Deep Shear Wave Velocity of Southern Bangkok and Vicinity

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Abstract

Bangkok is located on the soft marine clay of the Lower Chaopraya Basin which can amplify seismic wave and affect building shake. Shallow shear wave velocity to depth 30 m. (V_s30) is widely studied recently but data of deeper layer to bedrock are still absent. The missing data are useful for earthquake engineering design and ground shaking estimation.

This study aims to measure deep shear wave velocity profile down to bedrock of southern Bangkok region. Microtremor measurements with 2 seismographs using Spatial Autocorrelation (2-SPAC) technique were done at 8 sites. The data were collected during a day time on linear array geometry varied between 5-2,000 m. Long natural wavelength at the frequency 0.2-0.6 Hz was detected at many sites. The results show that shear wave velocity function of the Southern Bangkok is between 100-2,000 ms^{-1} and indicate that the bedrock depth is about 600-800 m, except at Bang Krachao Very deep shear wave data of many sites are ambiguous due to noise and survey limitation.

Objectives

1. Find and measure bedrock depth of Southern Bangkok area.
2. Study its shear wave velocity profile.

Study Location

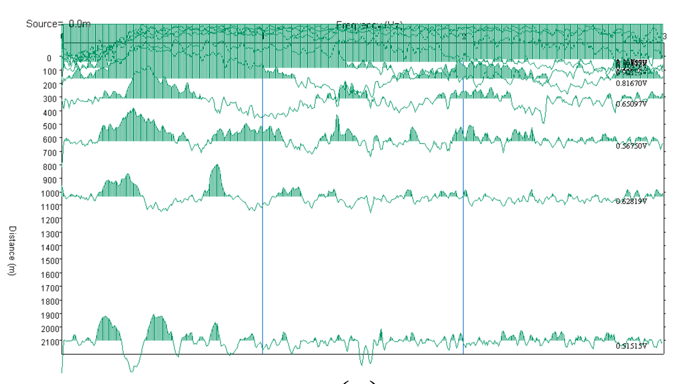
***Figure 1**: Eight measurement sites are divided into 2 lines contained:*
Line 1: Krathumban, Bangbon, Bangnamphueng and Suvannabhumi.
Line2: Bang Krachao, Samut Sakhon, Sakkhla and Samut Prakarn.

Data Acquisition and Geometry

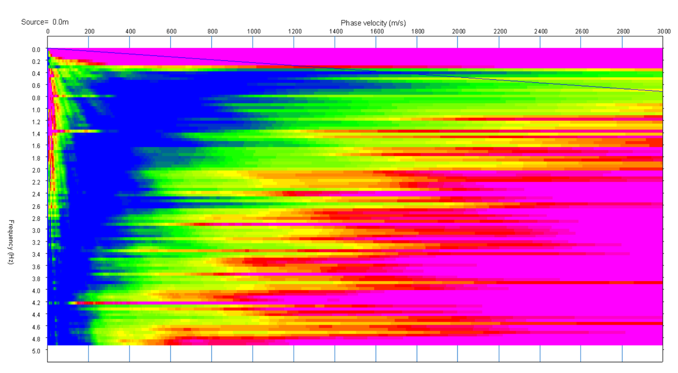
***Figure 3:** Sensors spacing at Bangnamphueng site, Samut Prakarn*

The 2 seismographs were placed in linear array with separation from 5, 10, 20, 40, 80, 160, 320, 640, 1,000 and 2,000 m. in 8 sites of Southern Bangkok. The collecting time was varied from 20-90 mins or 2 hours at some places. A seismograph position was fixed while another was moved entire the survey.

Research and Data Processing Steps



(a)



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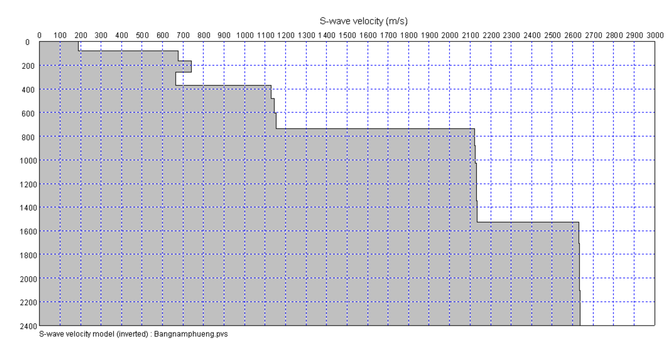

(c)

Vertical microtremor observation

Input data and check coherency (a)

Calculate and pick phase velocity (b)

Create initial Vs model

Inversion modeling (c)

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Microtremor and SPAC Theory

Microtremor or ground oscillation is a passive seismic method which usually use S-wave velocity to survey the target areas. The properties of S-wave can describe for local site effect and earthquake engineering study. Its high frequency wave usually appears in shallow surface while low frequency of ambient noise can be measured down to several kilometers. Spatial Autocorrelation (SPAC) is a statistical method for the survey design and phase velocity calculation of the non-source wave propagation such as, the ambient noise.

$$SPAC(\Delta x,\omega) = J_0$$

whereas x is a distance between receivers, ω is an angular frequency, c(ω) is a frequency-dependent phase velocity and J_0 is a zero order Bessel's function.

The fundamental concept of SPAC is to record the vertical microtremor composition in several positions of the target sites to collect varied azimuthally angle propagation of Rayleigh wave identity. The data pair is then calculated to compare its wave coherency spectrum, determine correlation, phase velocity and generate SPAC coefficient which fits the formula above. The phase velocity model displays correlation of a velocity of each frequency. Then, it will be converted to velocity-depth profile model by inversion analysis for the final result.

Figure 2: Instrument and data acquisition

*2 sensors of 3-axis seismograph: **Geomtric McSeis MT-Neo** Sampling rate 2 ms. Frequency band 0.1-200 Hz*

Results and Discussion

The phase velocity models display minimum frequency of 0.2 - 0.6 Hz. For the top 50 m depth, shear wave velocities are between 80-180 ms^{-1}. Next shear wave velocity range from 200-800 ms^{-1} which could be sand and saturated clay layer, was found at depth between 100-500 m.

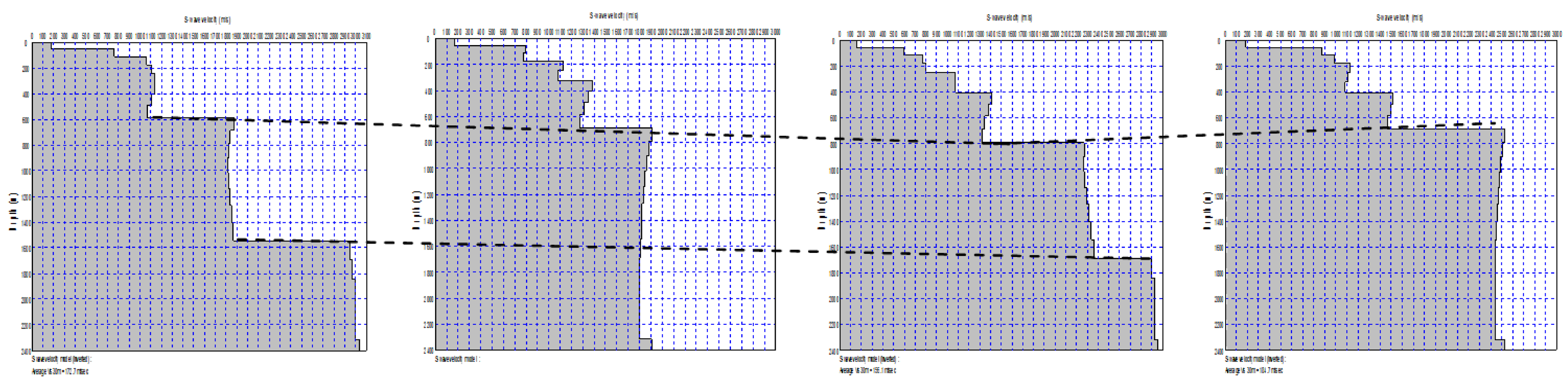

***Figure 4:** Inversion velocity models of W-E transect line 1 (a) Krathumban (b) Bangbon (c) Bang Namphueng and (d) Suvannabhumi respectively.*

The upper dashed line indicates the depth of the bedrock with shear wave velocity of 800-2,000 ms^{-1} at 700-800 m. The lower dashed line is basement velocity 2,000- 3,000 ms^{-1} showing at depth of 1,500-1,700 m.

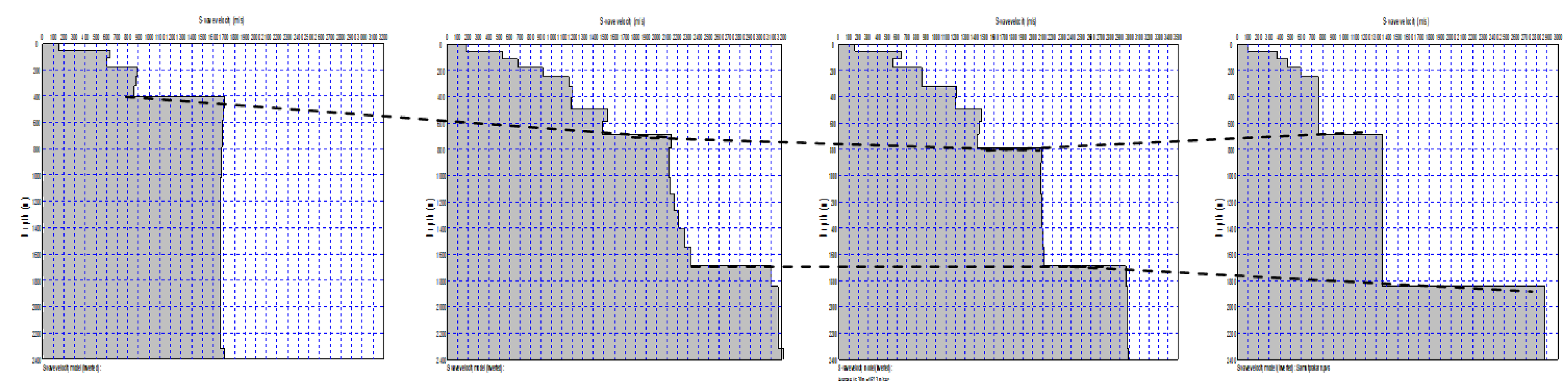

***Figure 5**. Velocity models of W-E transect line 2 (a) Bang Krachao (b) Samut Sakhon (c) Sakhla and (d) Samut Prakarn respectively.*

The upper line indicates bedrock depth level of shear wave velocity 800-2,000 ms^{-1} found at 400, 700-800 m depth and the second lower line is basement velocity 2,000- 3,200 ms^{-1} at depth 1,700-1,900 m.

Conclusion

One of the limitations of the data acquisition is strong noise interference of long wavelength which appeared in many areas. It reduces accuracy or even tampers with all bedrock depth information. In the future, the 2-SPAC survey should be conducted throughout the Greater Bangkok for creating accurate bedrock map.

Reference: Poovarodom N and Jirasakjamroonsri P 2015 Investigation of Long Period Amplification in the Greater Bangkok Basin by Microtremor Observations. *Proc. of the Tenth Pacific Conf. on Earthquake Engineering Building an Earthquake-Resilient Pacific*