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Sediment Acoustic Characteristic Measurement at Hashirimizu Port for Study of Sound Propagation at Very Shallow Water
浅海域音波伝搬のための走水港における底質の音響特性計測

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1. Introduction

When the sound propagates at the coastal area, it always reflect at the sea surface and bottom. We cannot ignore the surface and bottom reflections. Especially at the bottom reflection, the bottom sediments and its geometry exert enormous influence over the sound reflection. Usually, bottom sediments are not uniform both in vertical and horizontal. From the vertical view, sound speed gradually faster according to the increasing of density of the sediment. But there are not enough research about sediment sound speed gradient.

Authores had conducted a reciprocal sound propagation experiment for several years at Hashirimizu Port in Yokosuka, Japan. The distance between the two transducers was about 120 m and the depth at the experimental area was less than 7 m. From some analysis of the experimental result, sea level change by tidal effect and large temperature gradient at the sea surface effected sound path between the two transeivers[1-3]. However, many reflected waves were monitored and there were many interfere between the direct path and reflected paths. It is required to understand more about sediment acoustic charactaristics. In this paper, we will report the sediment acoustic charactaristics by core sampling from the experimental area.

2. Core Sampling

The experimental area, Hashirimizu Port has mad and sandy sediment over hard rock stratum. But its real sediment construction is not sure. Figure 1 shows the overview of Hashirimzu Port. The black circles on in Fig. 1 indicate the location of the transducers for sound propagation and receiving. The core samplers were obtained at the middle area of the reciprocal sound propagation path. Each core sample was obtained into an acrylic tube with 4 cm diameter by a gravity core sampler (RIGO: no.5167). Four core samples with about 6 cm sediment were obtained with this sampler. Figure 2 shows a sample of the obtained core. There were not large difference in the sediment but fine mad with about 5 mm layer was overlay on the black sediment. In some samples, small fractions of sea shells were confirmed on the top of the sediments.

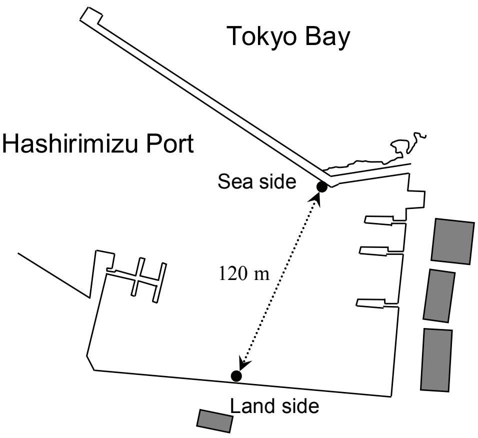

Fig. 1 Map of Hashirimizu Port.

Fig. 2 A core sampling at Hashirimizu Port.

3. Analysis of Sediment

3.1 Sound speed measurement

The each core has only about 6 cm depth, three samples (S1, S2 and S3) of core were separated to two parts, upper layer (U) and lower layer (L) with short 3 cm acrylic pipes. A transmitter and a receiver (KGK: 500 kHz) were faced each other across the sample as shown in Fig. 3. The samples were put into an incubator to control the temperature. A thermometer was inserted into sediment to check its temperature. 500 kHz phase modulated sinusoidal waves were generated from a function generator and both sending and receiving signals were monitored by oscilloscope (Agilent: 33220A) to measure travel time. At first, water

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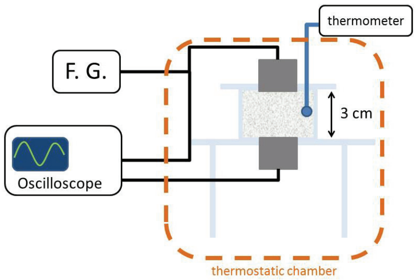

Fig. 3 A diagram of sediment sound speed measuring system.

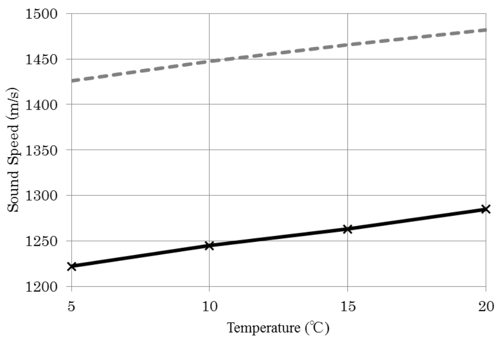

Fig. 4 Measured sound speed of water (black line) and calculated value by the equation of UNESCO (dashed line).

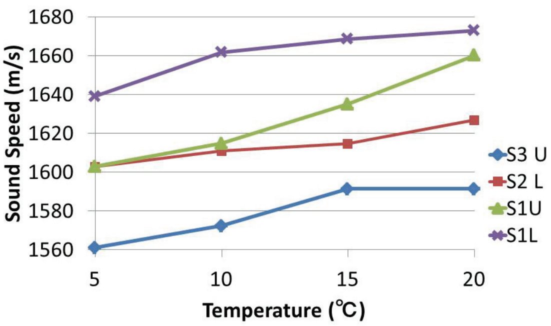

Fig. 5 Measured sound speed of sediment layers.

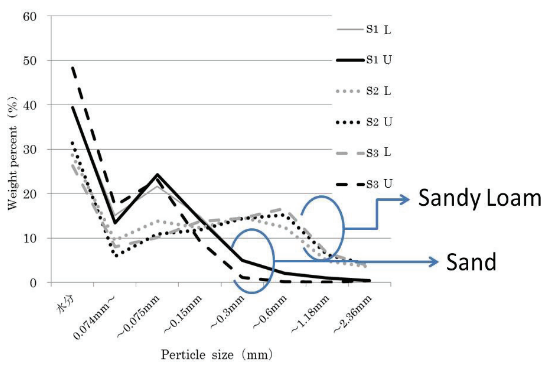

Fig. 6 Particle size distributions of each sediment layers.

sound speed was measured by the system to check the measurement system. Figure 4 plots the measured sound speed by the system and calculated value by the equation of UNESCO. It is confirmed that there were some bias value on measured sound speed. At this moment, it is hard to reveal the reason, but it seems that sound speed could be measured by this system by removing this bias value. Figure 5 shows sediment sound speed of each sample and layer measured by the sound measuring system. The bias value confirmed by water sound speed was removed from the original calculated results. As some samples it was not succeed for measurement, only samples of good measurement results were shown in Fig.5. The value sound speed of each sample was different, but all of them increase their sound speed according to temperature increasing. These changes may be caused mainly by water temperature changes in the sediment.

3.2 Particle size distribution

After sound speed measurement, the samples were screened by wet sieve analysis. All sieving were dried by electric dryer for 24 hours and measured their weight to get particle size distribution. Figure 6 shows particle size distribution of each sample and layer. From this result, it is confirmed that there are two types of sediment from the sample, sand layer and sandy loam layer. The porosity of each sample was about 35% to 45% and there were not clear difference according to the sediment type. According to the Schreiber's chart[4], the sediment sound speed must be more than 1600 m/s according to the porosities.

4. Conclusion

In this paper, sediment properties were measured by core sampling sediment from Hashirimizu Port. A sound speed measurement system used in this experiment had bias value because of some reasons, but comparative sound speed could be measured by this system. More detailed analyses will be required to compare with the sound propagation results at shallow area.

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