

Applicability Evaluation of the Surface-wave Exploration to the River Marine Geology Investigation

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ABSTRACT

The near-surface geotechnical investigations using a surface-wave method become more popular in the last few years. S-wave velocity of ground is directly related to the rigidity of the ground and it can be used to estimate a bearing capacity or liquefaction potential etc. It seems that the surface-wave method can be applied to a lot of geo-technical investigations because the method can delineate two-dimensional S-wave velocity structure non-destructively and quickly. Authors are developing a water bottom surface-wave method and carried out field tests in the pond and the river where water depth is about 2m. The result of field tests revealed that an air gun and a hydrophone were suitable as a source and receivers for the surface-wave method respectively. S-wave velocity model down to the depth of about 10m under water bottom was obtained by the phase-velocity analysis almost same as survey on land. This paper presents the feasibility study on water bottom surface wave method and the result of field tests performed at the Koyama-ike Lake and the Sendai-gawa River in the Tottori prefecture, Japan.

KEY WORDS: Geophysical exploration, surface-wave method, site investigation

INTRODUCTION

In Japan, there is a growing interest in renewable energy such as wind power, solar power, etc. these days. As an example of renewable energy facilities, the inshore area is taken into account to construct large wind power plants. We began a study about economical and efficient investigation methods to obtain geotechnical information to design basement structures of wind power plants at inshore areas. Surface-wave method could be one of the solutions for the sake of our study. In order to adopt surface-wave method on inshore area, following studies and experiments were conducted: 1) Theoretical study to understand the characteristics of surface-wave propagating at the bottom of water, 2) Water tank experiment, 3) Field experiments at a pond and a river.

FEASIBILITY STUDY ON WATER BOTTOM SURFACE-WAVE METHOD

Characteristics of Surface-waves Propagating at the Bottom of Water

At the bottom of water, surface-waves can not be simply analyzed because of the effect of a liquid layer on elastic material. Surface waves propagating along boundary between air and elastic material is called as Rayleigh wave. That of water and elastic material is called as Stoneley waves. In order to evaluate the effect of the liquid layer, dispersion character with the top liquid layer is studied by comparing the theoretical dispersion curves of Rayleigh and Stoneley waves. The velocity models used in the calculation is chosen as same as the site for field tests. S-wave velocity for elastic layer is 150m/s and the thickness of liquid layer is 2m (see to Fig. 1).

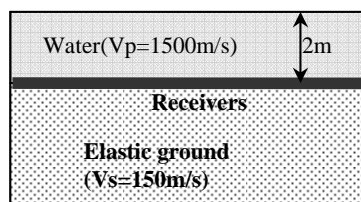


Fig.1. Velocity model for theoretical study.

Fig.2 shows the result of calculation. We can see that the phase-velocity is same as Rayleigh waves when frequency is close to 0Hz. On the contrary, phase-velocity is same as Stoneley waves in high frequency. The figure also shows that phase-velocity with liquid layer is between 143m/s and 135m/s, the velocity of the Rayleigh wave and Stoneley wave respectively, and close to the S-wave velocity (150m/s).

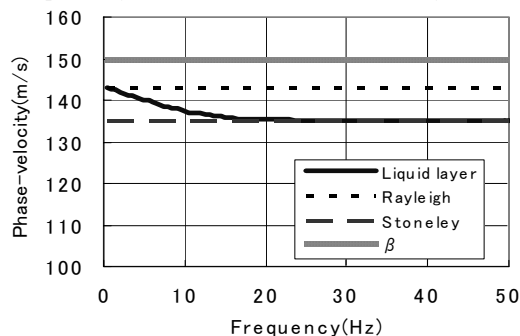


Fig.2. Phase velocity of water-bottom surface-waves in comparison with Rayleigh wave, Stoneley wave and S-wave (β).
 ($\alpha_0 = \alpha = 1500\text{m/s}$, $\beta = 150\text{m/s}$, $\rho_0 = 1000\text{g/cc}$, $\rho = 2000\text{g/cc}$, $H = 2\text{m}$)