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The Characteristics of Maximum Velocities in Wave Induced Water Flow Duct of Caisson Structure due to OWC Shape and Slope by 2-D Numerical Experiments

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ABSTRACT

In this study, the maximum water particle velocity, in the internal water duct of caisson structure embedding wave power generator, was investigated by CADMAS-SURF numerical modeling to determine the optimized shape of structure. It was considered that water oscillating turbine could be installed within the internal water duct in caisson structure. In this case, the water velocity in the duct is the main parameter of the turbine's power converting efficiency. Therefore, the maximum water velocity characteristics was investigated in various wave heights and periods on the variation of structure shape, specially OWC shape, the angle and the length of slope in front of structure.

KEY WORDS: Wave power generation; OWC(Oscillating Water Column); oscillatory duct flow; wave induced water flow; water turbine; caisson structure; CADMAS-SURF.

INTRODUCTION

The oscillating water column is one of the most widely used wave energy converting system all over the world. Many efforts have been made in the research of the wave energy converting efficiency and operating performance as the oscillating water column system. In recent, an experiment was performed concentrating on the effects of several shape parameters of OWC chamber in a view of wave energy absorbing capability(Hong, Shin, Hong, Choi and Hong, 2007) and the integrated system of chamber and turbine for OWC wave energy converting facility was studied(Liu, Hyun, Hong, Lee and Jin, 2010).
There are many studies in turbine types and energy converting types including OWC. However, most of OWC wave energy converting studies are about the turbine of oscillating air in OWC and few attempts have been made on the turbine of oscillating water in OWC so far.
Cho, Kim, Kim and Sim(2007) numerically analyzed the flushing effects and the likelihood of a vertical breakwater consist of immersed water channel and water chamber. This could be a research example of water turbine for wave energy converting.
Yoon(2008) briefly introduced various key concepts of OWC wave power structures with water oscillating turbine generator. Most of researches are focusing on air turbine power converter in OWC due to the various reasons; e.g. convenience of maintenance, safety of turbine from physical particle impact, free of biofouling on the turbine, and etc. However, if these weaknesses are overcome, the water oscillating turbine could be an important part of several types of power converting devices since energy density of water is around 800 times larger than that of air. There is another illustration of the same point that the length of tidal current turbine blade is shorter than that of wind turbine blade for same power converting performance. Moreover, if the power converting turbine is located in the oscillating water duct, "unmanageable" free surface shape from various incident waves to make pressure difference in the OWC and "inevitable" energy loss from air compression are not worthy to consider any more.

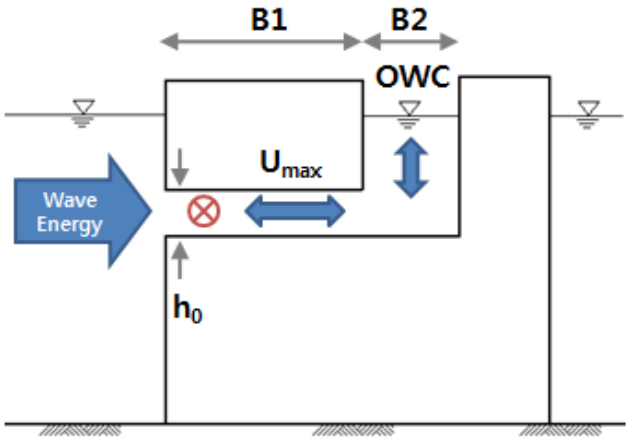

Fig. 1. Conceptual Design of Wave Power Structure with Wave Duct.

In recent studies, the maximum water particle velocities, in the internal water duct of caisson structure embedding wave power generation, were investigated for the optimized shape of structure by both hydraulic experiments and numerical modeling(Lee, Kim, Jeong and Yoon, 2009) and numerical modeling(Yoon, Kim and Lee, 2010). It was considered that water oscillating turbine could be installed within the internal water