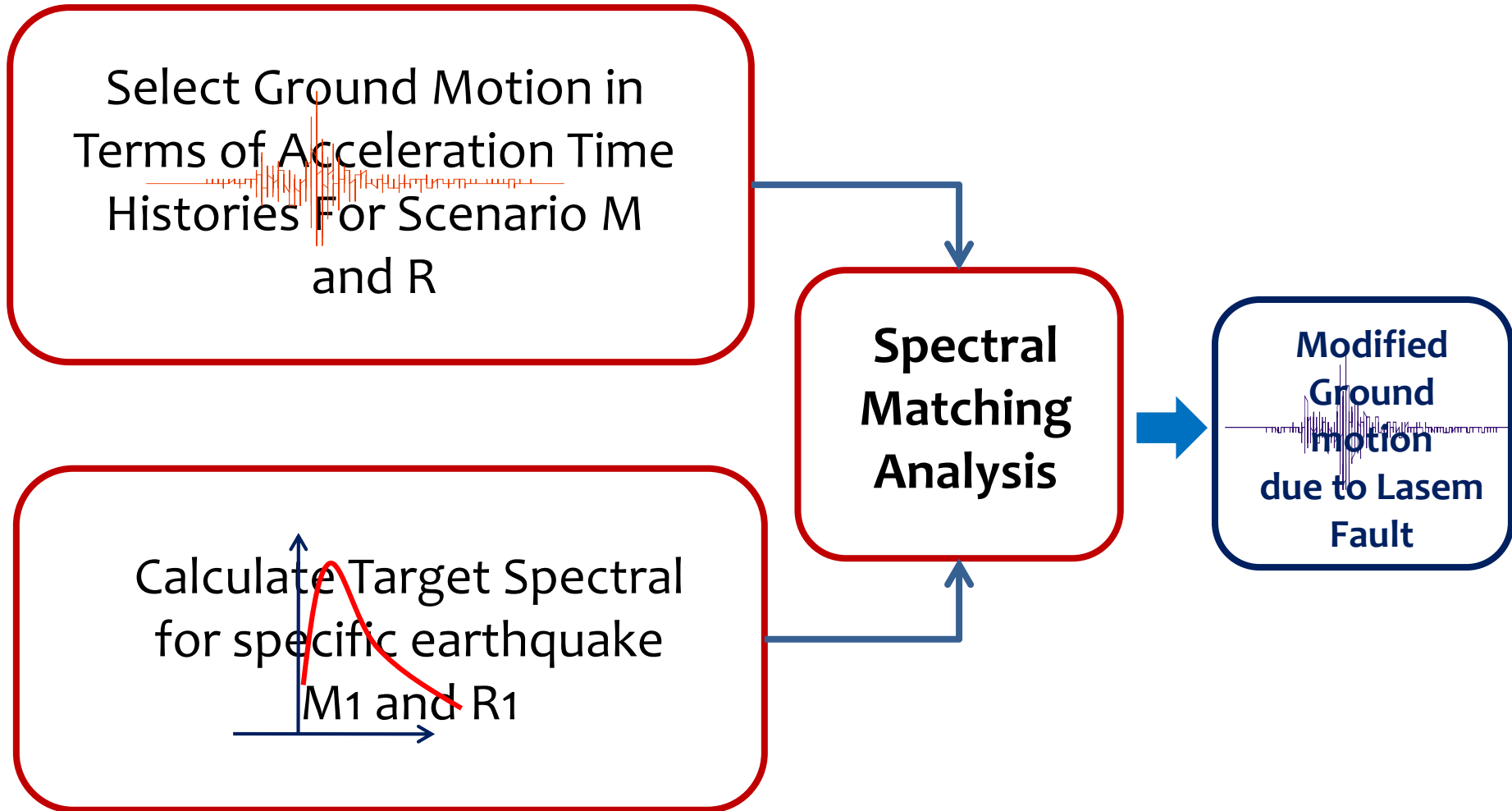
Spectral Target for building B3 (SD site class)

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

Spectral Target Horizontal (N-S and E-W Directions)



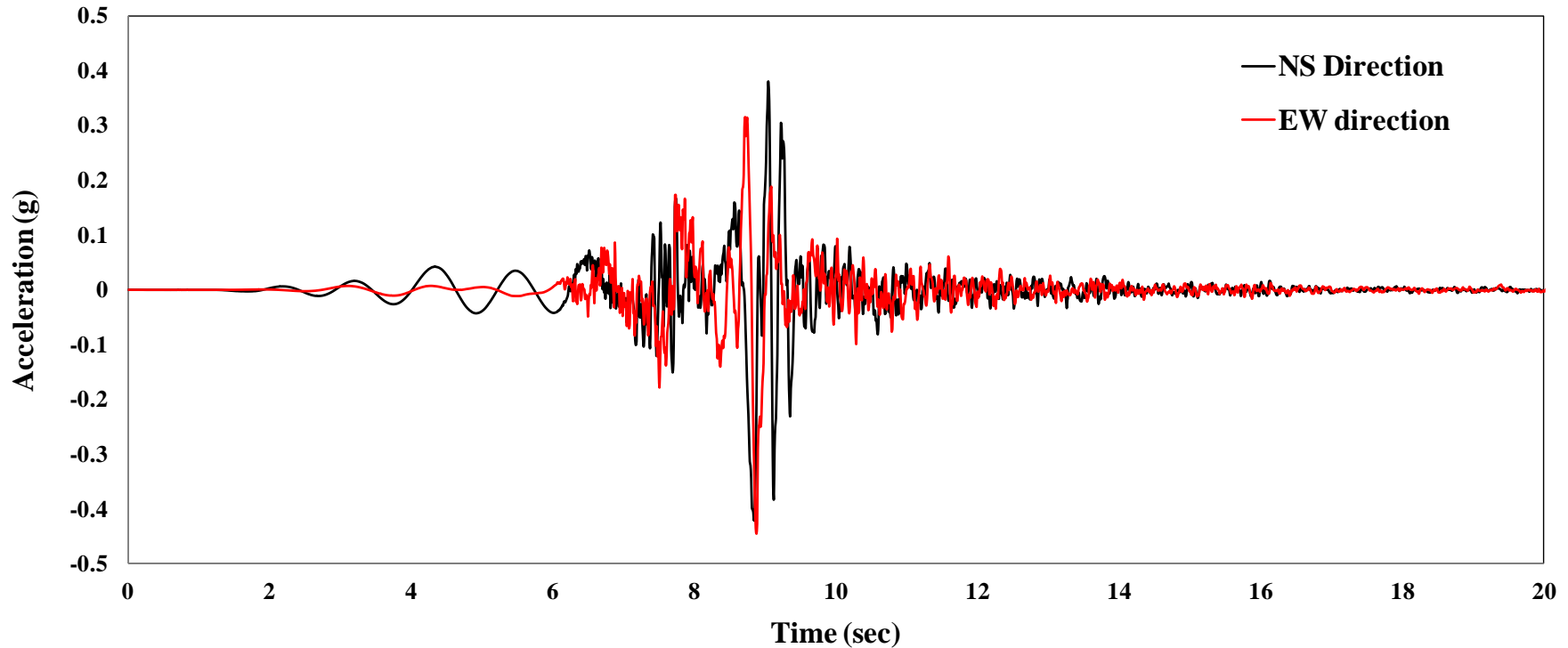
Data Analysis (Response Spectral Matching)



Data Analysis (Response Spectral Matching)

Response Spectral Matching San Simeon 6.52 Mw, 6.97 Km

San Simeon 6.52 Mw 6.97 Km

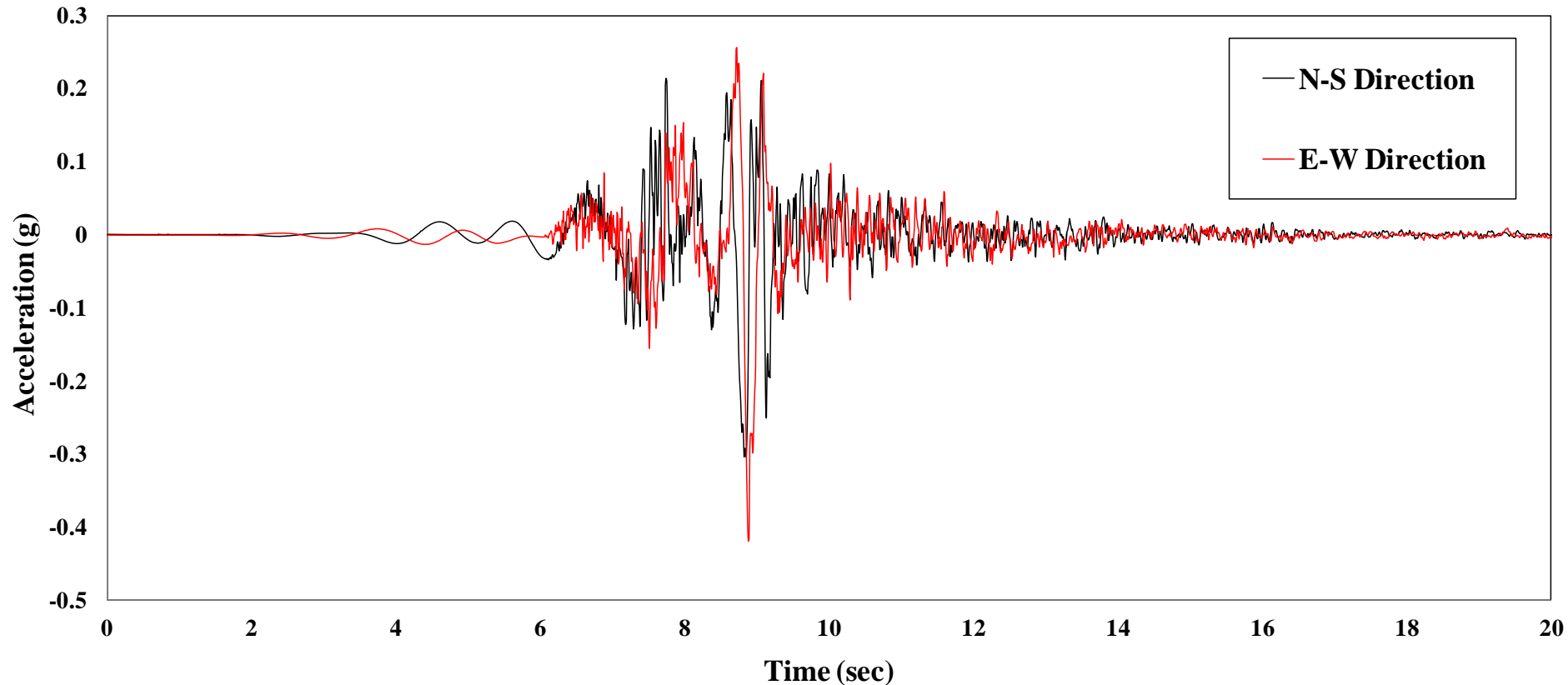


Original acceleration time histories

Data Analysis (Response Spectral Matching)

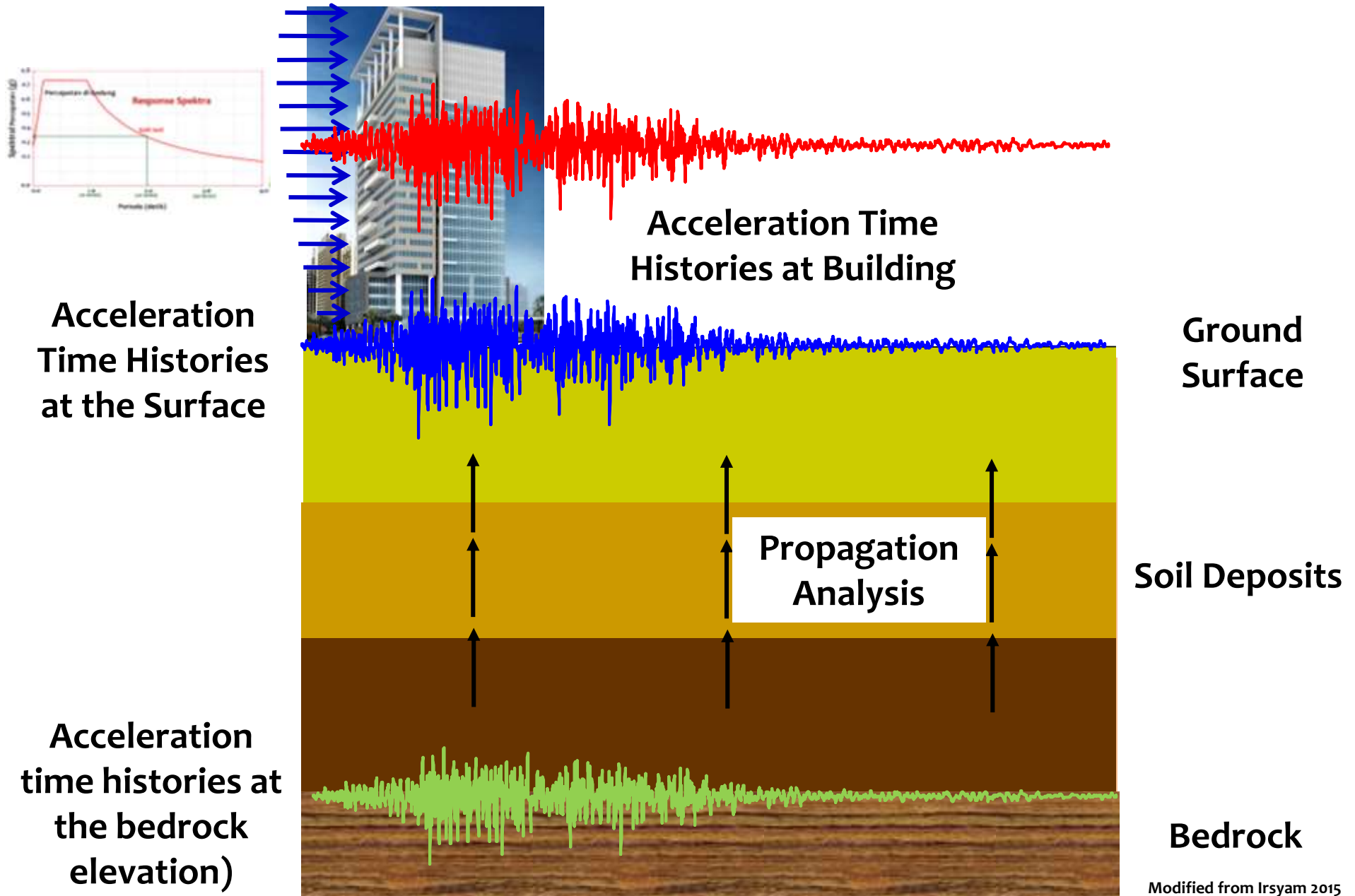
Response Spectral Matching San Simeon 6.52 Mw, 6.97 Km

Matched Acceleration Time Histories San Simeon 6.52 Mw 6.97 Km



Matched / modified acceleration time histories

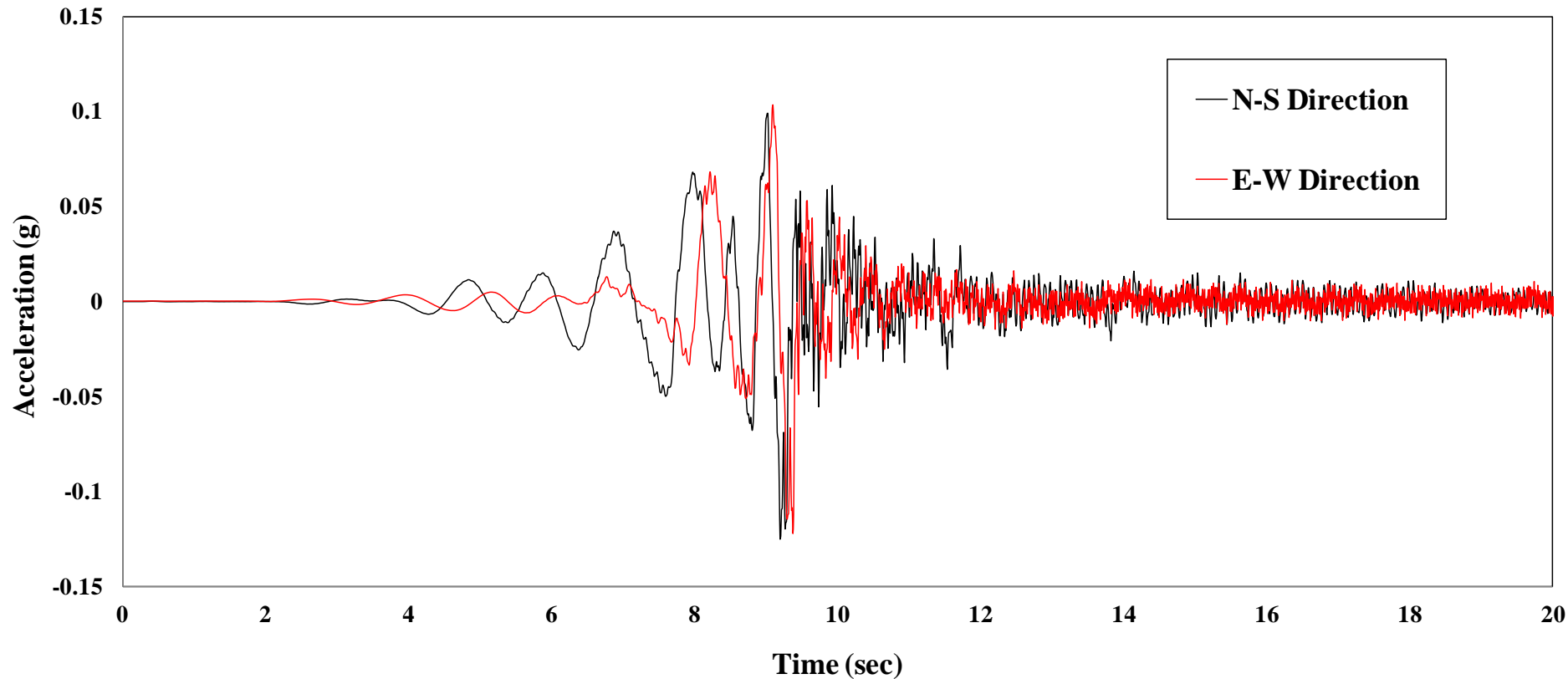
Data Analysis (Site Response/Propagation Analysis)



Data Analysis (Response Spectral Matching)

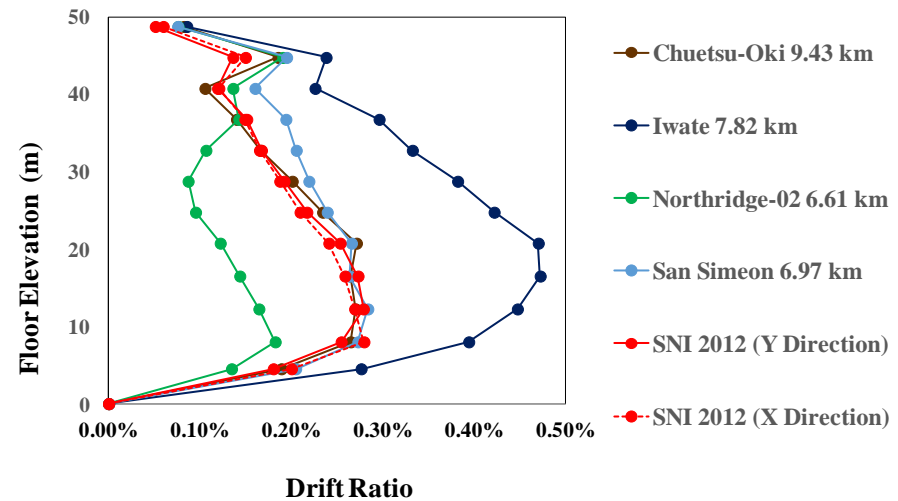
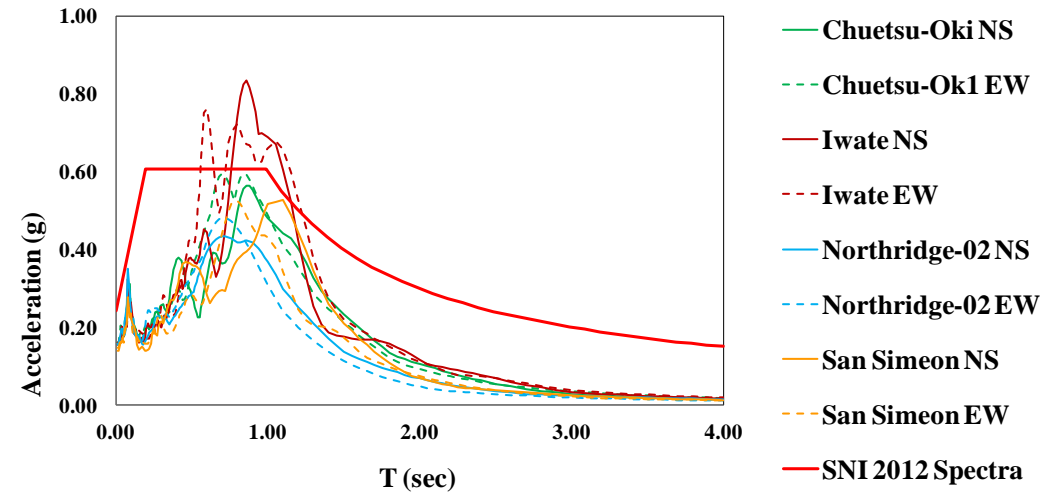
Response Spectral Matching San Simeon 6.52 Mw, 6.97 Km

Surface Acceleration Time Histories San Simeon 6.52 Mw 6.97 Km



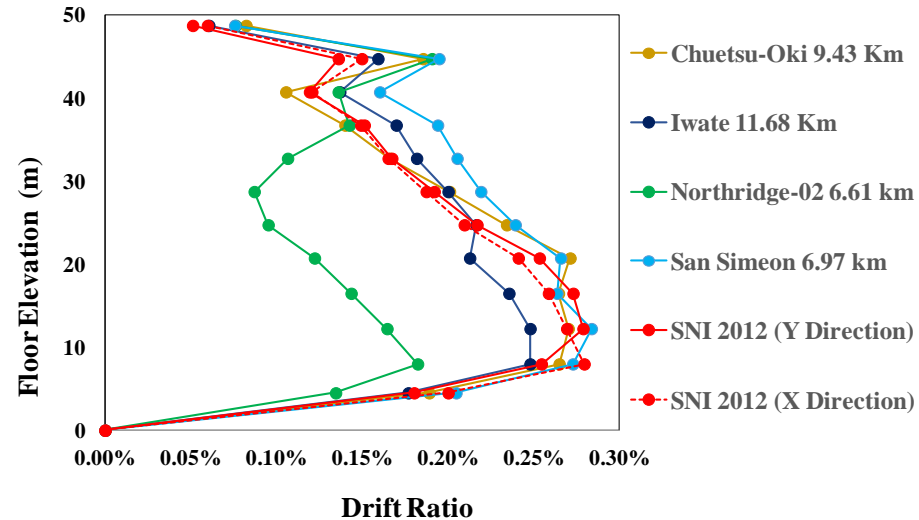
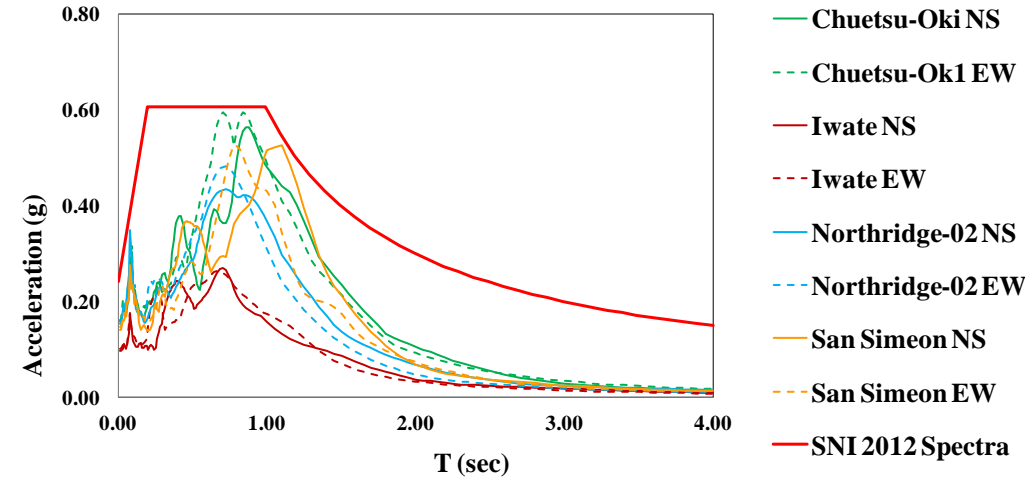
Propagating of modified acceleration time histories for producing surface acceleration time histories

Structural Analysis



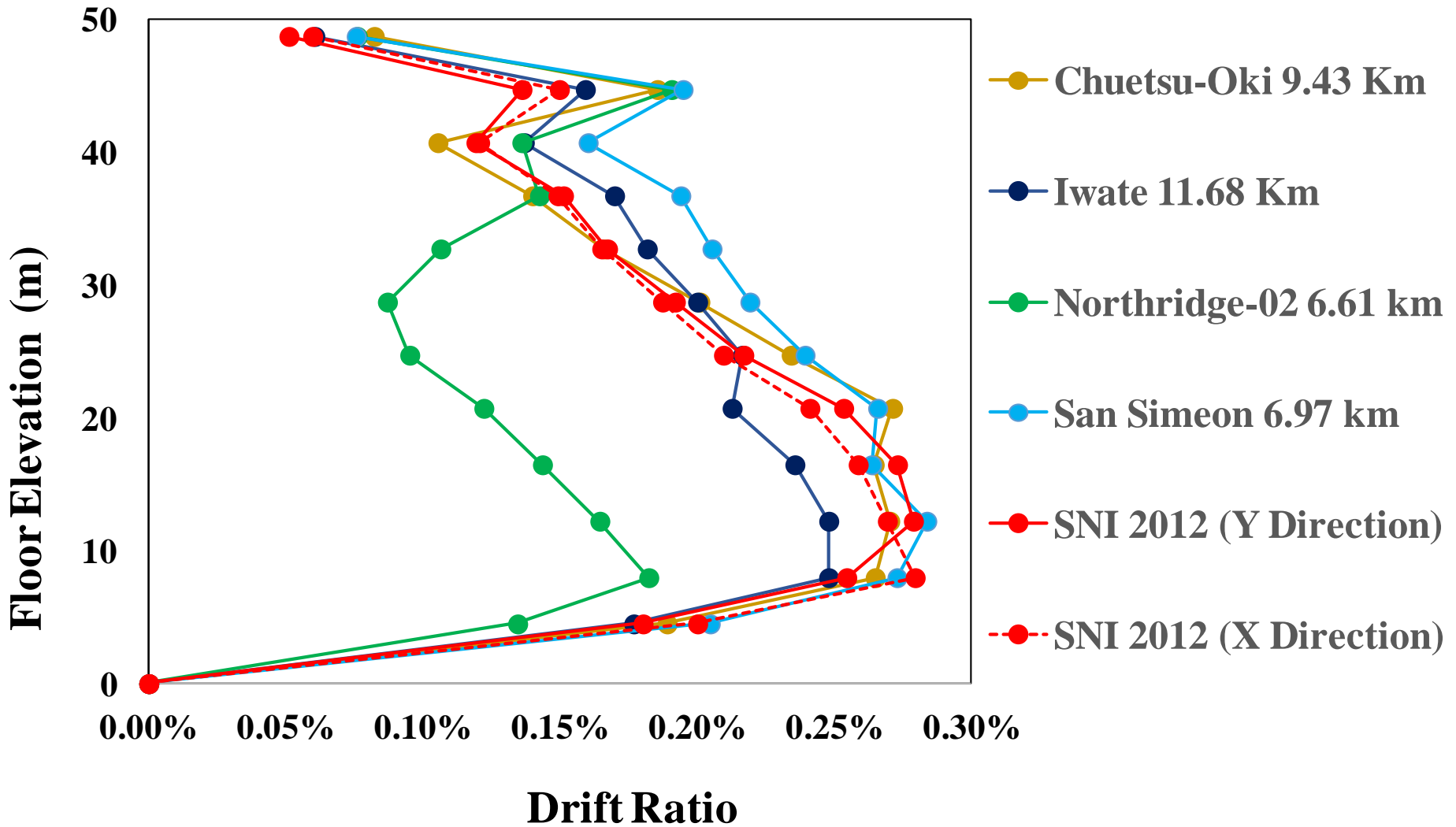
Comparison of spectral acceleration calculated from SNI-03-1726-2012 and two components acceleration time histories of four earthquake events (a) and drift ratio of building B1 when subjected to SNI-03-1726-2012 spectral acceleration and acceleration time histories of four earthquake events

Structural Analysis



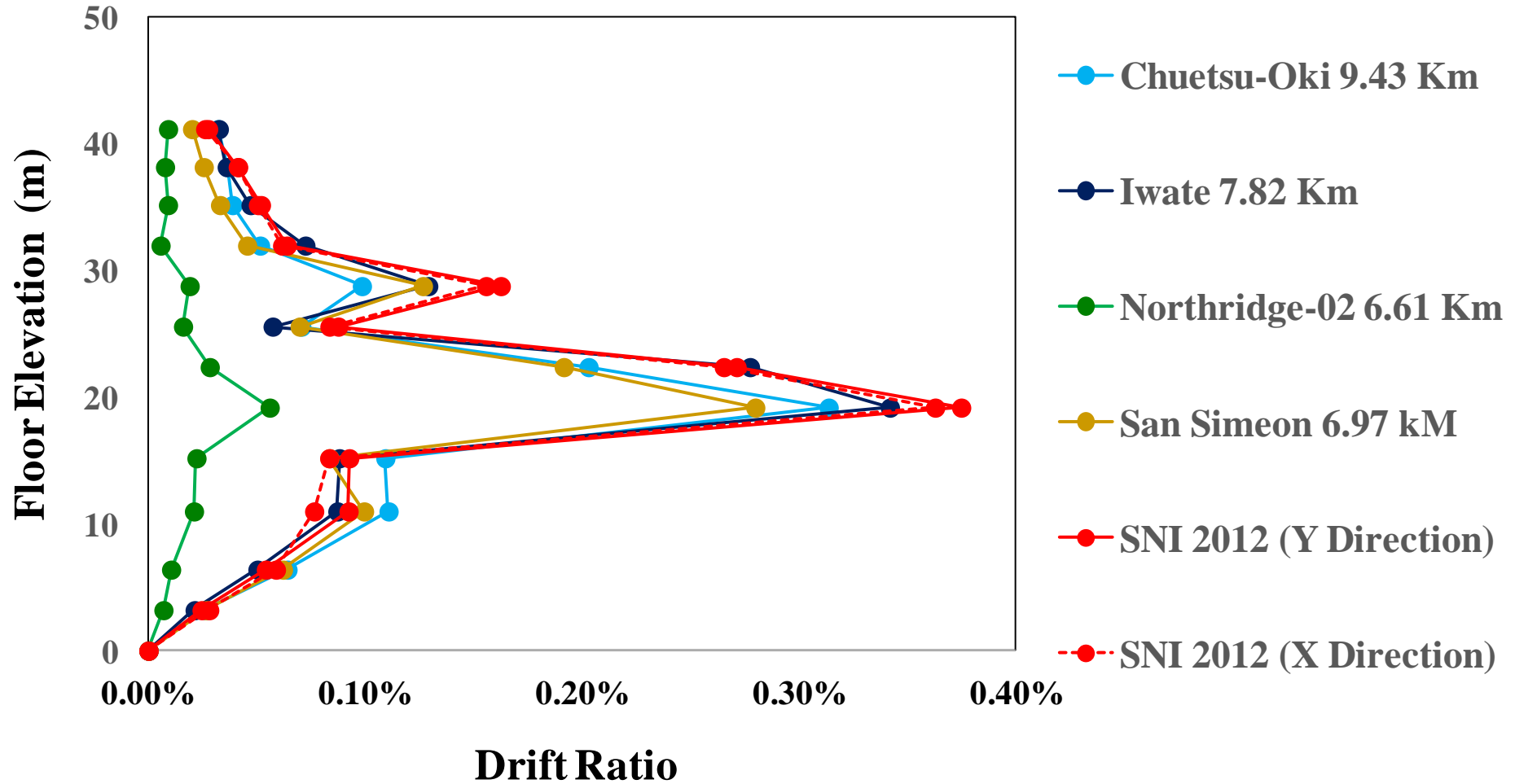
Comparison of spectral acceleration calculated from SNI-03-1726-2012 and two components acceleration time histories of four earthquake events (a) and drift ratio of building B1 when subjected to SNI-03-1726-2012 spectral acceleration and acceleration time histories of four earthquake events

Structural Analysis Results



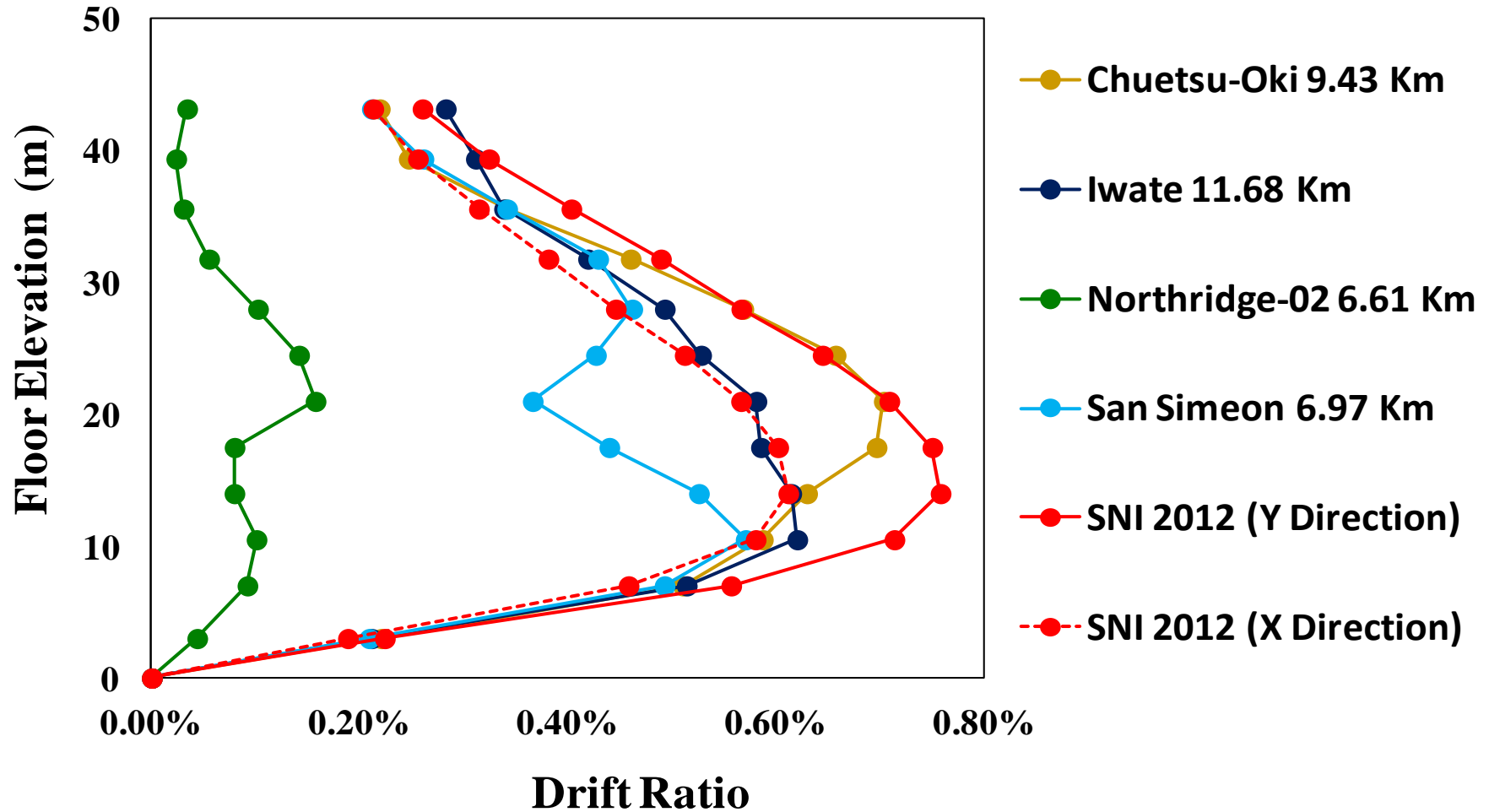
Drift ratio of building B1

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.

A photograph of a pumpkin patch. The image is dominated by large, vibrant green leaves with prominent veins. Several yellow flowers are visible, some in full bloom and others as buds. The background shows more foliage and a slightly overcast sky. The text "Thank you" is overlaid in the center in a bold, red font.

Thank you