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# Estimation of Shear Wave Velocity Structure in Sagaing City, Myanmar by Microtremor Observation

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## 1. Introduction

Our recent study mainly focuses to estimate the shear wave velocity structure of Sagaing City, Myanmar through the analysis of microtremor horizontal-to-vertical spectral ratios (MHVRs) and phase velocity of surface waves from array measurements. To reach this goal, we have conducted over 100 single-station measurements and 5 array measurements. As for the results, we obtained the 1D shear wave velocity models for each array site and we will use this information for construction of 3D basin structure and simulation of strong ground motion amplification when creating a microzonation seismic hazard map for Sagaing City.

## 2. Microtremor Observation

### 2.1 Single-Station Measurement

The single-station method, where a three-component records form a single seismometer is processed to yield a spectrum of horizontal to vertical spectral ratio and these routine spectral techniques can easily be applied to estimate the dominant frequency of vibration of the sedimentary structure. These frequencies of vibration are closely related to the physical features of the site under study, i.e., layer thickness, densities and shear wave velocities. As for the measurement in Sagaing City, over 100 single-station sites, which covers almost the whole area of the city, were measured by using the SMAR-6A3P instrument (Mitsutoyo) with LS8800 data logger (Hakusan Corp.). The interval from site to site is approximately 0.5km and the duration of recording was 20 minutes for each site. The sampling frequency was 200Hz and amplifier and low pass filters are set as 500 and 50Hz respectively. The results for all single station sites including their dominant frequencies are shown in Fig 1.

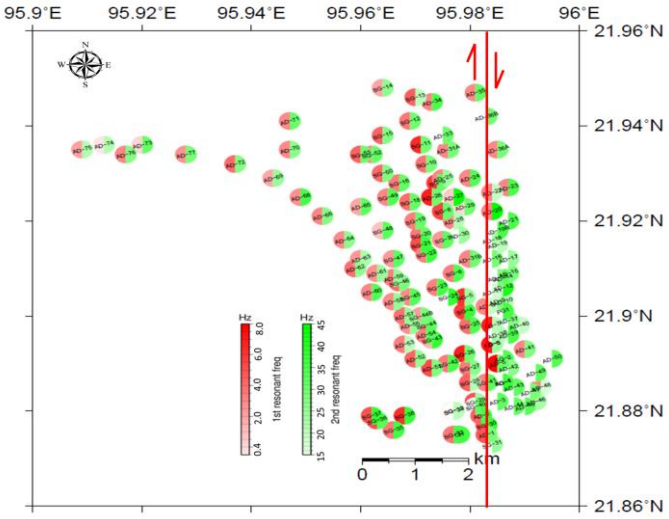



**Figure 1** Distribution of peak frequencies for all single station sites

### 2.2 Array Measurement

Array observation of microtremor is practically useful method for estimating shear wave velocity structures beneath a site where a seismometer array is deployed. This method basically involves extracting surfaces waves from microtremor in the form of dispersion, and then inverting the dispersion data for one-dimensional shear wave velocity structure. In Sagaing City, array measurement was conducted in 5 sites with 4 instruments at each array observation site. As for the shape of array geometry, one of the accelerometer was settled at the center of the circle and another three instruments were arranged to the circumference of the circle, equally separated. The observed duration time was 30 minutes for each array site with the sampling frequency of 200Hz.

### 2.3. Estimation of Shear Wave Velocity Structure

#### 2.3.1 Phase Velocity Analysis

In order to retrieve the information of Rayleigh wave phase velocity from the array measurement, we used the "BIDO" program of version 2.0 by (Tada et al., 2007). Basically, this program detects the phase velocity from the vertical components of array measurement by using the method of noise –compensated CCA (nc-CCA) method, a revised method extended from Spatial Autocorrelation (SPAC) method. The results of the Rayleigh wave phase velocity dispersion curves for 5 array sites in Sagaing City are shown in Fig 2.

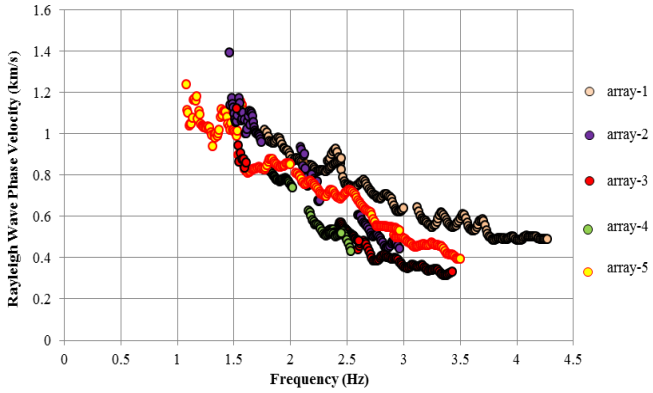


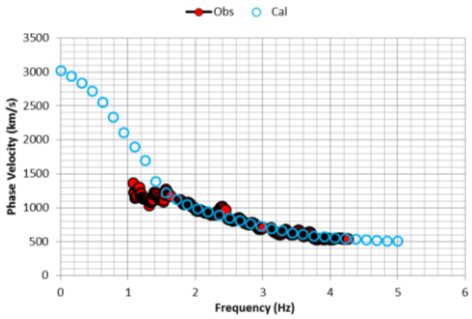

**Figure 2** Result of phase velocities for 5 array sites

#### 2.3.2 Inversion from Phase Velocity to Shear Wave Velocity

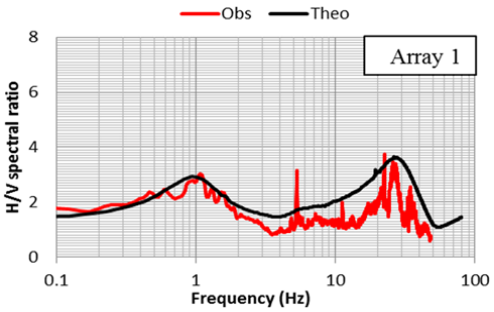
In this study, the observed phase velocities were converted as shear wave velocity structure profiles by using with the method of Ballard (1964) for reference in constructing the initial shear wave velocity structure model.

### 2.4 Forward Modelling

To achieve the 1D shear wave velocity structure model, primarily we constructed the initial model with four parameters; thickness (h), S-wave velocity (Vs), P-wave velocity (Vp), and Density (ρ). After that, we modified the initial model with two stages of inversion; (1) phase velocity and (2) horizontal to vertical spectral ratio (HVR) until to agree with the observed and theoretical one as described in Fig 4.




**(a) Phase velocity of Rayleigh wave**




**(b) HVR**

**Figure 3** Agreement of theoretical with observation for (a) phase velocity and (b) HVR

### Conclusion

MHVR technique with diffuse filed theory by Sánchez-Sesma et al. (2011) was applied for single station measurement. At the same time, array measurement technique (Tada et al., 2007) was also applied to obtain the shear wave velocity structure at 5 sites in Sagaing City of Myanmar. As this stage, we have created shear wave velocity structure model at 5 array sites which can reproduce both MHVRs and phase velocities.


### Acknowledgements

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### References


Tada et al., (2007). "Beyond the SPAC Method: Exploiting the Wealth of Circular-Array Methods for Microtremor Exploration", *BSSA*, **97**(5), 2080-2095, doi: 10.1785/ 0120070058.