Numerical Study on Response of Double-sleeve Pile Subjected to Negative Skin Friction

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ABSTRACT

In this paper, the negative friction resistance of double-sleeve pile in coastal underconsolidated soil is studied by three-dimensional numerical simulation. The feasibility of the numerical simulation method of double-sleeve pile is verified by comparing numerical simulation results with experimental results. Different loads are applied at the top of the pile, and the axial force and lateral friction resistance distribution of common pile and double-sleeve pile are compared and analyzed. By applying different forms of ground surcharge around the soil, the stress characteristics of double-sleeve pile is discussed. The results show that the double-sleeve pile can effectively reduce the negative friction resistance of pile and provide guidance for engineering construction.

KEY WORDS: Double-sleeve pile; negative skin friction; axial force; numerical modelling

INTRODUCTION

In coastal engineering construction, pile is an important form of foundation structure, such as pile foundation of cross-sea bridge, offshore wind power single pile foundation, high-piled wharf pile foundation and so on. In the eastern coastal area of China, there are deep silt and muddy soil and other underconsolidated soft soil in the upper surface area. The soil has the characteristics of high water content, large void ratio, high compressibility, low strength and so on (Zhang et al., 2020). Underconsolidated conditions can produce a large settlement under the action of natural consolidation settlement and surcharge, which can lead to dragdown along the pile, termed negative skin friction (NSF) of the pile.

NSF of pile will lead to the increase of axial force, settlement, damage of pile body and uneven settlement of structure, which has a negative impact on the construction of pile engineering. In the 1930s, the concept of NSF of pile foundation was first put forward by Dutch scholars Terzaghi and Peck (1959) in their book Soil Mechanics in Engineering Practice, and a simple calculation method was given. Over the years, a large number of scholars have carried out in-depth research on the NSF, including field test (Bozozuk, 1972; Keenan et al., 1985), laboratory model tests (Zhao et al., 2022; Huang et al., 2014; Bian et al., 2020), numerical simulation (Alarcón et al., 2021; Wu et al., 2022; Chiou et al., 2021) and theoretical calculation (Fellenius et al., 2004; Ye et al., 2021). In addition, a large number of studies have been carried out in the areas of underconsolidated soft soil (Salem et al., 2018), filling soil (Xiong et al., 2022), over-exploitation of groundwater (Duan, 2017) and collapsible loess (Xing, 2018), which provide important