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Research on a Method Decreasing Motions and Drift Force of a Floating Renewable Energy Facility in Waves

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ABSTRACT

The hydrodynamic force acting on a fin oscillating beneath a free surface is investigated. To safely utilize floating structures under severe environmental conditions in the sea, the motion of the floating body and the mooring forces acting on the body should be reduced. To decrease these motions and mooring forces, fins attached to the structure are proposed (Yago et.al 2007). In this paper, a flat plate was used as a fin. As a first step, the hydrodynamic forces acting on the fin oscillating near free surface were resolved in new method. This method uses the modified Morison equation added to a wave damping component.

KEY WORDS: Wave Energy, Fin, Hydrodynamic Force, Viscous Damping

INTRODUCTION

The amount of natural resources is decreasing because of the industrialization of developing countries. Because the amount of natural resources in Japan is limited and most of them are imported from abroad, the utilization of resources in an exclusive economic zone (EEZ) is planned. Japan has an EEZ domain that spans more than ten times the country area and is considered to have abundant resources under the seabed. Rare metals, minerals and natural gas can be found on the sea bottom.

To develop these EEZs, a large-scale platform for natural resources, renewable energy and fisheries is planned. In Japan, the technology for a large-scale platform is developed. In the Mega-Float project in 2000, a platform with a length of 1km was tested in the Tokyo bay, and a feasibility study for a floating airport was performed.

Additionally, an offshore platform that is used for the utilization of an EEZ was installed in severe wind and wave conditions as compared to the platform installed in coastal region. The installation of a breakwater that protects the platform from severe wind and waves is difficult in offshore area with deep sea. Therefore, a method that reduces the energy of storm waves is required for the platform.

In 2006, The National Maritime Research Institute of Japan proposed a fin-attached floating structure for severe offshore conditions (Yago et.al 2007). The attached fin dissipates the energy of motion of the structure as viscous damping (Fig.1). In this paper, a reduction of motion of the structure, maintenance technique and design method is investigated.

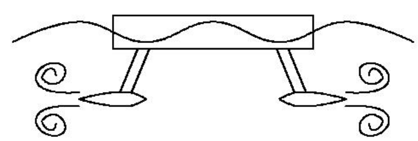

Fig.1 Concept of fin-attached platform

These fins also aim the reduction of mooring force due to so-called "wave devouring propulsion" effect. Terao (1982) reported the results of model test of a wave devouring ship that moves toward the incident waves by itself without any propelling power or control systems. The model consists of the deck, fins (fore and aft) and side plates (Fig.2). Side plates support the deck and wings. The upper deck surface coincides with the water surface. The devouring thrust decrease the wave drift force.

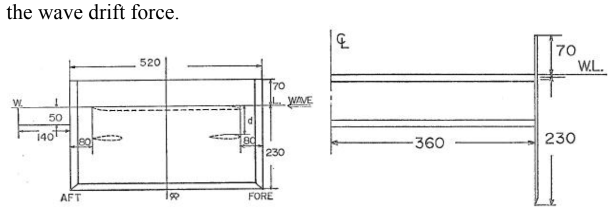

Fig.2 Model of wave devouring ship (Terao 1982).
Left: profile view, Right: sectional view

For the oscillating body in fluid, Morison et. al.(1950) decompose the hydrodynamic forces to acceleration dependent component and velocity-square dependent component. In case of the oscillating body at near a free surface, wave damping have to be also considered. Ohkawa (1986) added a wave damping term to the Morison equation, and decomposed the hydrodynamic forces acting on submerged rectangular cylinders oscillating relatively near a free surface to above-mentioned three force components. Measured added mass coefficient and radiation waves simultaneously were in good