

Hydroelastic Responses of the Mega-Float Phase-II Model in Waves

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ABSTRACT

In the second-phase research of the Technological Research Association of Mega-Float, a methodology for hydroelastic simulation has been developed for a Very Large Floating Structure (VLFS) in short-crested irregular waves to estimate its behavior and check the relevant airport functions. In this paper, the elastic responses of the Mega-Float Phase-II model in short-crested irregular waves were estimated, and the estimated values were compared with the measured values. The estimated significant values of inclinations at ILS (Instrument Landing System) positions and structural strains were in good agreement with the actual measured data. Thus, the validity of this methodology has been verified in practice.

INTRODUCTION

The Technological Research Association of Mega-Float in Japan was organized to start an R&D project of Mega-Float. In the first phase of the project, from 1995 through 1997, a 300-m class pontoon type of model was installed in a sheltered water area by breakwaters in Tokyo Bay, and field measurements were carried out of the response of the model and environmental conditions. In the second phase of the project, from 1998 through 2000, the actual Mega-Float Phase-II model—1000 m long—was installed in the vicinity of the Phase I site, and landing and take-off tests were conducted to verify the applicability of Mega-Float as a floating airport (Kobayashi, 2000).

As a floating airport, Mega-Float's safety and the reliability of airport functions are of essential importance. In the second phase of the project, a methodology for hydroelastic simulation has been developed for a Very Large Floating Structure (VLFS) in short-crested irregular waves to predict its behavior and check the relevant airport functions. Some RAOs (Response Amplitude Operators) of motions at ILS positions were calculated, first by a newly developed general-purpose 3-dimensional computer program for the detailed hydroelastic response analysis of VLFS in regular waves. Then, significant values of the corresponding responses at the appointed points in short-crested irregular waves were estimated, using a predicted directional wave spectrum and calculated RAOs.

Many simulations were carried out using this scheme for the Mega-Float Phase-II model. To verify the validity of this methodology in practice, the estimated significant values of inclinations at ILS positions and structural strains were compared with the actual measured data.

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Analysis Model

Fig. 1 shows the arrangement of the Mega-Float Phase-II model and breakwaters. The influence of varying bending stiffness within the structure was taken into consideration in the calculation using the anisotropic bending plate. Fig. 1 also shows the stiffness properties of the structure and the ILS devices and measuring points, used for the verification of the methodology.

Method of Analysis

The present 3-dimensional computer program is able to analyze the hydroelastic response of various types of VLFS in the water area sheltered by breakwaters and land in regular incident waves (Seto, 1998, 2000a and b). This program is composed of the combination of the existing FEM code (NASTRAN) to analyze the elastic responses, and the hybrid finite/infinite element method to analyze the hydrodynamic forces. In this program, then, it is possible to analyze the complicated form of the structure which is close to the actual shape of a VLFS. This paper briefly explains the flow of analysis of the hydroelastic responses of VLFS using this program. This analysis consists of 3 steps.

1. Modeling of the FEM structure model (*1 in Fig. 2). The FEM structure model of VLFS is created, and the eigenvalue analysis and modal analysis are carried out by NASTRAN code. The characteristic matrices of the structure model (mass, damping and stiffness matrix) and mode data are obtained and recorded.

2. Analysis of the hydrodynamic forces (*2 in Fig. 2). These are obtained by using the hybrid finite/infinite element method, taking into consideration the water area of the complicated environment that is close to the real situation. The characteristic matrices of the hydrodynamic forces (added mass and wave damping) corresponding to each modes and the vectors of wave exciting forces are obtained and recorded. Included in the stiffness matrix is the distribution of restoring force of buoyancy.

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KEY WORDS: Mega-Float, VLFS, Phase-II model, elastic response, estimated significant value, short-crested irregular wave, ILS, validity of methodology.