Random wave generation with ocean wave spectra for active water-wave control system

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1.Introduction

Problem

Vibration of a moored vessel interrupts cargo handling and cut mooring lines. The problem occurs due to the **resonance of the long period waves**.

Approach

Traditional method

Seawall causes environmental pollution due to insufficient water circulation.

Proposed method

Horizontal plate can improve wave elimination by active control system.

We employ ocean wave spectrum which is a kind of **Bretshneider-Mitsuyasu Spectrum (BMS)** for the control experiment.

Disturbance signal with BMS is used in Fig.1 of act-dis.

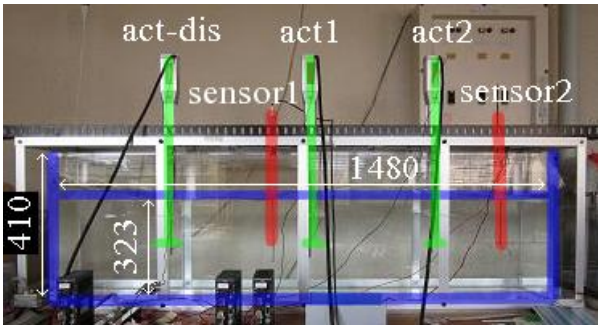

Fig.1 Experimental apparatus

2.Filter design

The filter turns white noise into designed disturbance signal (Fig.2).

White noise (random number) → **Filter** → **Disturbance signal (BMS)**

Fig.2 Generation of disturbance signal

BMS is defined as in Eq.1. Significant wave height and period are assumed by size of wave flume. The filter is to approximate the BMS (Fig.3). The filter is added some low pass filter and high pass filter (Eq.2-4).

$$S(f) = 0.205 H_{\frac{1}{3}}{}^2 T_{\frac{1}{3}}{}^{-4} f^{-5} \exp[-0.75(T_{\frac{1}{3}} f)^{-4}] \quad \cdots (1)$$

$H_{\frac{1}{3}} = 0.087$: Significant wave height [m]

$T_{\frac{1}{3}} = 0.77$: Significant wave period [sec]

f : Frequency [Hz]

$$F_{low} = \frac{1.0}{s+1.0}\left(\frac{1.6}{s+1.6}\right)^2\left(\frac{1.8}{s+1.8}\right)^4 \quad \cdots (2)$$

$$F_{high} = \frac{s}{s+0.6}\left(\frac{s}{s+1.2}\right)^2\left(\frac{s}{s+1.4}\right)^4 \quad \cdots (3)$$

$$F = F_{low} \times F_{high} \quad \cdots (4)$$

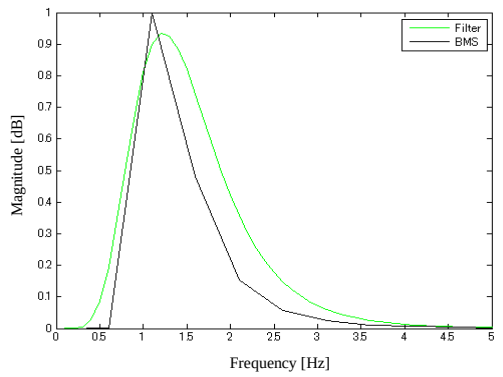

Fig.3 Gain characteristic of filter and BMS

3.Simulation and experiment

Disturbance signals were simulated by MATLAB and generated with the experimental apparatus (Fig.4). The linear spectra of the disturbance signals are shown in Fig.5

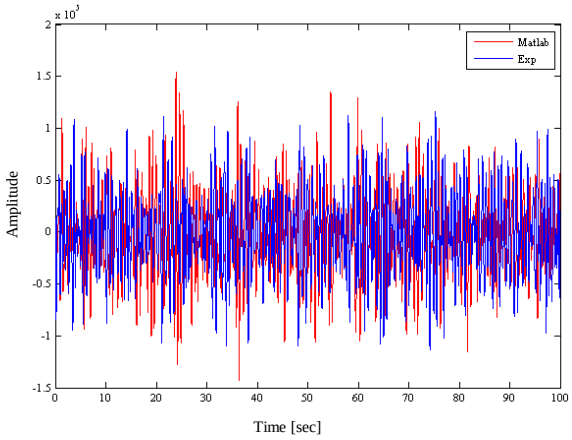

Fig.4 Time response of disturbance signal

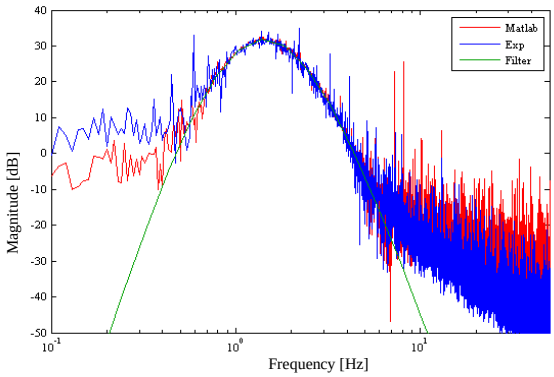

Fig.5 Linear spectra of Fig.4 with filter's gain

It can be confirmed that the resultant disturbance signals have desired spectra specified by the filter.

4.Conclusions

-A filter has been designed of which gain characteristic is similar to BMS.

-As a result of using filter, a disturbance signal with ocean wave spectrum has been generated.