Dynamic Response Evaluations of Offshore Wind Energy Platform with Reliability Index

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ABSTRACT  The reduction of greenhouse gas emissions is very important challenge on offshore engineering. The offshore structure is expected to have important contribution on development of wind energy production system. The dynamic response evaluation is required to figure out the effects of uncertainty including the dynamic forces as well as the structural properties. In the present study, the dynamic response analysis of the offshore wind energy platform is carried out with wave force and seismic force with uncertainty. It is shown that the reliability index leads to important roles on the dynamic response evaluation of the offshore wind energy platform subjected to the wave force and seismic force with uncertainty.

KEY WORDS: offshore platform, dynamic forces, uncertainty, reliability index, wind power production

INTRODUCTION

The great attention is placed on the development of energy without the greenhouse gas emission in these days. The reduction of greenhouse gas emission is great interesting challenges to the development of industry. It is appear that the wind energy production is one of the effective methods on the development of the clean energy. The offshore structure has great possibilities because it is essential to carry out development of the offshore wind energy production (Sanjeev(2009)). From engineering point of views, the characteristics of wind on sea space are studying with the observation data (Shimada(2009)). The steady wind force, which can be provided to generate the wind energy production, would be available in the coast area within water depth about 50m (Hendersons(2002)). 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 for the reliable design of the structure to carry out the dynamic response estimation on the wave force and seismic force (Kawano(2009)). If the offshore platform is subjected to seismic forces, it causes to very severe responses such as the bending stress may exceed the allowable stress. In that case, if the base isolation system is applied to the offshore platform with wind generation system, it is expected that the effective reduction of the dynamic response could be carried out with the application.

Moreover, in order to perform the reliable dynamic response of the offshore platform, it is essential to figure out effects on uncertainty due to the wave and seismic force which have very different characteristics on the dynamic response evaluations. For the dynamic response evaluation to the time domain, these uncertainty effects on the response can be effectively evaluated with the Monte Carlo Simulation (MCS) method (Marek(1998), Kawano(2009)). It is indicated that the MCS simulation plays important roles on the reliability evaluations of the offshore platform with wind energy production subjected to dynamic forces with considerably different characteristics.

On the other hand, it is presumed that deterioration on the strength of the offshore platform may be caused by severe environmental conditions and aging properties. In order to enhance the reliable evaluation of the dynamic response, it is supposed for the estimation of the deterioration effects to leads to important roles on the safety of the offshore platform.

In the present study, the dynamic response is carried out with the substructure method for the idealized model of the offshore wind energy platform with pile soil foundation, and it is examined about the dynamic response evaluation of the offshore wind energy platform subjected to wave force and seismic force with uncertainty. For uncertain parameters on the wave and seismic force, the Monte Carlo Simulation (MCS) method is applied to carry out the maximum response characteristics of the offshore wind energy platform, which can be evaluated with the second moment approach. Through the examination, it is suggested that uncertainty effects on the dynamic response evaluations including the aging effects could be evaluated with the reliability index due to the simulation results for the offshore wind energy platform. Moreover, for the offshore platform subjected to seismic forces, the reduction effects on the seismic response are examined with the base isolation system equipped under the deck of the structure. It is indicated that the base isolation is very effective to the reduction of the severe response due to seismic forces.

It is suggested that the uncertainty effects on the wave and seismic forces play important roles on the reliable estimation of the dynamic response of the offshore platform and the aging effects could be essential for the reliable estimation. Moreover, it is shown that the effective reduction of the seismic response could be carried out with the base isolation for the offshore platform with wing production tower.