Stress Analysis for Structurally Discontinuous Parts in a Mega-Float Structure

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ABSTRACT

The authors developed a new stress analysis method applicable to a mega-float structure with structurally discontinuous parts (girders with openings, etc.) and verified its appropriateness by the application of it to prototype structure. In the proposed method, the mega-float structure is represented by a FEM vibration analysis model of a 3-dimensional, slit-shaped girder supported by buoyancy springs, and excited at the end of the wave incident side in the vertical direction; the vibration response of the structure is thus analyzed.

INTRODUCTION

The hydroelastic response analysis for a mega-float structure in waves is usually made by coupling its structural model with the fluid model, but the degree of freedom in the analysis model is then unavoidably very large. Thus, when applying any of the presently available methods, it is difficult from the calculation-time limitation aspect to make this analysis by exactly incorporating into the analysis model such structurally discontinuous parts as girders with openings as well as uniform rigidity members.

On the other hand, it is very important to establish a stress evaluation method for such parts.

For this purpose, a method has been proposed (Inoue, 1999) such that the dynamic loads by hydroelastic response are given to a separately prepared structural analysis model. But this method needs complicated data input in order to exactly represent the structural behavior on the basis of the hydroelastic response.

In these circumstances, noting the fact that the wave-exciting forces acting on the mega-float structure are concentrated at the end of the wave incident side—as described in References (Yasuzawa, Kohno, Kagawa and Kitabayashi, 1997)—the authors have developed a new stress analysis method applicable to the mega-float structure with structurally discontinuous parts (girders with openings, etc.), and verified its appropriateness by applying it to a prototype model. In this method, the mega-float structure is represented by a FEM vibration model of a 3-dimensional, slit-shaped girder supported by buoyancy springs, and its vibration response is analyzed for the case when they are excited at the end of the wave incident side in the vertical direction, using a 3-dimensional FEM vibration analysis model of a 4,770-m-long and 15-m-wide floating structure supported by buoyancy springs.

In the vibration analysis, an assumed fixed logarithmic decrement was used because the magnitude of the hydrodynamic damping effect was not separately obtained from the results of the hydroelastic response analysis. The amplitude of vibration was then adjusted by adjusting the amplitude of the exciting force, and the wave length of vibration was adjusted by the added mass on the bottom of the model, so that it might have the same vibration mode as the hydroelastic response of the mega-float structure.

ANALYSIS OF HYDROELASTIC RESPONSE IN REGULAR WAVES

To obtain the hydroelastic response characteristics of the above-mentioned mega-float airport structure, a series of hydroelastic response analyses in regular waves was carried out using the 2-dimensional eigen-function expansion method (Yoshimoto, Ohmatsu, Hoshino and Ikebuchi, 1997).

Conditions of Analysis

The hydroelastic response analysis of the mega-float airport structure proceeded under the following conditions by the 2-dimensional eigen-function expansion method. Three kinds of longitudinal bending rigidity of the structure were considered:

- Rigidity of a girder without opening (R0)
- Rigidity of a girder with openings (0.64R0)
- A very weak girder (0.1R0)

The dimensions of the analysis model were: $L \times B \times D \times d$ (draught) = 4,770 m $\times$ (Infinite) $\times$ 7 m $\times$ 2 m. Girder space = 30 m. Water depth, $h$ = 20 m. Regular wave period, $T$ = 1.0~20.0 s (0.1 s in increment). Wave height, $H$ = 2 m. Bending rigidity of the model, $R$ = 9.0 $\times$ 10$^6$ kg-m$^2$/m (R0), 0.64R0, 0.1R0. The wave incident angle was parallel with the model’s longitudinal direction.

Analysis Results

Fig. 1 shows the relation between the wave period and the vertical deflection amplitude at the midpoint in the longitudinal

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