Numerical Study on Lateral Response of Piles Supporting Gravity Base Foundations for Offshore Wind Turbine

Yun Wook Choo, Ji-Hoon Seo
Department of Civil and Environmental Engineering, Kongju National University
Cheonan, Chungnam, Korea

Seong-Hwan Kim, Jeong-Min Goo
Dong Myeong Eng. Consultants & Architecture Co., LTD. Seoul, Korea

Youngho Kim
Centre for Offshore Foundation Systems, University of Western Australia
Perth, Australia

ABSTRACT

The aim of this paper is to study the lateral response of piles supporting a piled gravity base foundation for offshore wind turbine. The piled gravity in this study consists of a cone-shaped concrete base and five piles. The three-dimensional finite element analyses were carried out to simulate four cases: single pile, piled gravity base foundation, five group piles with the same arrangement of piled gravity base foundation, nine group piles with three by three arrangement. From the result, the lateral response of each pile was evaluated in terms of soil reaction force and deflection. The lateral response of the piles of the cases was compared and analyzed. Finally, the group effect of the cases on the lateral response of piles was evaluated.

KEY WORDS: Offshore wind foundation; Gravity base foundation; piles; p-y curve; P-multiplier; numerical analysis.

INTRODUCTION

With the increasing interest in renewable energy, offshore wind energy has been received attentions for the last decade. The foundation required to stabilize offshore wind turbines are significantly more expensive, and the proportion of total development cost are much high. Thus, foundation systems have been studied to derive a robust design concept or improve current design practice of conventional foundation types to reduce the cost and conservatism in the foundation design. Various alternative foundations have been investigated for the last decades combining typical foundations with other foundation elements, including multiple composite pile foundations (Shin et al. 2014), monopod and tripod bucket foundations (Houlsby and Byrne, 2000; Byrne and Hously, 2003; Kwag et al. 2013), clustered bucket foundation (Kim et al. 2013).

As a part of aforementioned struggles, this study aims to develop a hybrid gravity base foundation (GBF) to improve a conventional foundation type. The hybrid gravity base foundation consists of gravity base foundation and supporting five piles (so-called piled GBF). The purpose of the piles is to gain an additional bearing resistance from the piles embedded into hard layers as illustrated in Fig. 1. This concept may be beneficial to a site deposited with soft thick sediments. For instance, most of the Western coast of Korea is deposited with thick soft sediments comprising of several interchanging layers of silty sand and soft clay.

![Fig. 1. Conceptual design of piled gravity base foundation.](image-url)