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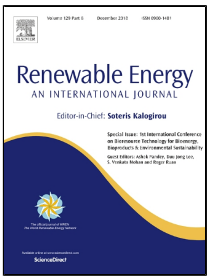

Investigation on Offshore Wind Turbine with an Innovative Hybrid Monopile Foundation: An Experimental Based Study

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Investigation on Offshore Wind Turbine with an Innovative Hybrid Monopile Foundation: An Experimental Based Study

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Abstract: The support structure for offshore wind turbines (OWTs) plays significant roles in maintaining the structural stability and reducing the initial cost. An innovative hybrid monopile foundation for OWTs is proposed. The concept has a wider adaptability by using established knowledge to solve for new problems. A series of centrifuge tests is performed to investigate the behavior of this hybrid foundation system in extreme and service conditions. OWTs with the original monopile foundation as well as the wheel-only foundations are tested for comparisons, and two clay profiles are considered. The test results show that the hybrid monopile foundation provides larger ultimate bearing capacities compared to the traditional foundations. Two analytical methods are proposed to estimate the ultimate bearing capacity of this innovative design, and the results are calibrated by the centrifuge tests. In service conditions, the hybrid monopile foundation shows stronger cyclic resistances. Influence factors of the cyclic responses are summarized. An analytical solution is put forward to estimate the accumulated lateral displacement of the hybrid monopile foundation. A degradation factor is suggested based on the results of the centrifuge tests. The study aims to enrich the understanding of the innovative foundation concept and to provide design references for practical applications.

Keywords: Centrifuge modeling; clayey soil; cyclic behavior; hybrid monopile foundation; offshore wind turbine; ultimate bearing capacity.

1. Introduction

The energy demand and global climate change caused by the excessive use of fossil fuels have become one of the most significant challenges to human society [1, 2]. This situation forces researchers to develop sustainable and renewable energy recourses. Wind energy, a clean, plentiful, and renewable alternative, has received an unprecedented development nowadays [3]. The global cumulative installed wind capacity reached 486.8 GW by 2016, and the wind energy contributes 34% of the annual new installed renewable energy capacity [4]. Currently, the development of onshore wind farm is limited by the land availability, and hence, the offshore wind industry attracts more attentions [5, 6]. Besides the more available spaces, wind resources at offshore areas are steadier and stronger; moreover, the greater generation capacity is obtained by moving into deeper waters and further from the coasts [7]. According to the global wind report, the total installed