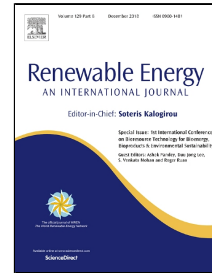


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Investigation on Offshore Wind Turbine with an Innovative Hybrid Monopile Foundation: An Experimental Based Study

Xuefei Wang, Xiangwu Zeng, Xinyao Li, Jiale Li



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# 1 Investigation on Offshore Wind Turbine with an Innovative Hybrid 2 Monopile Foundation: An Experimental Based Study

3 Xuefei Wang, Xiangwu Zeng, Xinyao Li, Jiale Li\*  
4 *Department of Civil Engineering, Case Western Reserve University, Cleveland, OH*  
5 *44106, USA*  
6

7 **Corresponding author email:** xxw165@case.edu.  
8

9 **Abstract:** The support structure for offshore wind turbines (OWTs) plays significant roles in  
10 maintaining the structural stability and reducing the initial cost. An innovative hybrid monopile  
11 foundation for OWTs is proposed. The concept has a wider adaptability by using established  
12 knowledge to solve for new problems. A series of centrifuge tests is performed to investigate the  
13 behavior of this hybrid foundation system in extreme and service conditions. OWTs with the  
14 original monopile foundation as well as the wheel-only foundations are tested for comparisons,  
15 and two clay profiles are considered. The test results show that the hybrid monopile foundation  
16 provides larger ultimate bearing capacities compared to the traditional foundations. Two analytical  
17 methods are proposed to estimate the ultimate bearing capacity of this innovative design, and the  
18 results are calibrated by the centrifuge tests. In service conditions, the hybrid monopile foundation  
19 shows stronger cyclic resistances. Influence factors of the cyclic responses are summarized. An  
20 analytical solution is put forward to estimate the accumulated lateral displacement of the hybrid  
21 monopile foundation. A degradation factor is suggested based on the results of the centrifuge tests.  
22 The study aims to enrich the understanding of the innovative foundation concept and to provide  
23 design references for practical applications.  
24

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

## 27 1. Introduction

28 The energy demand and global climate change caused by the excessive use of fossil fuels  
29 have become one of the most significant challenges to human society [1, 2]. This situation forces  
30 researchers to develop sustainable and renewable energy recourses. Wind energy, a clean, plentiful,  
31 and renewable alternative, has received an unprecedented development nowadays [3]. The global  
32 cumulative installed wind capacity reached 486.8 GW by 2016, and the wind energy contributes  
33 34% of the annual new installed renewable energy capacity [4]. Currently, the development of  
34 onshore wind farm is limited by the land availability, and hence, the offshore wind industry attracts  
35 more attentions [5, 6]. Besides the more available spaces, wind resources at offshore areas are  
36 steadier and stronger; moreover, the greater generation capacity is obtained by moving into deeper  
37 waters and further from the coasts [7]. According to the global wind report, the total installed

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