Estimation of 3-D Basin Structure Model for Strong Motion Simulation in Sagaing City, Myanmar

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Summary

In this study, we identified the 3D subsurface structure (S-wave velocity structure) through Microtremor technique and which can be used for strong motion simulation. To achieve this, at first, we identified the 1D array models for 5 array sites until reaching to the seismic bedrock (Vs = 3000 m/s) by using with two different approaches by García-Jerez et al., (2016) method and Mori & Nagashima et al., (2016) method. After that, we performed the S-wave velocity inversion for all single-station sites by applying with those 1D 5 array models from previous stage as an initial model. In here, since our objective is to create the 3D structure model, it is better to have more or less similar S-wave velocity (Vs) values and due to this, we fixed the Vs and thickness values for deep part of the structure (Vs > 500 m/s) and we changed only the 50 % values of Vs and thickness for shallow part (Vs < 500 m/s) from the initial model when we did the inversion for all single station sites.

Keywords: 3D subsurface structure, array models, S-wave velocity inversion, strong motion simulation

Introduction

In strong motion simulation, one of the essential parameter is the information of sub-surface structure, otherwise (S-wave velocity structure) for theoretical and actual basin response. However, in Sagaing City, Myanmar, there is no previous study about the information of sub-surface structure and therefore we cannot perform any detail seismic analysis for future and current situation as consequences. Due to this reason, our objective is intend to provide the S-wave velocity structure for Sagaing City, Myanmar through microtremor measurement due to its cost is low if we compare with other conventional techniques such as drilling a borehole. Many of the former evidences have also been successfully evidenced that microtremor is an effective tool for extraction of S-wave velocity structure such as Horike (1985), Kawase et al (1989), Satoh et al (2011) and others.

Microtremor Measurement

In order to estimate the 3D structure model, we performed 5 microtremor acceleration array sites and 125 sites for single-station measurement in Sagaing City, Myanmar. In addition, we conducted 2 additional microtremor velocity array (VSE array) and we combined those data with former 5 array sites in order to reach the seismic bedrock (Vs = 3000 m/s). In Figure 1, we illustrated the locations of the observation sites for microtremor array and single-station measurement in Sagaing City.

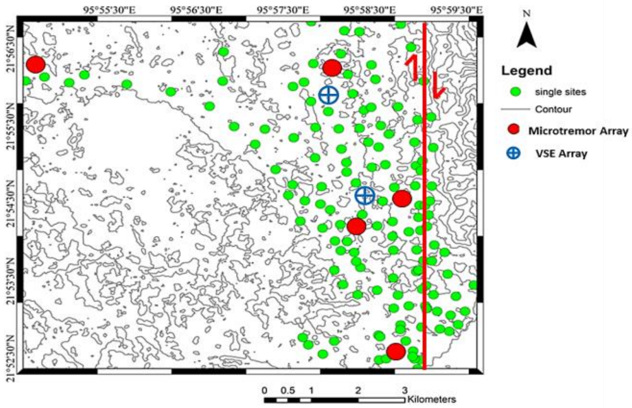

Figure 1. Location of Microtremor Observation Sites in Sagaing City

Estimation of 1D S-wave Structure Model

To identify the 1D S-wave Structure model, at first we extracted the phase velocity from array records of microtremor and we used Tada et al., (2007) method to do this step. Once we obtained the Rayleigh wave velocities for each array site, then we constructed the 1D model and here, we used two different approaches by García-Jerez et al., (2016) and Mori & Nagashima et al., (2016) method as stated in above. Firstly, we applied the García-Jerez et al., (2016) method and we got the 5 array models for 5 array sites. After that, we averaged those 5 array models for 5 array sites and we used this averaged model as an initial model to perform the Mori & Nagashima et al (2016) method. The main objective of identifying these two methods is to get the similar structure models for application of inversion of single-station sites. In Table 1, we showed the detail information of model parameter for ARRAY1. The agreement of H/VRs between the theoretical and observed one was illustrated in Figure 2 and S-wave velocity profile was shown in Figure 3.

Table 1. Parameters for Estimated Ground Structure

ARRAY1

Thickness (m)	Depth (m)	Vp (m/s)	Vs (m/s)	Density (g/cm³)
1.5	1.5	935	149	1.66
1.5	3	1139	247	1.73
10	13	1312	332	1.79
23	36	1457	404	1.83
21	57	1625	489	1.87
52	109	1939	651	1.94
48	157	2388	893	2.03
67	223	2566	992	2.07
256	479	3216	1374	2.19
332	811	3526	1568	2.24
978	1789	4145	1987	2.34
1105	2893	4846	2528	2.47
∞	∞	5368	3000	2.56

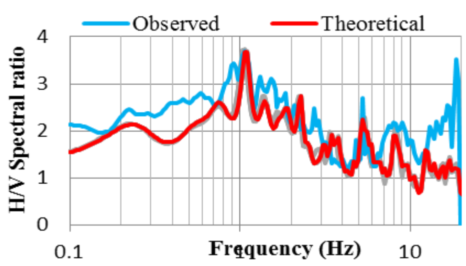

Figure 2. Agreement of H/VR between Theoretical and Observed one

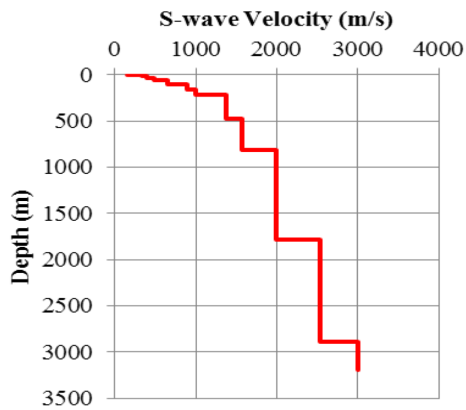

Figure 3. S-wave Velocity Profile for ARRAY1

S-wave Velocity Inversion for Single Station Sites

By using 5 array models from previous section, we performed the inversion analysis for single station sites in order to obtain the S-wave information for the whole area of City. To perform this step, we divided the 5 zones based on the closet of geographical situation according to 5 array sites. And then, we did the inversion for all single station sites by changing only the 50 % of Vs and thickness values for shallow parts (i.e. Vs < 500 m/s) from the initial model while the deep parts were fixed. After that, we got the S-wave structure values for the whole area of city and we could access to the 3D basin structure.

Conclusion

In order to construct the 3D basin structure in Sagaing City, we conducted 5 microtremor array sites and 125 sites for single station measurement. At first, we identified the Rayleigh wave phase velocities for 5 array sites. After that, created the 13 layers models including their thickness (h), shear wave velocity (Vs), P-wave velocity (Vp) and density (ρ) for each 5 array model. Then, applied those 5 array models for inversion of single station sites in order to construct the 3D basin structure and which will be used for strong motion simulation in Sagaing City, Myanmar.