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SHIP'S MOTION DETECTION IN COASTAL ZONE

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The paper presents the results of the investigations of the underwater ship noises in coastal zone. The signal was measured in frequency band covering range from 5 Hz to 12 kHz. It was investigated in different frequency bands. The method of signal analysis has been described in this paper. The results of investigations of average pressure spectrum of ambient noise and average pressure spectrum of ship noise in the frequency band from 5 Hz to 1000 Hz and the frequency band from 200 Hz to 1000 Hz have been presented. Moreover the sound pressure levels as a function of ship speed have been studied.

INTRODUCTION

Investigations of the underwater ship noises in shallow water have been carried out for many years. The knowledge about changes in pressure is practically useful. There are three important reasons of it: detection, localisation and identification of ships.

Investigations are much more difficult in coastal zone than in the open sea. The investigations of noises generated by ships in coastal zone are carried out together with investigations of ambient noise in this region. On the one hand, the ambient noise is a component of the environmental noise; on the other hand, it restricts the range of detection.

The commonly used methods that are described for example by Urick [2] are difficult to apply in coastal zone. It seems that in this situation it is better to use other methods.

The aim of this paper was to propose a useful method of ship detection in the observed zone relatively early.

1. THE METHOD OF INVESTIGATIONS

The investigations were carried out on the basis of the results of both underwater ship noise and ambient noise measurements in coastal zone. The measurement set up was composed of hydrophone with sensitivity 630 μV/Pa placed at fixed depth, measuring amplifier and tape recorder. Measurements were made in frequency range from 5 Hz to 12 kHz.

The signal was measured in frequency band covering range from 5 Hz to 12 kHz. It was analysed in different frequency bands. As it turned out the band from 5 Hz to 1000 Hz includes the most important information about ship noise. Therefore it has been decided that

the investigation of the signal will be carried out in this frequency band. Finally the average pressure spectra were considered in two frequency bands: from 5 Hz to 1000 Hz and from 200 Hz to 1000 Hz with resolution 1.25 Hz. They were averaged at time interval from 4.2 second to 24 second depending on ship speed.

Sound pressure level was calculated as a square root of integral of power spectrum density [1].

2. THE RESULTS OF INVESTIGATIONS

Investigations of ship noise and ambient noise were carried out using own computer program. Fixed ship type has been considered.

Figure 1 presents spectrum of ambient noise in coastal zone. Discrete spectrum components in range to about 200 Hz can be observed in this spectrum. The discrete spectrum components are rather accidental. The man-made activity in coastal zone is the main cause of it. The level of spectrum components gradually decreases for frequencies greater than 200 Hz.

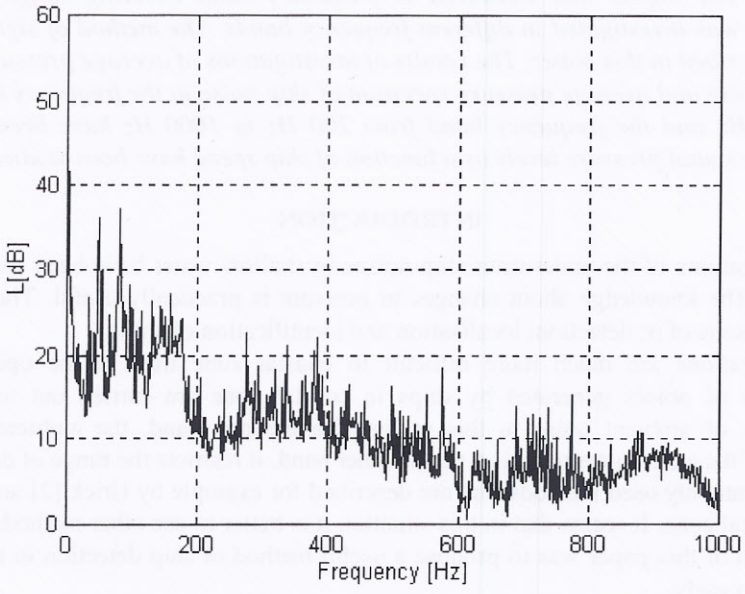

Fig.1 Average pressure spectrum of ambient noise in the coastal zone

Figures 2 and 3 show frequency characteristics of a ship with two different speed engines. The discrete spectrum components of ship noise are connected with work of ship machines (engine, propeller, etc). Number of them decrease when ship speed increase. The levels of spectrum components change in the band from 200 Hz to 1000 Hz but ship noise envelope shape is different than ambient noise envelope shape.

Due to accidental appearance of the discrete spectrum components of ambient noise in the frequency band covering range to 200 Hz one has decided to investigate ship noise in band from 200 Hz to 1000 Hz. Moreover another method of investigations has been proposed. We suggest investigating sound pressure level for two different bands.

Figure 4 presents sound pressure level as a function of ship speed for two fixed frequency bands. The curve number 1 presents sound pressure level in frequency band from

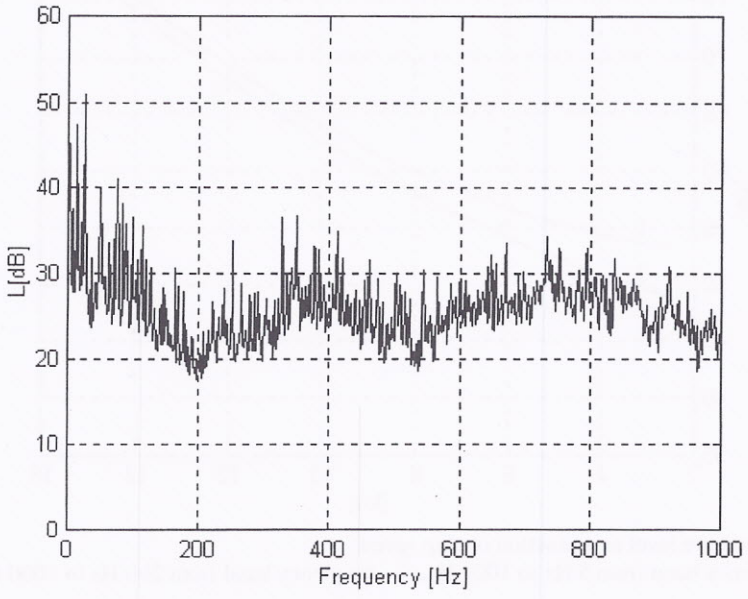

Fig.2 Average pressure spectrum of a ship (5 knots)

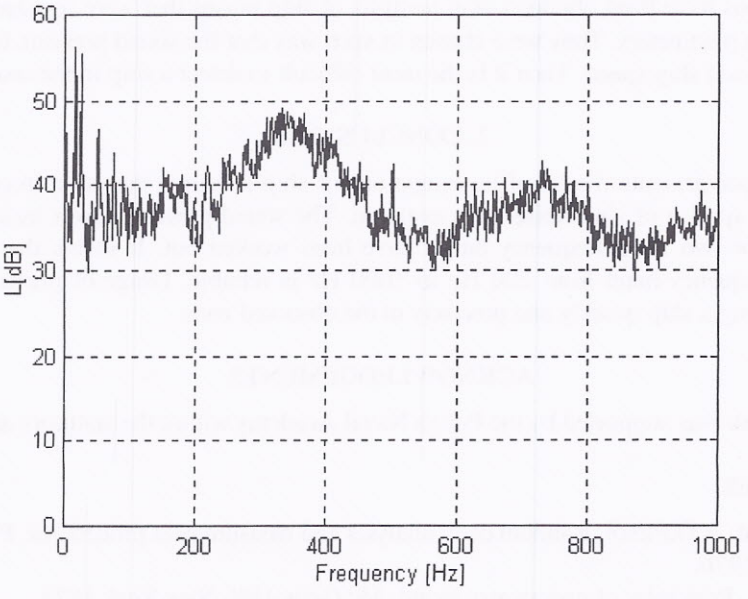

Fig.3 Average pressure spectrum of a ship (10 knots)

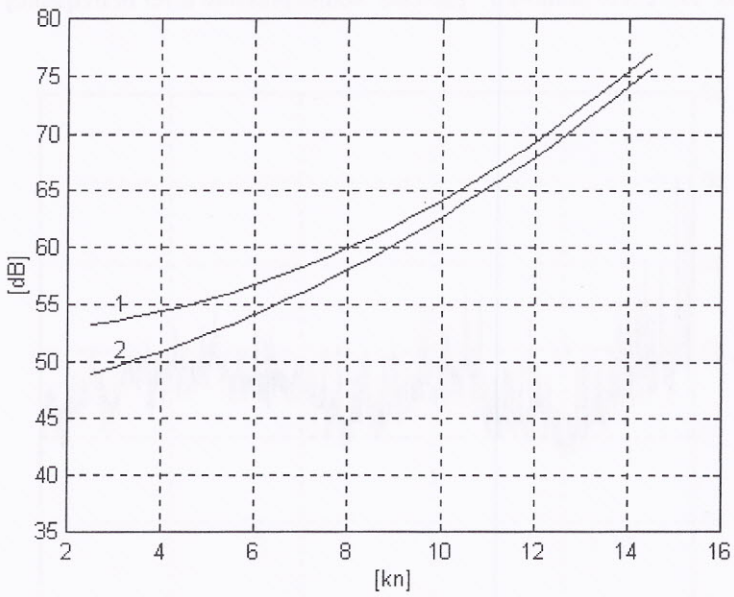

Fig.4 Sound pressure level as a function of ship speed:
1 - frequency band from 5 Hz to 1000 Hz, 2 – frequency band from 200 Hz to 1000 Hz

5 Hz to 1000 Hz, and line number 2 shows sound pressure changes in frequency band
from 200 Hz to 1000 Hz. In this situation pressure level of ambient noise was equal 35 dB. These functions have been obtained after analysis of ship noises that were registered for fixed ship's motion parameters. They were chosen in such way that the sound pressure level was the smallest for fixed ship speed. Then it is the most difficult to detect a ship in the coastal zone.

3. CONCLUSIONS

The paper presents results of investigations of ship's motion detection in coastal zone. The pressure spectra of ship noise were analysed. The sound pressure levels as a function of ship speed for two fixed frequency bands have been worked out. It seems that analysis of spectra in frequency band from 200 Hz to 1000 Hz is reliable. Usage of presented method allows detecting a ship quickly and precisely in the observed zone.

ACKNOWLEDGEMENTS

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2. R.J.Urick, Principles of underwater sound, Mc Graw-Hill, New York 1975.