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Responses of a Barge-Mounted Platform in Waves and Currents

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ABSTRACT

The forces on and responses of a barge-mounted platform (BMP) in waves and currents are investigated using various boundary element methods. A higher-order boundary element method (HOBEM) is developed in the frequency domain using a zero-forward-speed free-surface Green function and the results are compared with an independently developed constant panel method (CPM). The accuracy and convergence rate of the two methods are systematically compared. A time-domain higher-order boundary element method (THOBEM) is also developed to estimate wave forces, hydrodynamic coefficients, wave run-up, and mean drift forces in waves and uniform currents. The zero-current case of THOBEM agrees well with the frequency-domain results. The computed results are compared with experiments. The influence of neighboring boundaries, such as quays, is also studied. The responses of a BMP in the installation site of the South Sea of Korea are presented.

INTRODUCTION

For the utilization of ocean space and development of ocean resources, a BMP (barge-mounted platform) project has been launched in Korea and a full-scale construction is planned near Koje Island of the South Sea in the coming years (Chung and Chung, 1996). The main purpose of the BMP project is to develop key technologies for the design and construction of a floating-barge system for various kinds of purposes, such as desalination plants, waste-treatment plants and floating ports.

One of the most important design considerations of the proposed BMP is the ability to predict the responses and mooring-line forces of the system in a design sea condition. The prediction of wave run-up is also important to provide proper deck clearance. The wave forces, run-up, mean drift forces and platform responses may be appreciably influenced by the presence of neighboring structures and sea currents. To assess the performance of the platform in various kinds of sea environments, 3 different boundary element methods have been developed and the computed results are systematically compared.

First, a higher-order boundary element method (HOBEM) is developed in the frequency domain using a zero-forward-speed free-surface Green function and the results are compared with an independently developed constant panel method (CPM). The accuracy and convergence rate of the two methods is systematically compared. It is seen that the convergence of CPM is slower than that of HOBEM especially in the computation of drift forces, as has also been pointed out by Liu et al. (1993). A time-domain higher-order boundary element method (THOBEM) has also been developed (Kim and Kim, 1997) to estimate wave forces, hydrodynamic coefficients, wave run-up, and mean drift forces in waves and uniform currents. The effects of variable bottom topography or lateral boundaries can also be accounted for in THOBEM. The zero-current case of THOBEM agrees well with the frequency-domain results. Using THOBEM, the wave drift damping can be calculated by numerically differentiating the mean drift-force results for different current velocities.

To further verify the numerically predicted results, a series of experiments was conducted in the KRISO towing tank with a 1:15-scale model. The results for uniform coplanar or adverse currents were obtained by towing the model at various speeds. The experimental results in general correlate well with the computed results. The increase (or decrease) of mean drift forces in coplanar (or adverse) currents was observed in both computations and experiments.

EXPERIMENT

A series of experiments was conducted in the KRISO towing tank (200 m × 16 m) with a 1:15-scale BMP model to verify the results of numerical calculations. Its center of gravity was measured by inclining tests, while radius of gyration was estimated as the model width was too big to directly measure the mass moment of inertia due to the limitation of swinging table. The model has a very simple rectangular box shape and the material used is homogeneous, thus the estimation can be made in a reasonable manner. The measured metacentric height and estimated radius of gyration were verified to be within a relative error of 5%. The particulars of the model are given in Table 1. The water depth for this experiment was 7 m. Tests were performed in both regular and irregular wave conditions. The ratio of wave length to barge length ranged from 0.75 to 2.5. An ITTC 2-parameter spectrum was adopted to realize the irregular wave condition with significant wave height Hs = 1.12 m and average zero-up-crossing period Tz = 3.76 s. The motions were measured by 7 strap-down accelerometers (Hong et al., 1992). An FFT-based integration routine was used for synthe-

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