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Uncertainty Effects on Performance Based Evaluation of Offshore Platform due to Dynamic Forces

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ABSTRACT The performance based evaluation of an idealized three dimensional model of the offshore platform subjected to wave and seismic force is carried out using the MCS (Monte Carlo Simulation) approach in the present study. It is known that application of the reliability approach is very effective to estimate the response evaluation to not only the static forces but also the dynamic forces with uncertain situations. It is suggested that the reliability index determined by the MCS method to dynamic forces with considerably different characteristics plays the important roles on the available estimation of the performance based design on the offshore structure.

KEY WORDS: *uncertainty, wave force, seismic force, reliability, dynamic response analysis, reliability index, MCS*

INTRODUCTION

It is supposed that the reliable design of the offshore structure could be performed with the performance based evaluation. The dynamic forces such as the wave and seismic force include some uncertainties and it is important to examine the uncertainty effects on the dynamic response evaluation. Performing the elaborate evaluation of the dynamic response of the offshore structure, it is necessary to verify the uncertainty effects due to severe dynamic forces on the linear response situation as well as the nonlinear one. Many researches have been implemented to estimate the uncertainty effects on the design of the structure, especially to the land structure.

Furthermore, it is suggested that the damage estimation plays important roles on the performance based evaluation with respect to dynamic forces. There are several available methods on the damage evaluations of the structure subjected to seismic motions (Fajfar,P,1992, Park and Ang,1985). The strength demand spectrum is one of the most useful methods which can be treated with nonlinear effects on the structure subjected to seismic motions (Iemura,1998). It is supposed that the available damage evaluation could not be always carried out only the strength demand response spectrum. That is why it has been indicated that one of the important factors on the damage evaluation could be given by the total energy of the seismic motion on a structure. A lot of researches on damage evaluations have been carried out using the energy approach.

There are still problems remaining on the reliable performance based evaluation of the offshore structure subjected to combined dynamic wave forces with seismic forces. Since some uncertainties are included in the evaluation of these dynamic forces, it is very important to verify the uncertain effects on the response evaluations. From 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 effective 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 (Monte Carlo Simulation) method would be very effective to figure out these influences (Kawano,2007). Especially, it has been demonstrated that the MCS method plays the important roles on the reliability estimation for the nonlinear situation (Marek,1998). While the reliability estimation has been applied to the static response analysis for the offshore structure, there are few examinations on the uncertainty estimation to the dynamic force situation (Karadeniz,2005). Since the offshore platform system is subjected to dynamic forces combined wave forces and seismic forces with the uncertainty, it may be important for the reliability estimation to clarify the uncertainty effects on the dynamic response evaluations.

In the present study, it is carried out the performance based evaluation using the MCS approach for a three dimensional model idealized offshore platform subjected to both wave force and seismic force. Applying the MCS method to the dynamic response evaluations, it can be efficiently carried out with the second moment estimation for the uncertainty. It is suggested that in order to perform the performance based assessment of the offshore structure, it is important to examine not only the linear response property but also the nonlinear response one, which are closely related to both the variability of seismic intensity and the property of seismic motion. It is shown that it is essential for the reliable design of the offshore platform subjected to various dynamic forces to clarify the performance based evaluation using the second moment approach.

FORMULATION

The governing equation of motion