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Experimental Study on Hydrodynamic Forces acting on a Floating Wave Energy Converter "Backward Bent Duct Buoy"

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ABSTRACT

Backward Bent Duct Buoy (BBDB) which has a bent center-pipe opened to the lee side of the incident waves is a kind of moored floating OWC-type wave energy converter. In order to design this converter optimally, It is necessary to develop the numerical method in time domain on motions of BBDB, air flow in air chamber and rotation of air turbine in waves. In this paper, a experiment on hydrodynamic forces, which are used in this calculation, acting on BBDB is carried out. First in order to clarify the handling of air chamber of the BBDB in this experiment, the outline of the numerical method is also shown.In this experiment, the diffraction forces acting on fixed BBDB in waves and the radiation forces by forced oscillation test in still water in frequency domain are obtained in wave basin.

KEY WORDS: Wave Energy, Backward Bent Duct Buoy, Primary Energy Conversion, Experiment

INTRODUCTION

Many kinds of wave energy converters have been proposed in recent years. Backward Bent Duct Buoy (BBDB) proposed by Masuda (1986) is a wave energy converter of moored floating oscillating water column type which is composed of an air chamber, horizontal duct and buoyancy chamber and turbine as shown in Fig.1. The mouth of the horizontal duct in underwater is faced away from the waves. As BBDB has the advantage that the primary conversion performance is better than other floating type devises and mooring force is smaller than others because BBDB advances in the incident wave direction with slow-speed over specific frequency ranges. BBDB is said to be one of the best type converter among proposed wave energy converters.

Some researchers are investigating about BBDB in Japan, China, Denmark, Ireland, Korea and India. Masuda (1986) proposed BBDB and carried out the tank test. He showed that BBDB has the advantage that the primary conversion performance is better than other floating type devises, and the primary conversion efficiency of BBDB with the backward facing duct for the wave direction is larger than that with front facing duct for the wave direction in waves. Masuda et al. (1993) performed tank test for the various BBDB hull configuration to investigate of primary conversion performance.

McCormick and Sheehan (1992) have experimentally shown the presence of reverse time-mean drift force that make the buoy drift into waves over specific frequency ranges. Liang Xiangguang et al. (2000) carried out experiments for the mooring of BBDB. Some theoretical researches on BBDB are also being done. Lewis et al. (2003) carried out the comparison of physical model and numerical model based on the velocity potential theory for BBDB in frequency domain. Hong, D.C. et al. (2004, 2005) and Kim, J.H. et al. (2006) carried out the calculations on motions of BBDB in regular waves and drift force acting on BBDB, and compared the numerical results with the experimental results. Nagata et al.(2007) carried out experiments in waves for the comparing with the primary conversion performances of five BBDB models with different hull shape.

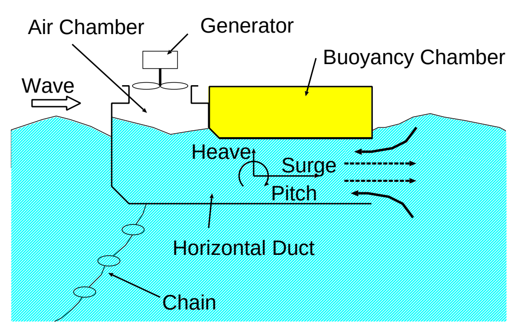

Fig. 1 Principle of BBDB

However, all these experimental or numerical researches are those in the frequency domain. In order to take the motions of BBDB, the air pressure fluctuation in chamber, the characteristics of turbine and the mooring system into consideration in a sea with irregular waves and design this converter optimally, it is