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Dynamic Response Evaluations of Offshore Platform with Wind Energy Production

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ABSTRACT

The dynamic response evaluation of the idealized offshore platform model on wind energy production subjected to wave force and seismic force is carried out in the present study. It is expected that development of the offshore wind energy production would be very effective to encourage the reduction of greenhouse gas emissions. The safety evaluation of the offshore platform would be carried out with the available estimation of the dynamic response to the wave force and seismic force with uncertainty. It is suggested that the evaluation with the MCS simulation gives important roles on the reliable performance based evaluations for the offshore platform with wind energy production subjected to dynamic forces with considerably different characteristics

KEY WORDS*: offshore wind energy production, wave force, seismic force, reliability index, MCS, uncertainty*

INTRODUCTION

It is expected that development of the offshore wind energy production would play important roles on the reduction of greenhouse gas emissions (Otsuka, 2002). The dynamic response evaluation of the idealized offshore platform model on offshore wind energy production subjected to wave force and seismic force is carried out in the present study. The steady wind force, which can be provided to generate the wind energy production, would be obtained in the coastal area with water depth about 50m (Hendersons, 2002). The offshore structure is expected to have important roles on development of wind energy production system. The environmental condition of the offshore structure is more severe than the land structure. If the offshore structure is located in the seismic activity area, it is essential to perform the dynamic response estimation on the wave force as well as seismic force in order to carry out the reliable design of the structure.

The wave and seismic force are usually estimated by relevant expressions with some parameters of uncertainties such as the significant wave height and the maximum acceleration of seismic motion. Since uncertain parameters on the wave and seismic force have very different characteristics on the dynamic response evaluations, it is suggested that the second moment approach could become an effective evaluation for the maximum response characteristics of the offshore platform with wind energy production. Applying the Monte Carlo Simulation (MCS) method to the dynamic response of the offshore platform, it is efficiently carried out the dynamic response estimations for these uncertainties. Performing the response estimation to uncertainties of the external forces with the random vibration approach, it is suggested that the second moment approach can provide an efficiently method for the response evaluation. If the uncertainty is limited within small variations, the sensitivity on uncertainties can be effectively evaluated by the perturbation method. However, if the uncertainty has relatively large variations and the structure response is caused to be nonlinear, the MCS method would be very effective to account for these influences (Guan et al., 2000, Kawano et al, 2007). Especially, it has been demonstrated that the MCS method plays the important roles on the reliability estimation for the nonlinear situation (Marek(1998).

In the present study, it is carried out the dynamic response evaluation of idealized two dimensional offshore platform models with wind energy production subjected to wave force and seismic force. The wave and seismic forces are usually estimated by relevant expressions of some parameters with uncertainties such as the inertia coefficient of wave force evaluation and the maximum acceleration of seismic motion. Since it is expected to cause considerable different contributions on the dynamic response evaluations by uncertain parameters on the wave and seismic forces, it is suggested that the second moment approach could be an effective method for the reliability evaluation by means of application of the MCS simulation. Applying the MCS method to the dynamic response evaluations, it is efficiently carried out with the second moment estimations for the uncertainty. Using the result from the MCS simulation, uncertain parameter effects on dynamic response of the offshore structure could be estimated with the reliability index. Moreover, while the offshore platform is subjected to dominant contributions due to seismic forces, it is important to make the comparison of the response due to seismic force and wind force, which is assumed to be evaluated by static forces. The contribution due to wind forces for the present model is not always essential loads as comparing seismic forces. It is demonstrated that contributions of uncertain parameters on the dynamic response evaluations of the offshore platform with wind energy production can be effectively evaluated with the reliability index by applying the simulation results. It is essential for the reliable design of the offshore platform with wind energy production to clarify the dynamic response evaluation using the second moment approach for various dynamic forces.