DEVELOPMENT OF WAVE POWER GENERATION SYSTEM SUITABLE FOR INNER BAY

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BACKGROUND AND AIMS OF THIS STUDY

The shift from fossil energy to renewable energy is now a global trend. There is a report that the ratio of world renewable energy to final energy consumption is 19.3% in 2015. Although various power generation devices such as Pelamis, PowerBuoy, TAPCHAN, and so on have been developed so far, the power generation in the ocean is extremely small. It is necessary to install the wave power generation system in large wave field in order to secure a significant amount of power generation. On the other had, it is necessary to ensure the resistance of the system against waves.

The purpose of this study is to develop a wave power generation system in a inner bay under relatively mild wave condition to avoid the system crash from huge wave action. In order to achieve the purpose, the laboratory experiments were carried out on two cases where a Savonius-type water rotor was installed in a wave-current coexistence field and in a vertically slotted caisson. Certainly, this type of the water rotor can only get a small amount of power. However, it is expected that significant amount of power may be made by collecting the small amount of power acquired by each of the adjacent water turbines.

EXPERIMENTAL SETUP

Experiment was carried out in the flume with 0.5 m width, 0.6 m height, and 20 m length. Water depth was h was constant 0.4 m. In this flume, current and waves were generated so that each direction of travel was opposite. In this study, a new Savonius water rotor, which three ordinary Savonius rotor with 0.042 m diameter, 0.312 m height, 0.15 kg weight, and 0.3 overlap ratio are stacked as shown in Figure 2, was used. The current velocity was measured by an electro-magnetic velocimetry and waves are measured by capacitance type wave gauges. The experimental conditions on current and waves are shown in Table 1. V_{C0} and V_{w0} represent velocity of current and of water particle by wave at still water surface respectively.

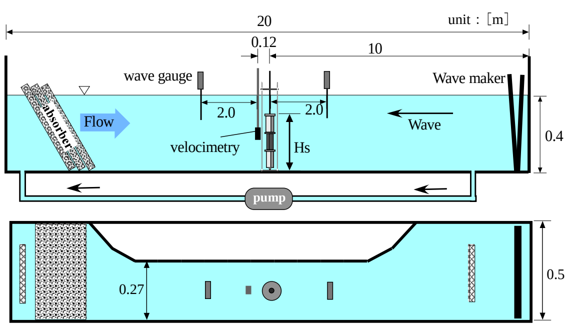

Figure 1: Experimental setup

Table 1: Experimental condition

h[m]	T[s]	H/L	H[m]	V_{wo}[m/s]	V_{co}[m/s]
0.400	0.88	0.010	0.012	0.040	
		0.017	0.020	0.051	0.042
		0.019	0.022	0.061	0.052
		0.031	0.036	0.102	0.060
	0.99	0.010	0.015	0.048	0.082
		0.013	0.019	0.056	0.104
		0.020	0.029	0.092	0.118
		0.029	0.042	0.150	0.142
	1.13	0.009	0.015	0.050	0.168
		0.010	0.018	0.066	0.202
		0.020	0.036	0.118	
		0.030	0.053	0.166	

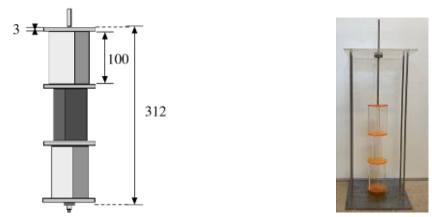

Figure 2: Savonius rotor used in this study

MAIN CONTENTS

First of all, it was confirmed the linear relationship between the rotational peripheral velocity of the rotor $r\omega$ (r: radius of rotor, ω: angular velocity) and the current velocity V_{C0}. It was also confirmed the linear relationship between $r\omega$ and water particle velocity by wave V_{w0}. Under the conditions of this experiment, it was found that the ratio of $r\omega$ to V_{C0} was larger than the all the ration of $r\omega$ to V_{w0} (Figure 3). The reason for this is presumed to be the influence of the vertical velocity distribution.

Furthermore, it was investigated the rotational efficiency of the Savonius rotor in current-waves coexisting field. It was found that the rotational peripheral velocity of the Savonius rotor $r\omega$ in current-waves coexisting field was faster than that in the current field. Cut-in velocity, that means the minimum velocity at which the rotor begins to rotate, in current-waves coexisting field was smaller than those in current field and in wave fields.

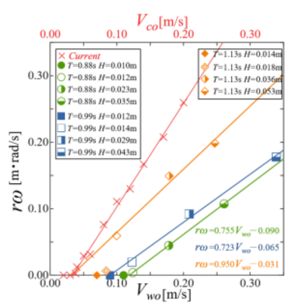

Figure 3: Experimental result

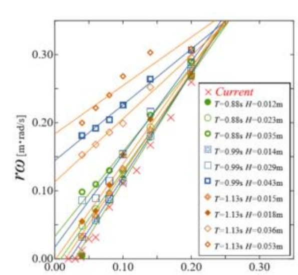

Figure 4: Experimental result