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Assessment Method for Seismic Safety Margin of Jacket Offshore Platform Structures

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ABSTRACT

This paper describes a methodology for assessing the seismic safety margin of jacket offshore platforms. The proposed methodology is based on seismic damage analysis using characteristics time-varying analysis method. Along with the concept of structural seismic safety margin coefficient is proposed and the corresponding expression of the coefficient according to different damage state is given. The computational procedures necessary to perform this type of analyses were implemented in the PHFX program.

KEY WORDS: Jacket offshore platform; characteristics time-varying analysis method; seismic damage states; structural seismic safety margin coefficient; computer program PHFX.

INTRODUCTION

Steel jacket offshore platforms are widely employed in offshore petroleum activities throughout the offshore areas of the world at the present time. There are hundreds of jacket offshore platform structures located in the seismically active region, such as the sea area in California, Alaska, Japan, China and so on. For a typical offshore structure located in a seismically active region, the environmental conditions affecting offshore platform structures are very complicated and harsh. And the earthquake ground motion becomes an equally important design load of structural excitations as well as the sea waves. This is due to abruptly changing stress amplitudes during the earthquake, which can cause serious damages although the earthquake duration is very short and does not occur so frequently as the wave load. Moreover, it is a pity that no appropriate means appears to forecast the earthquake well and truly due to limitations of state-of-the-art technology. Whereas the platform is a very important structure, once collapse induced by severe earthquake exceeds the “strength-level”, the loss as well as the social influence caused by the catastrophic results will be very grave.

To make optimal design decisions regarding safety and economy, it is important to have knowledge about the ultimate strength and post-ultimate strength behavior of structural components with certain damage, and the effect of such damage on the load carrying capacity of the total structure. Moreover, the integrity of offshore platforms is critical due to the issue of risk to human life (and also to the environment) and yet, in spite of significant recent progress in the computational modeling of non-linear structural response, little work appears to have been carried out in relation to the collapse of the jacket offshore platform under earthquake load.

Moreover, for the jacket offshore platforms located in extreme ocean environment, how about their damage degree, damage state, and collapse process is, what the margin of safety under extreme load exceeding the design standard is, research on these aspects will help to the design, maintenance of the jacket platform and to give useful information to make a decision whether a platform is suitable or not for continued service, which is of significance to both research and engineering practice.

Based on the understanding of the related structure security appraisal method and the foundation of the predecessor's research results, the seismic safety margin problem is discussed in this paper. And based on collapse analysis results calculated by a characteristics time-varying analysis method (Weiwei, 2004) presented by the first writer, in which the special emphasis is placed on the evaluations of the performance characteristics of platform systems when subjected to very intense earthquakes at ultimate limit states leading to global collapse of the system, a methodology for assessing the seismic safety margin of jacket offshore platforms is proposed.

SEISMIC DAMAGE STATE CLASSIFICATION AND CORRESPONGDING STATE CHARACTER

While designing such important structure as the ocean platform, generally to properly size the structure such that it behaves elastically under “strength-level” earthquake excitations during its normal service life span is taken into consideration. That is to say, once a component yields or breaks, then consider that the structure comes to the load-carrying limit and can work no longer normally. In this paper the stage when the structure keeps in elastic state is defined as the stage of intact condition, in which, the force and deformation of structures keep in