Prediction of Sound Radiation from Submerged Structure by Transfer Method Based on Measuring Vibration

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Aim

For an underwater vehicle, its own vibration and sound radiation usually needs to be known accurately. Therefore, accurate prediction of sound radiation from submerged structures is of great significance. Traditionally, BEM methodology is suitable for solving the problem of the acoustic field calculation by known structure vibration. However, the required number of measuring vibration points is very large; and, vibration phase information needs to be measured accurately - but we know that these requirements are difficult to be satisfied in practice. Therefore, this paper proposes a method of sound radiation prediction of submerged structures by using a transfer method.

Methods

Generally, the vibration and sound radiation process of a submerged structure excited by force are linear systems, so the mean square velocity of the structure and underwater radiated sound power have linear proportional relationship under the condition that the model and excitation were confirmed. In this way, the theoretical transfer efficiency from mean square velocity to radiated sound power can be worked out firstly. Then the radiated sound power prediction is made by a combination of theoretical transfer efficiency and practical mean square velocity measurement.

\[ W = \rho c \left( v^2 \right)_m \sigma - \text{the structure mean square velocity obtained from experiment} \]

\[ \sigma - \text{transfer efficiency} \]

Results

- Firstly, the underwater vibration and sound radiation model of a double cylindrical shell is built by means of FEM in order to find out how the excitation has influence on transfer efficiency.

- Lastly, a submerged double cylindrical shell vibration and sound radiation experiment was conducted for verification of the transfer method which is used to predict underwater structure vibration and sound radiation power in a lake. The calculated model of submerged cylindrical shell vibration and sound radiation is built according to practical parameters. According to transfer efficiency from internal mean square velocity to radiated sound power, the practical sound power is predicted.

Discussion

- The transfer efficiencies in different excitation situation are different. In order to obtain better results, the form of excitation should be considered as well as the position of excitation which is needed to be consistent with actual situation.

- Prediction of model radiated sound power is made by transfer method. The predictable and experimental results had a good agreement except at a few frequencies.

Conclusions

- It is proposed that a transfer method can be used to predict the radiated sound power of a submerged structure by monitoring vibration.

- A simulation research revealed that transfer efficiency was not sensitive to loads in low frequency. However, high frequency can cause a relatively big difference, which noticeably depended on the formation of excitation.

- A double cylindrical shell experiment was carried out. The results showed good agreement between predictable value and experimental value; and, that this method of submerged structure radiated sound power prediction was feasible.