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Behaviors of the breakwaters on the foundation system utilizing buoyancy

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ABSTRACT

A series of numerical simulations of the caisson type breakwaters on the foundation system utilizing buoyancy were carried out in plane-strain conditions using the modified Cam-Clay model and the Biot's consolidation theory. Improved foundation system by the replacement of original ground with light weighted material, expandable poly-styrene (called below EPS) and suction pile foundation with buoyant cells were used as the foundation systems utilizing buoyancy. From the results of numerical simulations we found that the foundation systems utilizing buoyancy are efficient to reduce the maximum consolidation settlements without reducing lateral safety.

KEY WORDS: Soft ground; breakwater; buoyancy; consolidation settlement

INTRODUCTION

Recently several new large structures near shore are being constructed in Korea. Many breakwaters are needed to construct large structures off shore and most of them are located on the soft ground. In the construction of the breakwater on the soft ground, two requirements should be taken into account; one is to ensure the sufficient lateral resistance; the other is to prevent the excessive long-term consolidation settlement. Many methods, such as grouting, soil reinforcement, dynamic compaction and so on, to satisfy these requirements have been studied and developed for the poor ground condition. In this paper we suggested a new method to reduce the breakwater's consolidation settlement by adding the buoyancy to the foundation system in case of deep and thick soft ground condition. This method was applied to caisson type breakwater and the numerical simulations were carried out to find out the lateral behavior against wave loading and consolidation behavior.

CAISSON TYPE BREAKWATER ON THE FOUNDATION SYSTEM UTILIZING BUOYANCY

For a conventional caisson type breakwater, a friction between rubble mound and concrete plays a major role in resisting the lateral wave force as shown in Fig.1. Because friction is increased with normal force between two objects, increase of caisson's weight can make lateral resistance increase. On the other hand decrease of the weight of whole breakwater system can make its settlement decrease. Therefore the methods to decrease the weight of entire breakwater system without decreasing the weight of caisson can be used in case that the lateral resistance requirement is satisfied but the consolidation settlement requirement is not satisfied. We suggested the method to reduce whole breakwater system's net weight by adding buoyancy to its foundation system without the loss of lateral resistance. In this paper two foundation types were used as the foundation system to apply this method; one is EPS foundation and the other is suction pile system with buoyant cell filled by EPS. EPS foundation means the replaced ground with EPS. A suction pile is an open-ended pile that is sealed at the top and installed by applying a suction pressure inside the pile, which acts as an external surcharge to push the pile into the seafloor (Bang et al., 2000). Suction piles have been used extensively in offshore applications, since they can be installed easily in deep water locations (Tjelta et al., 1990). Also they provide a greater resistance to vertical and lateral loads than driven piles