The dispersion curve of P-SV wave propagation with a high velocity top layer

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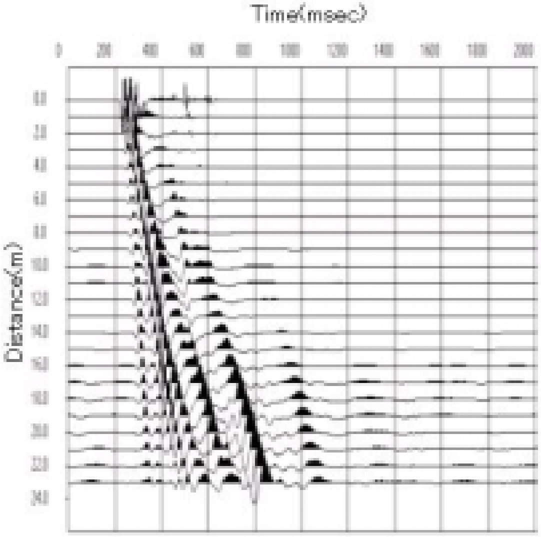
It is well known that the dispersion of phase-velocity of surface-waves (Rayleigh waves) mainly reflects the S-wave velocity structure. A lot of studies have been made on the use of surface-waves for near-surface S-wave delineation in the past decade. Micro-tremors array measurements and surface-wave methods have been developed as geophysical exploration methods in which phase-velocity of the Rayleigh waves are used. Generally, we have assumed that the vertical component surface-waves mainly consist of fundamental mode of the Rayleigh waves.

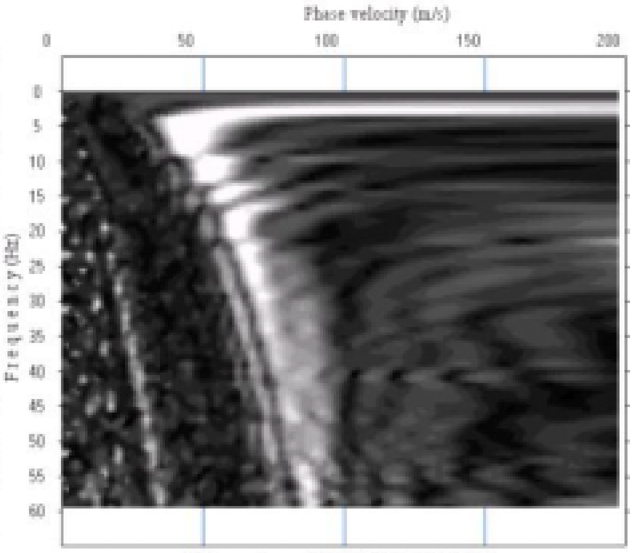
The authors developed the surface-wave method using MASW(Multi-channel Analysis of Surface Waves) in which an impulsive source and multi-channel receiver array are used. The one of the advantage of our method is it can separate a fundamental mode and higher modes using multi receivers. We have applied the method a lot of site and found that the higher modes dominate at the site where velocity model is complex such as a high velocity top layer is over a low velocity layers. In this article, we are going to analyze the observed dispersion curves obtained at the site with a high velocity top layer.

Figure 1 shows a waveform (vertical component) observed at the site a top 1m is seems to be high velocity. A 10kg sledgehammer was used as a source. Twenty-four geo-phones (4.5Hz) were deployed with 1m intervals. The nearest source-to-receiver offset was 1m. Figure 2 shows the phase-velocity image of the data and we can see that the phase-velocity is increasing higher than the frequency of 5Hz. It cannot be explained by a fundamental mode of Rayleigh wave dispersion curve. The dispersion curve is not continuous at the 10 Hz or 15Hz. We estimated the S-velocity model that satisfies the observed dispersion curves with try and error.

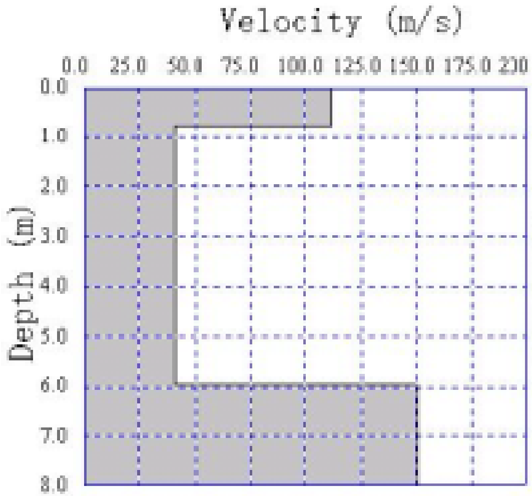
Figure 3 shows the estimated S-velocity model. Figure 4 shows the phase-velocity image of theoretical waveforms for the estimated velocity model. Figure 5 shows dispersion curves obtained by calculating the root of characteristic equation. In the Figure 5, solid lines indicate phase-velocity and dashed lines indicate amplitude. Black circles indicate maximum amplitude phase-velocities in each frequency. Figure 5 shows the observed dispersion curve can be explained by maximum amplitude phase-velocities.



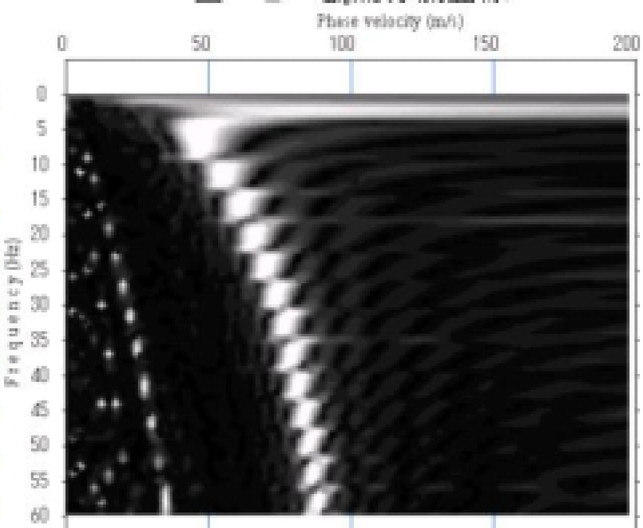
図－１　観測波形例



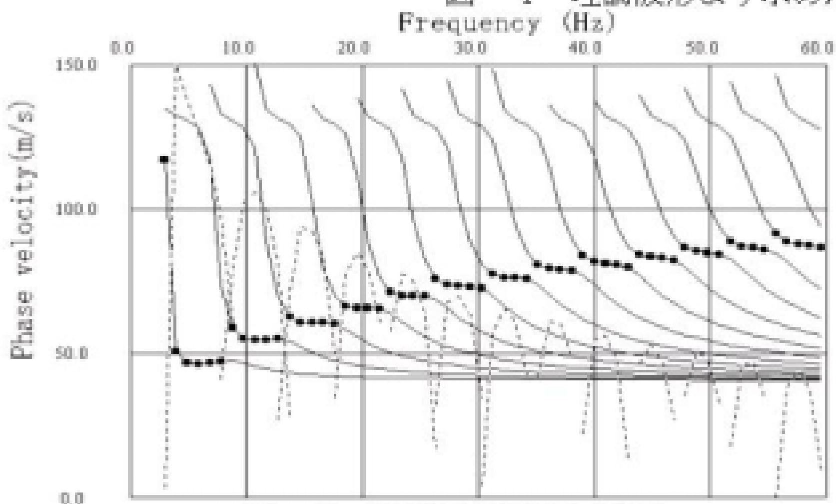
図－２　観測分散曲線



図－３　推定Ｓ波速度構造モデル



図－４　理論波形より求めた分散曲線



図－５　理論分散曲線と振幅