2P-66

Proceedings of Symposium on Ultrasonic Electronics, Vol. 31 (2010) pp. 421-422
6-8 December, 2010

Measurement of Low Frequency Ambient Noise using Screened Hydrophone in Shallow Water

Seongwook Lee[1†], Yong-Kuk Lee[1], Seong-Ryul Kim[1] , Jihyun Park[2] and Jong Rak Yoon[2] ([1]Korea Ocean Res. and Dev. Inst.; [2]Pukyong Nat. Univ., Korea)

1. Introduction

The infrasonic and low frequency bands of underwater acoustic signals contain the fundamental and low order harmonic components originating from the blade of ship and some marine animals. The signals in these bands, which propagate long in deep sea, might be important to passive detection and clasification of the underwater targets, but the acoustic measurements in these bands might have difficulties due to the pseudo-noise, which is a kind of self-noise induced by the presence of a hydrophone in flow field.[1-5)]

In this paper the technique of screening the hydrophones with open-cell foam for reducing the flow-induced self-noise is investigated experimentally in a shallow sea.

2. At-sea Measurement

The experiment was conducted in a shallow bay, which is located at the southern part of Korea. The flow field of the bay is controlled by the tidal current which reverses the direction periodically. **Fig. 1** shows the schematic of the experiment.

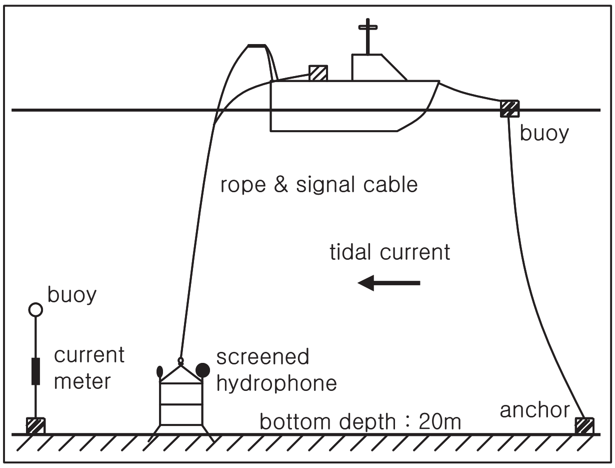

Fig. 1 Schematic of ambient noise measurement in shallow sea.

The ship is moored using a anchored large buoy. First, a current meter of self-recording type is deployed and then the hydrophone supporting structure of 1.4 m height, which is made up of steel of 2 cm diameter, is lowered at the bottom. Four hydrophones are attached to the top of the rectangular structure. One hydrophone is installed without screening and the others are screened with the 10 ppi polyurethane open-cell foam around the hydrophone protection guard. The ppi is an abbreviation for pore per inch and 10 ppi implies that the number of open cells per inch is 10. The diameter of the hydrophone is 2.4 cm. The thicknesses of the foams screening the hydrophones are 1, 2, and 3 cm, and the inner diameter of the screens is 12 cm. The current meter was moored at the same depth with the hydrophones and separated from the hydrophones by 10 - 15 m.

†E-mail address: jryoon@pknu.ac.kr

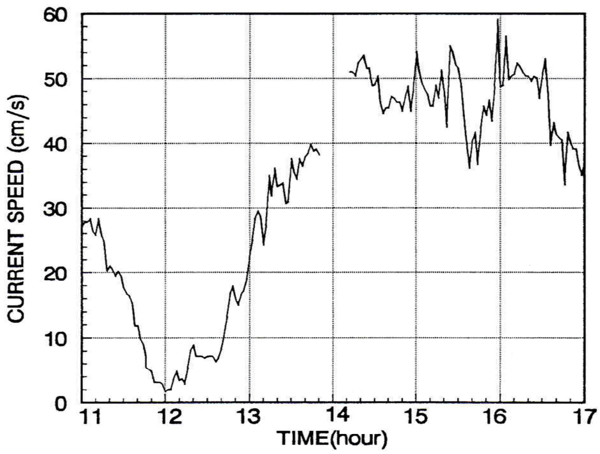

Fig. 2 Current speed measured during the experiment.

3. Result and Discussion

Fig. 2 shows the variation of current speed measured in situ during the experiment. The current meter was deployed in the course of high tide. The speed is nearly zero at the time of high tide (12 hr) and increases to the maximum of nearly 60 cm/s during low tide.

Fig. 3 shows the spectrum levels of ambient noises measured using bare and screened hydrophones at the current speed of nearly maximum. The solid line having the spectral slope of -10 dB/octave indicates the level of the flow-induced ambient noise measured at the bare hydrophone. The dotted and dash-dotted lines represent the spectra measured at the hydrophones screened with the 2- and 3-cm thick polyurethane open-cell foams around the hydrophone protection guard.

It could be seen from Fig. 3 that the low frequency ambient noise measured at the bare hydrophone is affected by the tidal current and the levels of flow-induced noise could be reduced up to 24 dB below 50 Hz at the speed of 1.1 knot by screening the hydrophone with 3-cm thick open-cell foam.

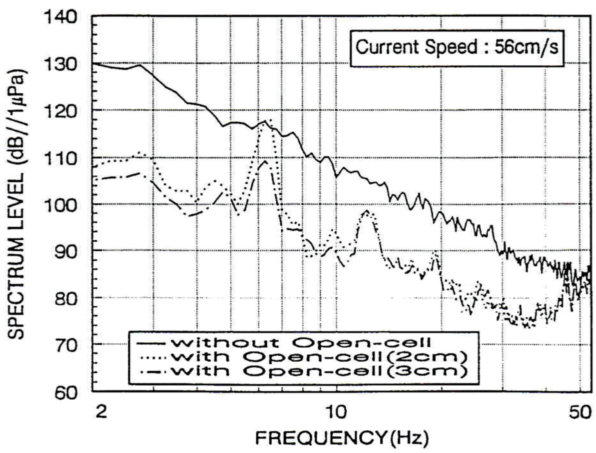

Fig. 3 Spectrum levels of ambient noises measured using bare and screened hydrophones at the current speed of 56 cm/s.

The interesting in Fig. 3 is the multiple peaks appearing at the spectra of the screened hydrophones in harmonic pattern which do not appear at the spectrum of the bare hydrophone. The peaks are considered to be related with the vortex shedding near the hydrophones. The vortex shedding frequency (f_s) is a function of flow speed (U) and the diameter of the structure (D), which is given as $f_s = S(U/D)$, where $S \approx 0.2$ is the Strouhal number.

The expected fundamental frequencies of vortex shedding at the measurement condition due to the hydrophone screened with 3-cm thick foam, bare hydrophone and hydrophone supporting structure are 0.7 Hz, 4.7 Hz and 5.6 Hz, respectively. The frequency due to the hydrophone support structure is most close to the measured. So, it has the possibility that the peaks might be originated by the vibration of the structure caused by vortexes shedding behind the structure.

Acknowledgment
This work was supported by the Korea Ocean Research and Development Institute through PM55893.

References

1. S. Lee, Y.-K. Lee, H.-S. Yoo, S.-R. Kim, K.-S. Jeong, Y. Park, J. Na, J. R. Yoon and P.-H. Lee: Jpn. J. Appl. Phys. **49** (2010) 07HG06.
2. V. I. Bardyshev: Acoust. Phys. **53** (2007) 167.
3. M. Strasberg: J. Acoust. Soc. Am. **66** (1979) 1487.
4. J. F. McEachern and G. C. Lauchle: J. Acoust. Soc. Am. **97** (1995) 947.
5. S. C. Webb: IEEE J. Oceanic Eng. **13** (1988) 263.