Research report for the ERI visit from 9 April to 11 June 2018

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Background

Earthquake hazard analyses provide important inputs to the seismic assessment of new and existing buildings and infrastructure. In seismic hazard analyses, we need to characterize the effects of earthquake source, propagation path of seismic waves, and superficial sedimentary layers at a site of interest on ground shaking. Particularly, the topographical, geotechnical and geophysical properties of near-surface soil layers (< 200 m) play a significant role in modifying the characteristics (amplitude, frequency content and duration) of the incoming waves.

In current engineering practice, site effects are accounted for using

- Code-based site factors;
- Geotechnical one-dimensional (1D) site response analysis using flat-layered soil models subjected to vertical propagating SH waves; or
- VS30-based empirical site amplification models in many ground motion models (GMM).

Neither of these above approaches is adequately effective in estimating the long-period (3-10 s) ground motion, which is indispensable for the seismic design of buildings and infrastructure with long natural periods, e.g., tall buildings and long-span bridges, especially when these safety-critical projects are situated in deep-sedimentary basins (e.g., Kanto basin, Los Angeles basin and Mexico City basin).

Overall Aim

Improve the site effects assessment approaches to better characterize the long-period ground motion using empirical data

Specific Objectives and Outcomes

Select seismic events that generated long-period ground motions in the Kanto basin

Table 1 Selected strong earthquakes in this study

No.	Code	Date	Time (JST)	Location (Lat.[N], Long[E])	Depth [km]	Mag. (M_JMA)

1	0007011602	2000-07-01	16:02	34.208, 139.219	15	6.4
2	0007151030	2000-07-15	10:30	34.426, 139.25	5	6.3
3	0409051907	2004-09-05	19:07	33.031, 136.797	38	6.9
4	0409052357	2004-09-05	23:57	33.146, 137.139	44	7.4
5	0410231756	2004-10-23	17:56	37.291, 138.867	13	6.8
6	0410231803	2004-10-23	18:03	37.353, 138.982	9	6.3
7	0703250942	2007-03-25	9:42	37.220, 136.685	11	6.9
8	0707161013	2007-07-16	10:13	37.557, 138.608	17	6.8
9	0806140843	2008-06-14	8:43	39.028, 140.88	8	7.2
10	1103111451	2011-03-11	14:51	36.733, 142.028	11	6.8
11	1103120359	2011-03-12	3:59	36.985, 138.597	8	6.7
12	1103131026	2011-03-13	10:26	35.800, 141.900	10	6.4
13	1104111716	2011-04-11	17:16	36.945, 140.672	6	7
14	1302251623	2013-02-25	16:23	36.873, 139.412	3	6.3
15	1411222208	2014-11-22	22:08	36.692, 137.89	5	6.7
16	1611220559	2016-11-22	5:59	37.353, 141.603	25	7.4

Compile site information (Latitude, longitude, VS30, Z0.8, Z1.0, Z1.5, Z2.5) of recording sites

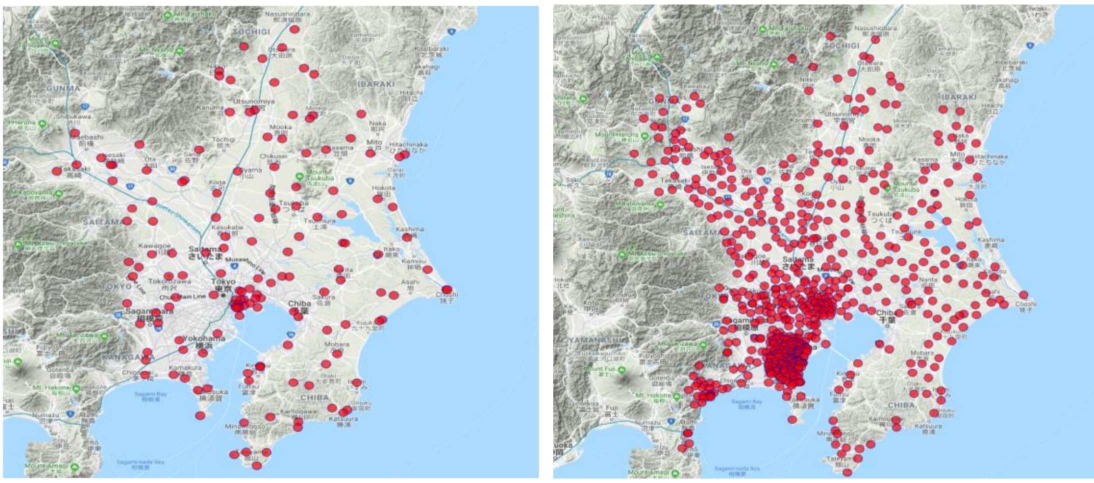

Fig. 1 Recording station in the Kanto basin, (a) K-NET and KiK-net; (b) SK-net

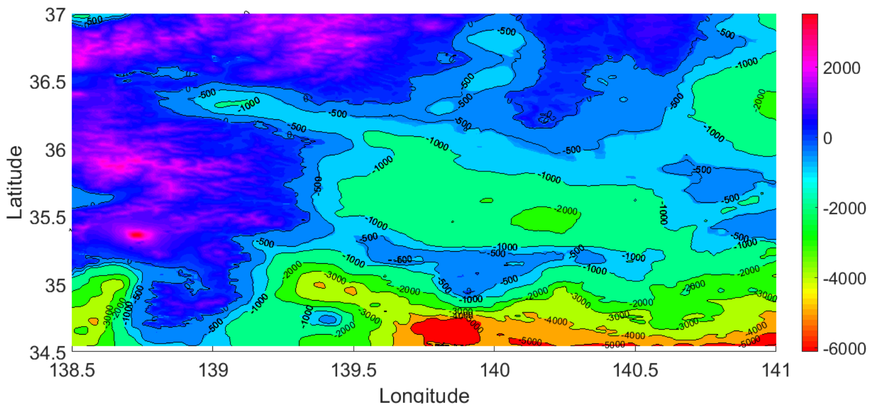

Fig. 2 Basement (1.5 km/s) depth of the Kanto basin

Compile and process seismic records in the Kanto basin during the selected events

All selected seismic records were baseline corrected and bandpass filtered. Absolute velocity response spectra were then calculated and the geometrical mean of two horizontal components was used in the following analysis.

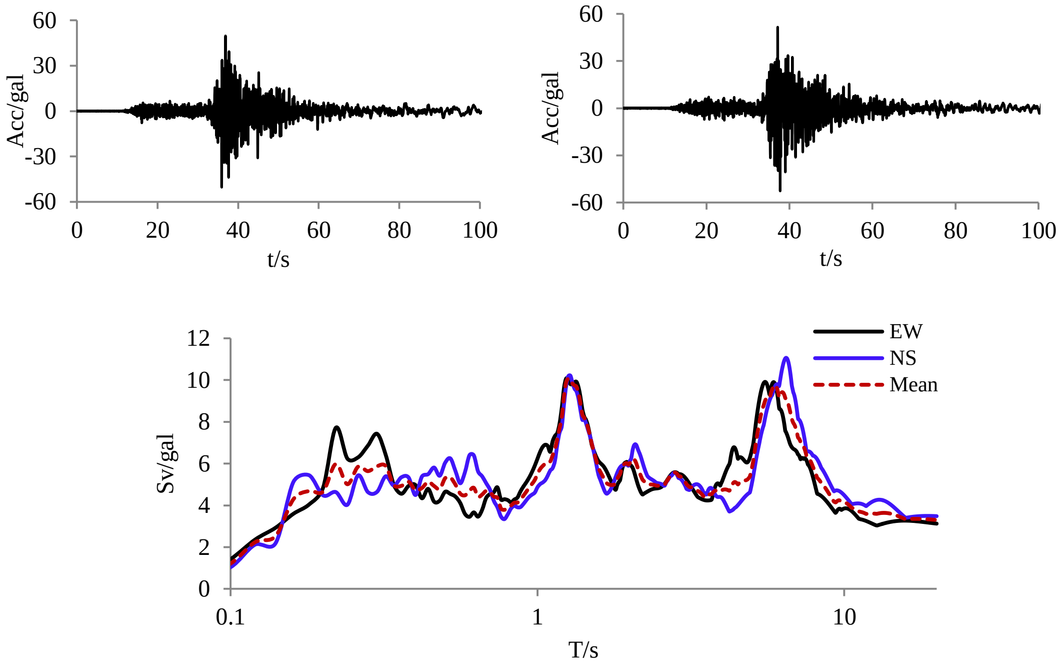

Fig. 3 Record at site CHB001 during an event at 17:56 on 23 Oct 2004. (a) Acceleration time-histories in EW direction; (b) Acceleration time-histories in NS direction; (c) Absolute velocity response spectra of two horizontal components and their geometrical mean

Determine reference ground motion and calculate site amplifications

Records at borehole stations are averaged and used as the reference ground motion for each event.

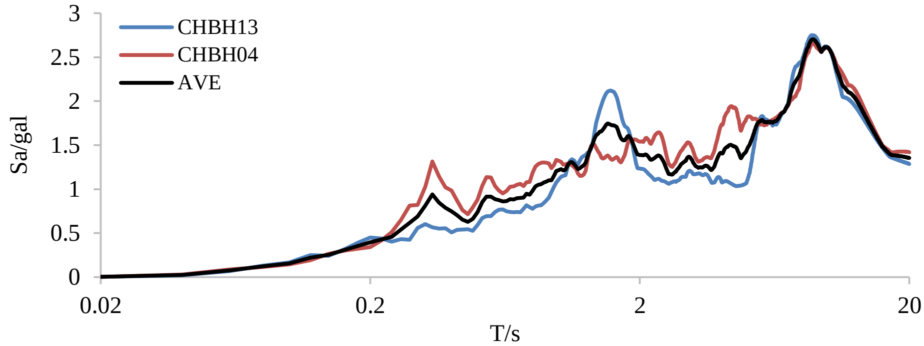

Fig. 4 Reference ground motion for the event occurred at 16:23 on 2013/02/25

*Identify optimal site parameter(s) to characterize the long-period amplification in the Kanto basin using statistical approaches (**on-going**)*

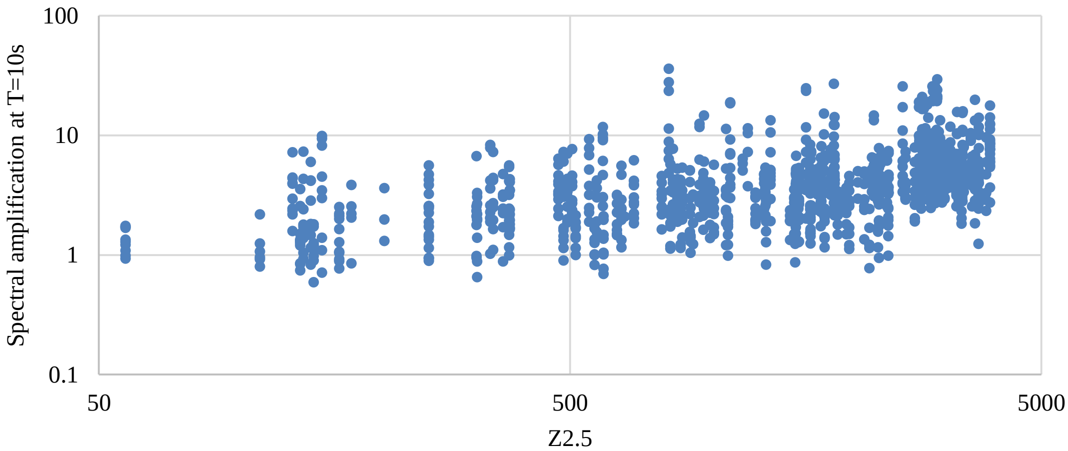

Fig. 5 Z2.5 versus spectral amplification at T=10s for K-NET and KiK-net sites

Acknowledgements

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