1P6-3

Measurement and Modelling of Ship Noise in Shallow Water

浅海域における船舶放射雑音の計測と伝搬シミュレーション

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1. Introduction

From 1970s, there have been concerns on the potential impacts of the underwater anthropogenic noise on aquatic life. Among them, low-frequency sound wave from shipping is the largest contributor to the underwater anthropogenic noise [1]. Currently, Twelfth meeting of Conference of the Parties to Convention on Biological Diversity are planning to formulate guidelines which encourages stakeholders to take appropriate measures to avoid, minimize and mitigate the potential significant adverse impacts of the underwater anthropoginic noise on aquatic life.

In response to this, “Research project on the underwater noise from commercial shipping on marine and coastal biodiversity” is launched by ministry of Land, Infrastructure, Transportation and Tourism in Japan for making guidelines based on scientic evidence [2]. In February 2016, the investigation on behavioural response of humpback whales under the shipping noise exposure is conducted in the sea surrounding Ogasawara Islands as part of this project. This sea where only one regular cargo-passenger liner navigates once a day is quiet, so that is suitable for the investigation.

Many papers on actual sea investigation obtain the received level of the receiver is through the use of the formula of ideal transmission loss. However in actual sea, especially shallow water as the sea surrounding Ogasawara Islands, environmental parameters dominates the sound propagation. Therefore the accurate received level may not be given by the formula of ideal transmission loss.

The objective of our research is to establish the method for estimating the accurate received level of the receiver by the sound propagation modeling taking account to the environmental parameters in actual sea investigation. We conducted measurement, sound propagation modelling, calculation by the formula of ideal transmission loss of the shipping noise in the sea surrounding Ogasawara Islands, and comparing results of those.

2. Measurement, Modelling and Calculation

2.1 Measurement with Hydrophone

First, we measured the shipping noise radiated from the regular cargo passenger liner with the hydrophone over the navigating time about 2 hours at the depth of 10 and 20 m of the measurement position. The ship trajectory and the measurement position are shown in **Fig. 1**. The spectrum chart measured in 10 minutes from departure is shown in **Fig. 2**. The shipping noise received by the hydrophone can be detected clearly at the period of time from 12:38 to 12:49 in Fig. 2. The shipping noise is shielded by shore reefs at the period of time from 12:30 to 12:38. The range from the ship to the measurement position becomes minimum at the time of 12:39.

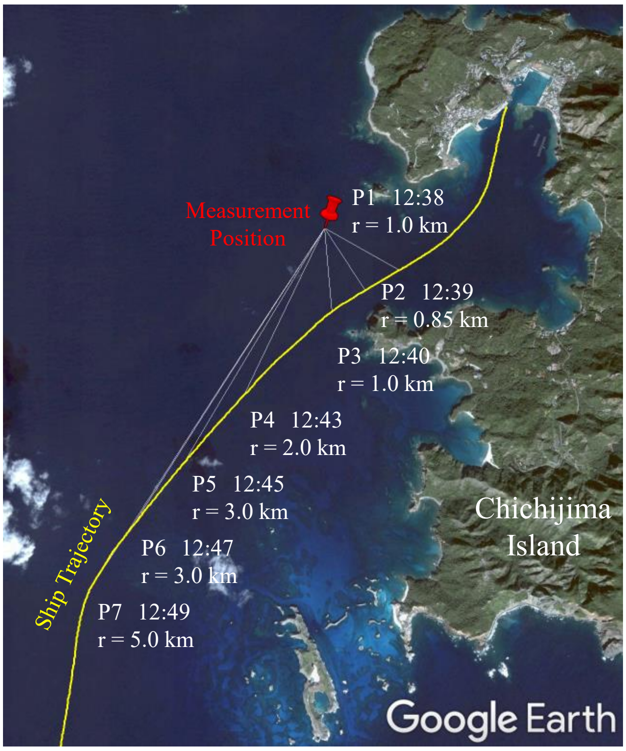

Fig. 1 Ship trajectory, measurement position, modelling paths and range from ship to measurement position.

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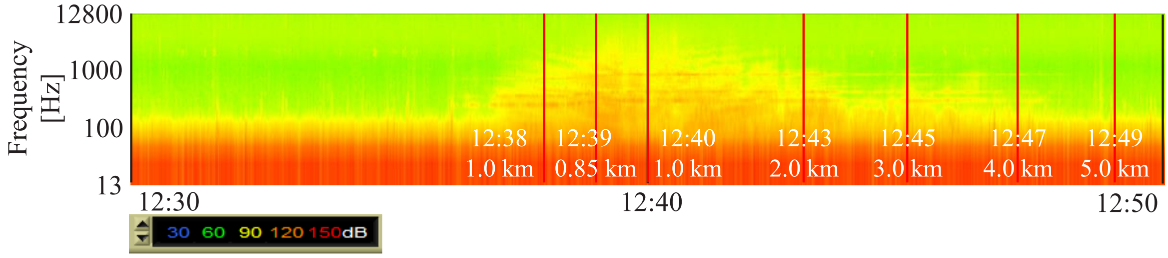

Fig. 2 Spectrum chart measured at the depth of 20 m.

2.2 Sound Propagation Modeling

Next, we computed the transmission loss from the ship to the measurement position by using Parabolic Equation (PE) model "FOR3D" taking account to the environmental parameters (bathymetric profiles, seabed sediment parameters, sound speed profiles). The modelling paths which connect points of the ship and the measurement position at the same time are shown in Fig. 1.

2.3 Calculation by Ideal Transmission Loss

In addition, we calculated the transmission loss from the ship to the measurement position by the formula of ideal transmission loss given by Eq. (1), (2), (3).

$$TL = 10\log_{10} r \tag{1}$$

$$TL = 10\log_{10} r + 10\log_{10} D, \quad \text{where } r > D \tag{2}$$

$$TL = 20\log_{10} r \tag{3}$$

where r is the horizontal range between the source and the receiver (in m), D is the water depth at the source position.

3. Results

Received level which was measured at the depth of 10 and 20 m, received level which was measured, modelled, and calculated at the depth of 10 m, received level which was measured, modelled, and calculated at the depth of 20 m are shown in **Fig. 3**. Fig.3 (1) indicate that received level at the depth of 10 and 20 m are close values and the one at the depth of 20 m is larger than the other. Fig. 3 (2) and (3) indicate that the differences between measured and modelled received level cannot exceed 15 dB. Fig. 3 (2) and (3) also indicate that measured received level is in between calculated by the formula of ideal transmission loss given by Eq. (1) and (2).

4. Conclusion

In this comparison, we found that the accuracy of modelling and calculation by the formula of ideal transmission loss are comparable. Therefore, we need to conduct similar comparison for other environments and longer distances in the future.

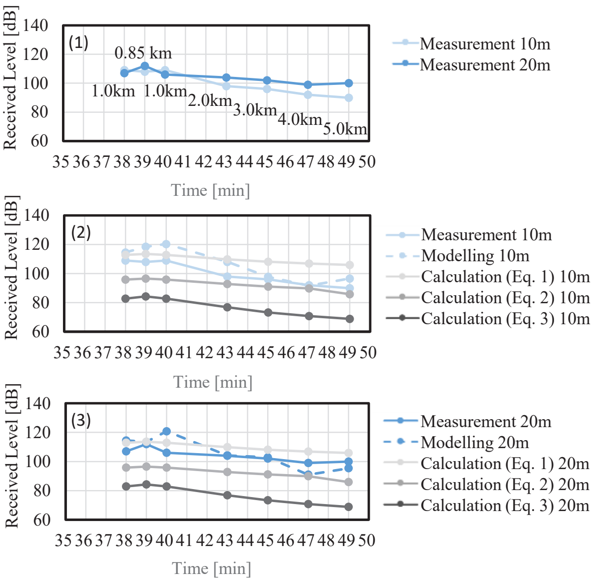

Fig. 3 (1) Received level measured at the depth of 10 and 20 m, (2) Received level measured , modelled, and calculated at the depth of 10 m, (3) Received level measured , modelled, and calculated at the depth of 20 m.

Acknowledgment

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References

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