

A Study on Motion of a BBDB Type OWC Wave Energy Device considering Pneumatic Damping Coefficients in the Duct

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ABSTRACT

The motions of floating BBDB (backward-bent duct buoy) wave energy absorbers with an orifice type air-duct located at the middle of the top lid in regular waves are calculated taking account of the oscillating surface-pressure due to the pressure drop in the air chamber above the oscillating water column within the scope of the linear wave theory.

A series of model tests has been conducted in order to verify the motion responses in regular waves at the ocean engineering basin, MOERI/KORDI. The pneumatic damping through an orifice-type duct for the BBDB wave energy device are deduced from experimental research. Numerical simulation for motion responses of the BBDB wave energy device considering pneumatic damping coefficients has been carried out and the results are compared with those of model tests.

KEY WORDS:

OWC (Oscillating water column), BBDB (Backward-bent duct buoy), Pneumatic damping coefficient, Regression analysis, Model test, Numerical simulation

INTRODUCTION

During last two decades various ideas have been proposed to utilize wave energy, and the system based on OWC concept has been turned out to be the most promising candidate for commercialization (McCormick, 1981; Masuda et al., 1986) because of its simplicity of operational principle and easiness of construction.

The BBDB (Backward Bent Duct Buoy) type OWC wave energy device has been proposed by Masuda (1987) where the basic principle of the oscillating water column has been maintained, but the oscillating mass of the water has been increased by using a L-shape bent duct, a short vertical and long horizontal inner duct (Fig. 1).

Since the BBDB has the broad resonance ranges due to surge, pitch and heave motions, it has the advantage in view of wave absorption power comparing with the conventional cylinder type OWC wave energy device.

McCormick et al. (1992) and Kim et al. (2006) have experimentally shown the presence of reverse wave drift of the BBDB with an air-duct that makes the buoy drift into the waves over specific frequency ranges. The reverse drift force of the BBDB has also been found numerically by Hong et al. (2004).

The theory for the OWC devices has been presented by Evans (1982) and Sarmiento and Falcão (1985) for fixed devices and by Falnes and McIver (1985) for multiple floating devices.

Choi et al. (2004a; 2004b) have studied the pneumatic damping force for a floating type OWC system by performing forced heaving experiments for an idealized simple OWC model. They have proposed a formula for the pneumatic damping coefficient as a function of frequency & amplitude of the heave motion and the solidity of the duct from their experimental study.

In this paper, a set of model tests for BBDBs with an orifice type air-duct located at the middle of the top lid have been carried out at MOERI ocean engineering basin. The pneumatic damping coefficients through an orifice of the air-chamber are deduced from a regression analysis of experimental data, and a formula for the pneumatic damping coefficients is proposed.

Numerical results considering pneumatic damping force coefficients are also presented in order to compare the motion of the BBDB with the experimental results.

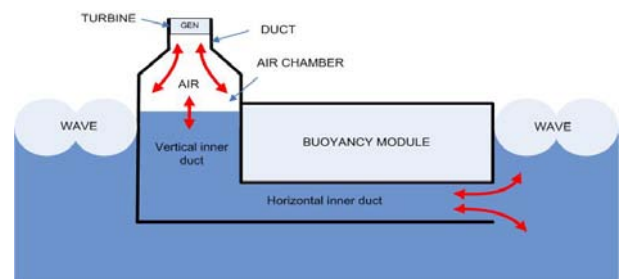


Fig. 1 Concept of BBDB Type OWC Wave Energy Device