Hydrodynamic Motion of Composite Bucket Foundation for Offshore Wind Turbines

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ABSTRACT

The large composite bucket foundation (LCBF) was used for the first offshore wind turbine in Qidong sea area of Jiangsu Province in China. The most critical technique of the foundation is self-floating towing technique based on a reasonable subdivision inside the bucket. In order to predict the dynamic behaviours of aircushion supported the LCBF in waves, the hydrodynamic software MOSES is used to simulate the three-dimensional motion of the foundation in towing construction site. The floating technique of the LCBF with supported aircushions in waves is highly competitive for saving lots of cost with few expensive types of equipment during the towing transportation.

KEY WORDS: Large composite bucket foundation (LCBF); towing; Moses; offshore wind turbines.

INTRODUCTION

With the rapid development of offshore wind power, the foundation design requires the development of highly cost-effective constructions, such as a bucket foundation, because the share of the foundation’s cost relative to the overall cost of the offshore wind farm is considerably higher than that of an onshore foundation (Byrne, 2002; Houlsby, 2005 and 2006). Several studies indicate that large savings can be made by using bucket foundations instead of, for example, driven piles. A bucket foundation is a large cylindrical structure that is open at the base and closed at the top. The cylindrical part is denoted as the bucket skirt, and the upper plate that closes the bucket is denoted as the bucket lid. During installation, the bucket skirts are penetrated into the soil until the bucket lid is resting on the seabed (Zhang, 2013a and 2013b). However, a suction bucket foundation design is not, given variable subsurface sediments (e.g., presence of cobbles to boulders, near-surface gas layers), always a workable solution.

A new type of wide-shallow large composite bucket foundation with large diameter (30 m or more) and small bucket height (7 m or less) used as the foundation of offshore wind turbines is presented, which is proposed by Tianjin University (Ding, 2013; Lian, 2011 and 2012; Zhang, 2013c). The large-scale composite bucket foundation is made of reinforced concrete. In order to make the various loads from the upper tower structure successfully transmitted to the foundation, an arc transition structure of prestressed concrete between the tower structure and the top of the bucket foundation is designed.

In October 2010 the first and to date only large-scale composite bucket foundation (design loads according to 3.0 MW) for a fully operational wind turbine was installed at the offshore test facility in Qidong City, in the eastern part of Jiangsu Province (Ding, 2013; Lian, 2011 and 2012; Zhang, 2013c). The wind turbine is a XEMC 2.5MW turbine with a total height equal 80 m. The diameter and the bucket skirt length of the composite bucket foundation are equal 30 meters and 7 meters respectively, and the total weight of the foundation is nearly 2400 tons with an 18 m arc transition structure of prestressed concrete. The bucket foundation prior to and upon installation is shown in Figure 1.

Figure 1. Pictures of the LCBF for an offshore wind turbine

The foundation with self-floating characteristics was towed to the construction site, see Figure 2. In order to float the open bottom structures and to tow them from the construction yard to the final location offshore, air was pumped underneath the structure and