Structural Ice-Resistant Performance Analysis of Offshore Bucket Foundation Platforms with a Single Pillar

Dayong Zhang, Xiaofei Che and Qianjin Yue
Department of Engineering Mechanics, Dalian University of Technology Dalian, China

Alexander Brindle
Department of Mechanical Engineering, Tufts University, Medford, MA, USA

ABSTRACT

The bucket foundation platform is a new foundation pattern in ocean engineering, and will take the place of the traditional pile foundations. There are very good economic benefits in the manufacture, installation, removal, and other aspects. Until now, many bucket foundation platforms with a single pillar have been deployed in Bohai bay. But the structural ice-resistant performances have not been well developed, because most of the research is focus on failure analysis and reaction force of the bucket foundation. In this paper, combined with the field monitored data of some bucket foundation platforms in Bohai bay, ice-induced vibrations are analyzed. The results show that even though these structures may effectively resist extreme static ice forces, the ice-induced acceleration is more significant than the jacket platforms. Then spectral-based method is provided to analyze the fatigue life of a real bucket foundation platform, according to the results, the fatigue life of the key joint can meet the requirement. Finally, the ice-resistant strategy is presented, which provides a basis for the design of these platforms in ice zone.

KEY WORDS: bucket foundation; ice-induced vibration; ice zone; ice-resistant structure

INTRODUCTION

The cost of construction for the offshore platforms in the oil field development occupies an important proportion to the total investment. Taking the steel jacket structure for example, the steel of the piles is as much as the jacket structures’. While the cost of installing one platform at sea is nearly half of the total cost. Nowadays, the bucket foundation platform is known as a new style foundation of platform, which is paid more attention for it’s peculiarity such as low weight, easy installation and repeat use, and other aspects. Therefore, the bucket foundation platform is very significant for the oil field development in the marginal oil fields. The bucket foundation platforms have been widely used in Denmark and Norway. And a large bucket foundation jacket platform is achieved (Bye A, etc, 1995). There were six simple bucket foundations platforms, which have been used for some auxiliary function, such as shooting practice for navy, anchoring for mooring buoys, and so on, designed and successfully installed from 1996 to 2000 in China. At present, the research of the bucket foundation platform are mainly concentrated on the foundations, including suction penetration and the installing stability of the bucket foundation (Eide O,etc,1997;Tjelta T L,etc,1990;Byrne B W,etc,2000). For the marginal oil field in Bohai Sea, ice load is the control force for the ice-resistant structures. And the interaction between the ice-induced vibration and the bucket foundation platform has not been recognized clearly, which is one of the reasons that restrict the development of the bucket foundations of offshore platform in the ice zone. Therefore, the application of these platforms in Bohai only accomplished some auxiliary function. In this paper, combined with the field monitored data of some bucket foundation platforms in Bohai bay, ice-induced vibrations are analyzed. It indicates that the ice-induced acceleration is so serious, and is more significant than the jacket platforms. Then spectral-based method is provided to analyze the fatigue life of a real bucket foundation platform, according to the results, the fatigue life of the key joint can meet the requirement. Finally, the ice-resistant strategy is presented, which provides a basis for the design of these platforms in ice zone.

FIELD MONITORING TEST OF THE BUCKET FOUNDATION PLATFORM WITH A SINGLE PILLAR

In order to analyze the dynamics response of the bucket foundation platform under the time-varying ice forces, extensive monitoring has been conducted on some of the Bohai Sea platforms. The observation methods used are: accelerometers installed at different levels measure the structural response in different directions, load panels installed on the legs measure the time-varying ice forces, video cameras observe the ice failure mode and are used to estimate ice thickness, and a marine radar, meteorological station, and current meter are used to track environmental conditions and monitor ice movement. Figure 1 below shows the test set-up on the bucket foundation platforms with a single pillar. From this image, we get quantity of data including the ice force and the ice-induced vibration response. Therefore the anti-ice performance of the bucket foundation platform with a single pillar will be studied.