S049-008 Room: C102 Time: May 28 11:30-11:45

Near-surface S-velocity delineation by a surface-wave method using artificial sources

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1. Introduction

Near-surface S-wave velocity structure is very important in many engineering problems, such as earthquake hazard protection. We have developed the surface wave method for delineating near surface S-wave velocity model. The surface waves (Rayleigh waves) are elastic waves propagating along the surface. The phase velocity of surface waves mainly reflects S-wave velocity structure of near surface. Therefore, near surface S-wave velocity structure can be estimated by analyzing surface waves. We have developed the surface wave method using artificial sources. The velocity distributions up to the depth of twenty meters obtained through the surface-wave method.

2. Data acquisition

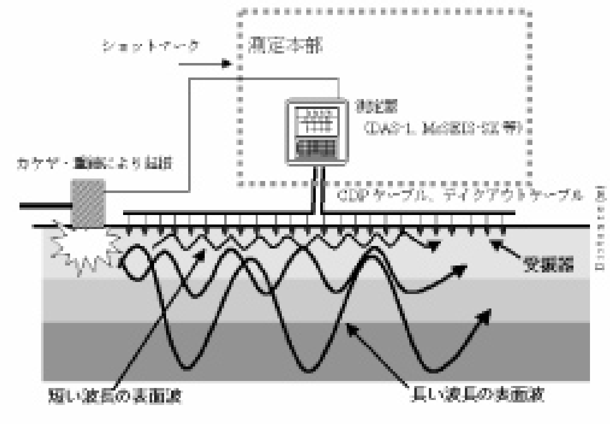
Sledgehammers or weight drops are used as sources and low frequency (4.5 to 28Hz) geophones are used as receivers. Receiver spacing is 0.5 to 2m. Sampling interval is 0.5 to 1ms and data length is 0.5 to 1s. Figure 1 shows the schematic diagram of the data acquisition of the surface wave method. Figure 2 shows the example of waveform data. The data acquisition system is similar to the shallow seismic reflection and refraction system.

3. Analysis

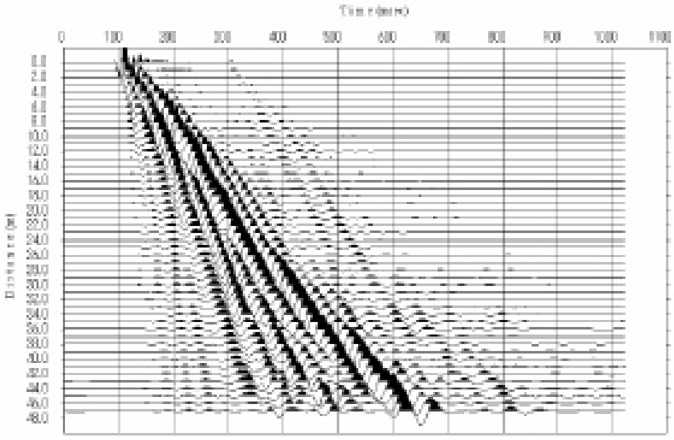
Surface waves on a multi-channel record are converted directly into images of multi mode dispersion curves through a simple waveform transformation method. The method consists of two transformations. At first, time domain waveforms (X-T) are transformed into frequency domain (equation 1). Next, we integrate in X-direction with respect to phase-velocity so that the waveforms are transformed into phase velocity - frequency domain (equation 2). We have applied this method for analyzing surface waves shown in Figure 2. Figure 3 shows the phase velocity - frequency domain image of the phase velocity converted through the waveform transformation. A dispersion curve is picked as the maximum amplitude in each frequency. A non-linear, least square inversion is applied to each dispersion curve in order to obtain a S-wave velocity model.

4. Comparison with PS-logging and N-value

In order to evaluate the applicability of the surface wave method, we have compared S-velocity model obtained from the proposed surface wave method with the one obtained from PS-logging and N-value obtained from SPT. Figure 4 shows the comparison between the surface wave method and PS-logging. Figure 5 shows the comparison between the surface wave method and N-value. We can see that the S-velocity model obtained from the surface wave method agree with the PS-logging and N-value. The results show the applicability of the surface wave method for delineating near surface S-wave velocity model.



図－１　測定の模式図



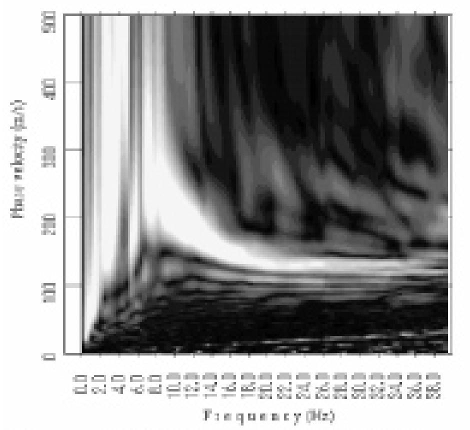
図－２　測定波形例（振源は重錘落下）

$$F\left(x,\omega\right)=\frac{1}{2\pi}\int_{-\infty}^{+\infty}f\left(x,t\right)\cdot e^{-i\omega t}dt \quad （１式）$$

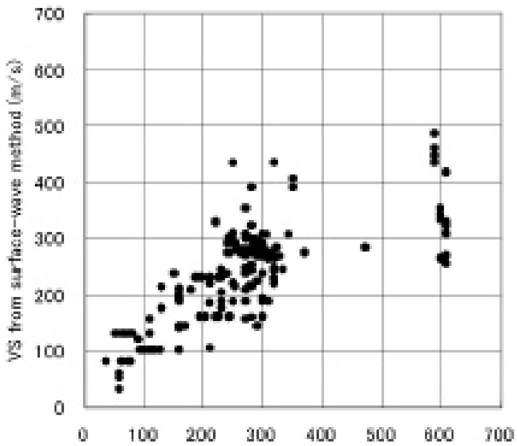
ここで、x は距離、t は時間、ωは角周波数、$f(x,t)$は時間領域の共通起振点記録、$F(x,\omega)$はそのフーリエ変換である。

$$F\left(c,\omega\right)=\int_{-\infty}^{+\infty}F\left(x,\omega\right)\cdot e^{i\omega\frac{x}{c}}dx \quad （２式）$$

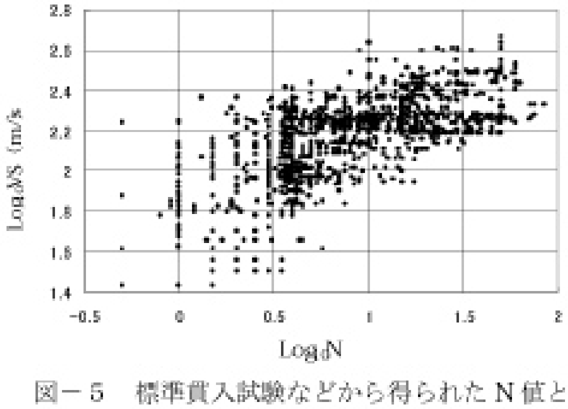
cは位相速度である。



図－３　周波数領域の見かけ速度分布



図－４　PS 検層から得られたＳ波速度と表面波探査から得られたＳ波速度の比較



図－５　標準貫入試験などから得られたＮ値と表面波探査から得られたＳ波速度の比較