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Hydroelastic Motions and Drift Forces of Very Large Mobile Offshore Structure in Waves

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We propose a new concept of VLMOS, which is composed of slender beams and demi-hulls. The main topic of this paper is to understand the hydroelastic behavior of VLMOS. We have carried out the experiment and the calculation for the hydroelastic behavior of this structure. We conclude that the agreement between the experimental results and the numerical results is good. The strain of the transverse beam in the beam waves has a high peak, which should be lowered for the realistic design of this concept. It is found that drift forces are not significant except for the frequency of the resonance of the 2-nodes vibration mode. Summarizing the results obtained by the experiment and the computation, it is found that minimizing the 2-nodes vibration mode occurring at the transverse beam is a key to realizing this concept.

INTRODUCTION

We currently face a lot of environmental problems, such as acid rain, desertification, global warming and so on. We must decrease these influences. In addition, fossil fuel is being exhausted. Thus, our interest has been heightening in those uses of natural energy that could be supplied infinitely. Wind power conversion is rapidly expanding in Europe, and wind power plants on the ocean have evolved from those on land.

One of the authors proposed a new design concept for a solar and wind power plant with thrusters. We called this structure a Very Large Mobile Offshore Structure, referred to as VLMOS below (Takagi et al., 2002, 2003). The Floating Structures Association of Japan (2004) proposed a similar concept for wind power plants, and this paper targets its analysis.

The structure is composed of slender beams, demi-hulls and struts. The struts are wing-shaped, so that the wing induces a lateral force to counter the wind's drag force. The structure is planned to work in the exclusive economic zone. The mobility of VLMOS plays an important role in this concept, since weather conditions greatly affect power plant efficiency.

Since the plant is in service in the ocean with wind and waves, we expect that VLMOS will demonstrate an extremely complicated hydroelastic behavior due to waves. It is necessary to know the wave-induced hydroelastic motions of VLMOS in real seas. In this paper, we carried out a model experiment of VLMOS in waves to know its hydroelastic motions and drift forces. We also performed numerical computations with the coupled pFFT-NASTRAN technique by Takagi (2005).

EXPERIMENTAL MODEL AND CONDITION

We used a 1/100-scale model in this experiment. Since the test tank is too small to install the entire model, we used one-third of the entire model. The model was 4 m long and 4.5 m wide. Fig. 1 shows the overview of the experimental model; Fig. 2 shows the detail.

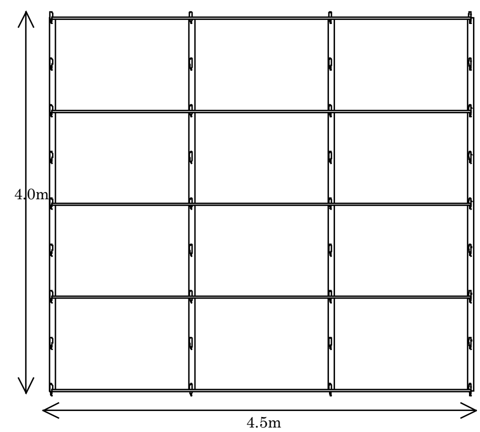

Fig. 1 Overview of experimental model

The model has 5 transverse beams, 4 demi-hulls and 36 struts. Transverse beams are made of aluminum so as to estimate the hydroelastic motion of VLMOS. Demi-hulls are made of foaming urethane and have an aluminum backbone. Struts have an aluminum core, which ensures the elastic connection between the transverse beam and demi-hull. It is important to satisfy the similarity law of the elasticity between the experimental model and the full-scale model.

However, for all practical purposes, it is impossible to satisfy the agreement of the value of vertical and horizontal rigidity at the same time. We chose the most suitable combination for the transverse beam and the demi-hull from the regular size of aluminum bar. Table 1 shows the rigidity of the experimental model, where it is required that values accord to the similarity law. Since usually the difference of the rigidity value between the experimental model and the full-scale model is not sensitive to motions in waves, we can consider that it is the elastic scale model.

Another difficulty in designing the experimental model is the buoyancy balance. Since the structure is very flexible, its local weight should be equilibrated with the local buoyancy. We

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