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Improvement of Soft Soil Using Linear Distributed Floating Stone Columns under Foundation Subjected to Static and Cyclic Loading

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Abstract

A stone column is one of the soil improvement methods that are mainly used for improving the geotechnical behavior of soft soils. For deep improvement of soft soil, the floating stone columns are considered the best and effective economically which provide lateral confinement and drainage and longitudinal skin friction. In this study, six tests were carried out on the natural soft soil of undrained shear strength of 5.5 kPa improved by single and two linear distributed floating stone columns. The stone column dimensions are 30 mm in diameter and 180 mm in length and the stone column material is sand of high internal friction angle of 48°. The natural and improved soil samples are tested under isolated raft foundation of dimensions 120×120 mm subjected to vertical static and cyclic loading of frequency 2Hz and continued for 50 seconds. The results showed a significant improvement in soil bearing capacity when reinforced with stone columns despite the small area replacement ratio, where the bearing capacity of improved soil increased by 120 to 145%. The compressibility of improved soil decreased by 57 to 86% in comparison with that of natural soft soil. Also, the floating stone columns reduced the porewater pressure, where the stone columns considered efficient in providing short drainage pathways. This can be one of the reasons why soil reinforced with floating stone columns hold higher cyclic and static stresses regardless the end bearing of stone columns.

Keywords: Floating; Stone Column; Soft Soil; Axial Loading; Cyclic Loading.

1. Introduction

Most of the soils located in the middle and southern parts of Iraq are considered as soft to very soft cohesive soils especially in areas close to the marshes. Many projects are planned to be constructed in these areas, in the next coming years, it is expected to construct more than 1400 km of new railway networks and rehabilitation of the current network [1]. Soft clay soil is alluvial sediment formed in the last 10,000 years on a flat surface [2]. The soil is recognized by its high compressibility index ranged (0.19-0.44), the low shear strength (c_u<40 kPa), and high moisture content (40-60) %. One of the challenges that facing the geotechnical engineers is building on soft soil and meet the design project requirements. Mitchell and Jardine [3] recommended alternative method using additional appropriate materials rather than soft soil, relocating the projects to pass the poor area or using deep foundation, redesign the plant to satisfy the weak soil specification or modification of weak natural soil properties to adapt to the design specification of the facility. A stone column is one of the soil improvement methods that is used to increase soil strength, decrease the compressibility of soil, accelerate the consolidation rate and reduce the liquefaction potential of soils, they are mainly used for improving soft soils. Shivani et al. [4] studied the geosynthetic-encased stone columns with combination of ring model footing

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