論 文 の 内 容 の 要 旨

論文題目　A numerical study of dynamic responses of floating platform considering nonlinear hydrodynamic forces and nonlinear wave effects
（非線形水力と非線形波の効果を考慮した浮体動揺の数値予測に関する研究）

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Floating Offshore Wind Turbine (FOWT) is potential for using offshore wind energy. In Japan, potential offshore wind energy is 1600GW, and more than 80% are located at the water depth greater than 50m, where some researches have shown that FOWTs are cost effective and are expected to produce more energy comparing with the fixed foundation offshore wind turbines. Types of FOWTs have been installed in the world in the complex ocean environment at different water depths. Dynamic responses play a significant role on the safety and cost-effective design of floating platforms. Hydrodynamic coefficients and wave theories are significant for predicting hydrodynamic loading which determines dynamic response of a floating wind turbine platform. Present study focuses on the accuracy of predicted hydrodynamic coefficients and nonlinear wave effects, to evaluate the dynamic response in the design of FOWTs.

In Chapter 1, general background of this study, current situation in the world and particularly in Japan, literature review, motivation and outline of this dissertation are presented.

In Chapter 2, water tank tests including forced vibration tests and dynamic response tests in various conditions, for a semi-sub model and an advanced spar model are introduced. Forced vibration tests are conducted to obtain hydrodynamic coefficients for different KC numbers and periods, in both horizontal and vertical directions. Free decay tests are employed for natural period, and regular wave tests are developed in dynamic response tests. In addition, dynamic responses for the semi-sub model are measured in both deep and intermediate water depth are measured while advanced spar model are set only in the deep-water depth.

In Chapter 3, hydrodynamic coefficients of a semi-sub type and an advanced spar type of floating offshore wind turbine model are investigated by large eddy simulation (LES) with volume of fluid method (VOF) and are validated by the water tank tests. Firstly, the grid dependency on prediction of hydrodynamic coefficients is systematically studied and Richardson extrapolation method is employed to estimate the grid independent solution. The effects of KC number and free water surface on the added mass and drag coefficients are then discussed and the mechanism of hydrodynamic force are clarified by the pressure distribution of floater. Then the hydrodynamic coefficients for each component are investigated and the interaction correction factors are proposed. Finally, predicted hydrodynamic coefficients depending on KC number for an advanced spar type of floater are investigated, and the distribution of hydrodynamic coefficients is presented.

In Chapter 4, predicted dynamic responses of floating platforms by numerical methodology proposed are compared with the water tank test, and effects of KC-dependent and distributed hydrodynamic coefficients are clarified by numerical simulation. At first, method of using iteration and applying variable hydrodynamic coefficients on dynamic response prediction is proposed and validated. Then for both a semi-sub and an advanced spar platform model, effect of KC number dependent hydrodynamic coefficients on evaluation of dynamic responses is investigated At last, effect significance of distributed hydrodynamic coefficients on predicted dynamic responses are systematically investigated experimentally and numerically.

In Chapter 5, nonlinear wave effect on dynamic responses in the intermediate water depth is investigated. Numerical models for prediction of dynamic responses in the intermediate water depth are validated by a water tank test, then are applied in different sea states. The effects of nonlinear wave on dynamic responses of FOWT are then examined by comparing response amplitude operators (RAO) and time histories of wave elevation, dynamic responses and mooring tensions predicted by linear and nonlinear wave theories. Finally, the power spectrum densities (PSD) of dynamic responses of FOWT are analyzed to explain the nonlinear wave effects in the frequency domain.

In Chapter 6, the conclusions and contributions obtained from this study are summarized.