Simulation Database on Structural Reliabilities of Jack-up Platforms

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ABSTRACT

The incidents of jack-up platforms could unpredictably occur during drilling or production operations and hence result in some damages of the structures. No matter what kinds of failures of the structures are caused, it is very important to estimate if the jack-up platforms are able to be qualified for operations, and therefore what necessary procedures should be applied immediately. The paper proposes a method to quickly evaluate integrities of the jack-up platforms for the subsequent operations. A typical Sinopec jack-up platform “Kantan II” is selected to perform the structural analysis and the follow up calculations of the structural reliabilities. A number of scenarios of the structural failures on different members of the platform are assumed for ultimate strength pushover analyses to obtain all the required results of Reserved Strength Ratios (RSR), and then the results are utilized for the corresponding computations of the reliabilities in accordance with the acceptable criteria by industry. The criteria of the structural reliability are introduced to assess if the damaged structures are still capable of operations. Once the simulation database is established, it is convenient that quick appraisals of the structural capabilities and safety issues can be carried out if the incidents of the jack-up platforms occur during the operations.

KEY WORDS: Jack-up; Structural reliabilities; Structural failures; Pushover; RSR; Simulation database; Safety

INTRODUCTION

In offshore oil and gas industry, the mobile jack-up platforms are widely used for the drilling and production operations of the oil and gas fields in the shallow water. However, the incidents caused by harsh environmental loading, geotechnical conditions or operation cases could unpredictably take place during the operations, and the structural failures could be usually caused. Safety of the operations for the platforms must be the first priority issue in appraisal of capabilities of the platforms. In this case, it is very important to assess if the platforms are robust enough, and if no further failures, in particular, no fundamental collapse of the structures could occur. In order to develop a useful approach for quick assessment before the subsequent operations, a novel method by means of combination of ultimate strength push-over structural analyses (Hellan, 1995) and reliability calculations has been proposed for practical operation purpose.

Structural reliability analysis, as an effective method for structural safety assessment of existing platforms, has been developed in offshore oil and gas industry. Marshall and Bea (Marshall and Bea, 1976) applied the structural reliability theory for risk analysis of the offshore platform structures and the selection of environmental load standards, which laid the foundation for the reliability research of the offshore platform structures. Sigurdsson et al. (Singurđsson and Cramer, 1995) used a structural probability collapse analysis method to evaluate the structural failure probabilities of three different type jacket platforms located in the North Sea under extreme storm conditions, and proposed a reliability analysis method for structural system resistance and load effects. Onoufriou et al. (2001) proposed an analysis method for structural design, maintenance, and monitoring of the offshore platforms using structural reliability theory. Melchers et al. (2005) analyzed the influence of corrosion on the reliability of steel marine structures. Hosseinia et al. (2008) took a jacket platform in Lavan oil field as the research object by pushover analysis method to find dangerous components of the platform, and the influence of these dangerous components on the reliability of the platform was analyzed.

During past years, design standards related to reliability analysis of the offshore structures have also been formulated and implemented, such as ISO 19900, ISO 19902, and ISO 13822. At present, the methods such as First Order Reliability Method (FORM), the Second Order Reliability Method (SORM), Monte Carlo simulation (MCS) and structural reliability analysis (SRA) have been developed to assess the existing offshore structures. Structural reliability analysis software such as PROBAN, STRUREL and RASOS has also been successfully developed for reliability analysis of the offshore structures.

This paper presents a detailed structural reliability analysis method to evaluate the reliabilities of the jack-up platform structures quickly for the drilling and production operations. It consists of two major phases, ultimate strength push-over structural analysis for determining the RSR and then subsequent reliability calculations are implemented based on the obtained RSR values. Therefore, a typical Sinopec jack-up platform “Kantan II” was selected to implement the proposed approach. A number of scenarios of the structural local failures on different