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Measurements of Underwater Ambient Noise Generated by Breaking Waves in Surf Zone

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1. Introduction

Underwater noise in the sea is used for monitoring wind speed and rainfall on the sea surface, as well as for tracking whale's migrating route. In particular, low-frequency ocean noise has recently been of concern with relation to the behavior of marine mammals [1]. It is reported that underwater noise generated by breaking waves in the surf zone greatly contributes low-frequency ocean noise in coastal waters [2]. And mechanisms on underwater sound generation due to breaking waves in the surf zone have been studied by some researchers [3, 4]. Underwater ambient noise was measured to investigate the effect of the surf noise on the ocean noise in the eastern coastal waters of the middle part of the the Korean Peninsula. The measurements results on underwater noise generated by breaking waves in the surf zone are introduced. And we consider the effect of the surf noise on the underwater ambient noise.

2. Experiment

Underwater noise had been measured near the surf zone in the eastern middle coast of the Korean Peninsula during June 2009. Self-recording hydrophones were used to measure underwater noise. They are moored on the sea bottom with range of 100 m, 200 m 400 m, 800 m, 1600 m, and 3200 m from the shoreline, respectively. At this time the hydrophone sensors are positioned at 1 m above from the sea bottom.

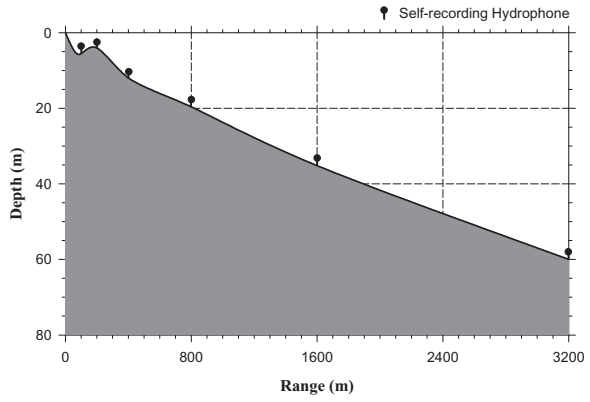

Fig. 1. Depth profile along mooring position of the hydrophones.

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Figure 1 shows water depth profile along mooring position of the self-recording hydrophones. The water depths moored the hydrophones are between 4 m and 60 m. And in order to get reference noise level a cabled hydrophone was deployed on the sea bottom of the range 5 m from the shoreline and the water depth 1.8 m.

The self-recording hydrophone was made up a hydrophone sensor, filters and amplifiers, a CPU with an analogue to digital converter and a controller, a memory, a clock, and batteries [5]. The hydrophone sensor receives underwater sound wave and converts it to electric signal when the hydrophone turns on by a controller through a clock. The signal is filtered and magnified by the filters and the amplifiers. Then the signal is digitized by 16 bits and with 65 kHz by the analogue to digital converter and is stored in the memory. Wave height, wind speed, and water temperature profile were measured during the noise measurement as environment variables. The wave height and the wind speed were measured by a wave height meter (Directional Waverider MK III) and an anemometer (Wizard III), respectively. And the water temperature profile was measured by a CTD profiler (SBE19 plus).

3. Results and Discussion

Sea bottom of the area measured the underwater noise is covered with sand. Mixed layer depth is about 10 m at the range 3200 m from the shoreline and the water temperature profile below the mixed layer depth has a negative gradient with increase of the water depth.

Figure 2 shows underwater noise spectrum levels measured by the bottom-mounted self-recording hydrophones. The underwater noise levels are increasing with increase of the significant wave height and are decreasing with increase of the range from the shoreline. In particular, these phenomena are remarkable in case of high wave height. The noise levels within the frequency bands of 50 Hz to 100 Hz and 700 Hz to 2000 Hz are considerably different with the ranges from the shoreline. It is thought that this result is due to the effect of the underwater noise generated in the surf zone. The surf noise may greatly affect the underwater ambient noise within the range 800 m from the shoreline in case of significant wave

height below 0.67 m.

Figure 3 shows underwater noise spectrum levels measured by the cabled hydrophone deployed on sea bottom of the range 5 m from the shoreline and the water depth 1.8 m. According to Fig. 3, the noise levels within the frequency bands of 700 Hz to 2000 Hz are gradually increasing with increase of the significant wave height. But the noise levels within the frequency bands of 50 Hz to 200 Hz are rapidly increasing with increase of the wave height. It is thought that this is due to the turbulence-generated noise as hydrodynamic noise [3].

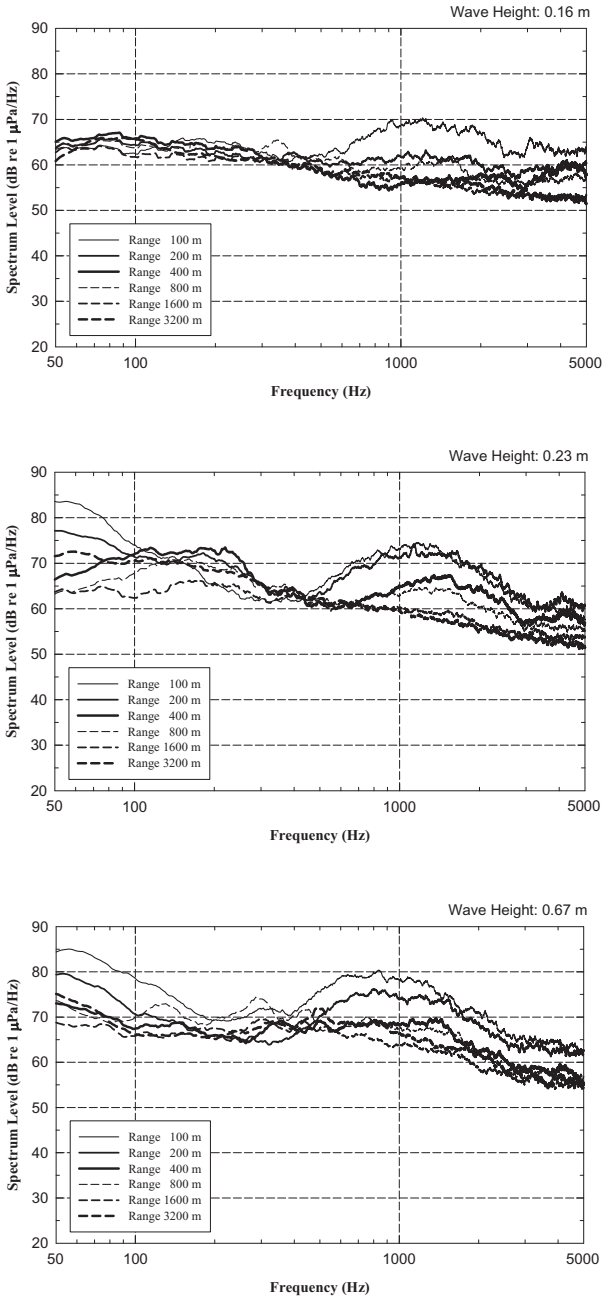

Fig. 2. Underwater ambient noise spectrum levels measured by bottom-mounted self-recording hydrophones.

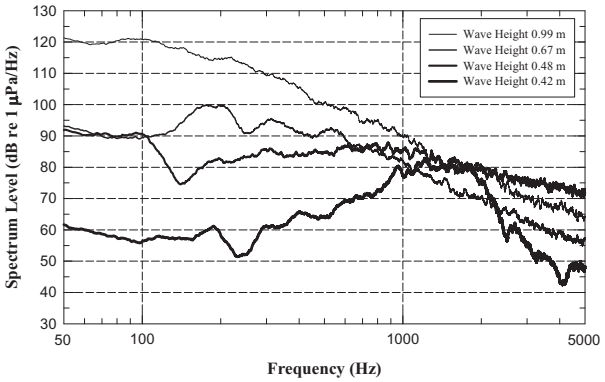

Fig. 3. Underwater ambient noise spectrum levels measured by cabled hydrophone located 5 m from shoreline.

4. Summary

The underwater noise in the sea was measured in order to investigate the effect of the surf noise on the ocean noise in the eastern coastal waters of the middle part of the Korean Peninsula. As a result, the surf noise greatly affects the underwater ambient noise within the range 800 m from the shoreline in case of the significant wave height below 0.67 m. In particular, the noise levels within the frequency bands of 50 Hz to 100 Hz and 700 Hz to 2000 Hz are increasing by underwater sound generated by breaking waves in the surf zone.

Acknowledgment

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