Structural Ice-resistant Performance Evaluation of Offshore Wind Turbine Foundation

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ABSTRACT

As a kind of clean and renewable energy, wind power has been greatly developed by various countries. Offshore wind turbines are one of the most promising sources of renewable energy in China. Offshore wind farm currently located mostly in ice free area. However, the wind farm in Bohai will be affected by drifting ice loading. In order to make clear the ice-resistant performance and the rationality of the ice-resist design for the offshore wind turbine foundation. In this paper, based on the research results of observation of ice and the interaction between ice and structure, it is clear that the ice load model is suitable for the offshore wind power. Using the finite element numerical simulation method, the ice induced vibration response of the structure is simulated and compared with the wind vibration response, and then the ice-resistant performance is analyzed by taking a wind turbine foundation in Bohai Sea as an example. This study provides a reasonable basis for the ice-resist concept design of the wind turbine foundations in the cold regions.

KEY WORDS: ice region; wind turbine foundation; ice loads; ice induced vibrations; ice-resistant performance.

INTRODUCTION

As a renewable and green resource, wind energy is widely developed by many countries. Offshore wind energy resources are more stable, offer greater reserves, and have a smaller impact on the surrounding environment than the onshore wind energy (Zhou, 2011). At present, more and more countries are beginning to set up offshore wind farms, and offshore wind power has become the development trend for wind power.

Power cost is a key factor that restricts the development of wind power. European studies show that the investment in offshore wind turbine foundations accounted for 20% of the total cost. At the same time, as the water depth increases, the cost of the wind turbine foundation will also increase, sometimes even accounting for 30% of the total cost (Snyder, 2009). Therefore, a reasonable design for wind turbine foundations is even more important. Offshore wind turbine foundations have four characteristics. The characteristics are ocean engineering structures, high-rise structures, dynamic structures and complex ground conditions (Shang, 2010). At present, the development of offshore wind power is most concentrated in shallow areas, and the foundation is mainly based on a fixed pile foundation. Based on the offshore jacket platform design, wind turbine foundation types are mainly single pile foundations and three pile foundations. Because the wind turbine height is more than 60 m, much higher than an oil platform, a wind turbine structure is more flexible than the offshore jacket platform structure.

In recent years, China's offshore wind potential has seen great development, and a number of wind farms will be established in Bohai. The wind turbine and boost station structure must have certain ice-resistant characteristics in ice regions to ensure the safe operation of the wind farm in winter. Currently, flexible ice-resistant structure design is still in the state of static design, which only considers the maximum static ice force or the maximum overturning moment, ignoring the