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A new bracing system for improvement of seismic performance of steel jacket type offshore platforms with float-over-deck

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Abstract: In this paper, the seismic response of a newly designed steel jacket offshore platform with a float over deck (FOD) system in the Persian Gulf was investigated through incremental dynamic analysis. Comparison of incremental dynamic analysis results for both directions of the platform shows that the lateral strength of the platform in the float over direction is less than its lateral strength in other direction. Dynamic characteristics measurement of a scale model of platform was also performed using forced vibration tests. From experimental measurement of the scaled model, it was observed that dynamic characteristic of the platform is different in the float over direction compared to the other direction. Therefore, a new offshore installed bracing system for the float over direction was proposed for improvement of seismic performance of this type of platform. Finally, the structure with the modified system was assessed using the probabilistic seismic assessment method as well as experimental measurement of its dynamic characteristics. It was observed that the proposed offshore installed bracing system improves the performance of platforms subjected to strong ground motion.

Key words: Steel jacket type offshore platform, float-over deck, mean annual frequency, force vibration test, seismic performance, dynamic characteristics

1 Introduction

Jacket type offshore platforms are comprised of three main parts structurally, the jacket, pile foundation and deck. There are two main methods for the installation of the offshore deck on jacket namely lifting method and float over deck (FOD) installation method. The float over method is used usually for installation of heavier decks in which the deck is placed on a float over barge and then it is installed on a pre-installed jacket by barge ballasting. The sequence of the float over deck installation is described by O'Neill et al (2000). In the jacket type offshore platform with the float-over deck installation, there is not any vertical bracing in the top bay of the installed jacket in the FOD direction in order to allow the float over barge to come within the jacket legs. In the other direction, there is not any restriction for configuration of the jacket vertical bracing in all bays.

Jacket type offshore platforms during their service life are subjected to various lateral dynamic loads such as earthquake, wave forces, wind forces and ship impact. Dynamic response of the structures is highly dependent on the characteristics of the structures. For this type of offshore platform, the dynamic behavior of the structure in two main directions is totally different. In one of the direction, due to absence of vertical bracing in the top bay of the jacket (because of FOD installation), the system is more flexible and vertical irregularity exists. On the other hand, in the other direction, the system is stiffer and generally more regular in the vertical direction. Lateral strength of such a braced frame is also affected by the vertical bracing configuration. Consequently, the lateral strength in the float over direction is generally less than the strength in the other direction.

In this paper, dynamic behavior of a newly installed jacket type offshore platform with the FOD installation system in the Persian Gulf was studied by numerical and experimental investigation. The probabilistic seismic assessment of the platform was performed first for both directions. Then by experimental observation of the response of the scaled model of the platform, the dynamic characteristics of the platform for both directions were evaluated. An offshore-installed vertical bracing was proposed for the float over deck installation direction to strengthen the platform against lateral loads. The effectiveness of the proposed method was also validated by numerical seismic assessment of the real structure and experimental study of the strengthened scaled platform.

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