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Numerical Modeling of Encased Stone Columns Supporting Embankments on Sabkha Soil

Imad Eddine Debbabi [a*], Remadna Mohamed Saddek [a], Ahmad Safuan A. Rashid [b], Abubakar Sadiq Muhammed [c]

[a] *Department of Civil Engineering and Hydraulic, NMISSI Laboratory, Biskra University, BP 145, Biskra 07000, Algeria.*

[b] *Centre of Tropical Geoengineering (GEOTROPIK), School of Civil Engineering, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia.*

[c] *Department of Civil and water Resources Engineering, University of Maiduguri, Borno Nigeria.*

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Abstract

The present research work is concerned with the construction of road embankments on a specific soil called Sabkha in Algeria. This soil is not only soft and very humid during the flooding seasons but also has frequent small areas of very soft soil which we here call Locally Weak Zones (LWZ). LWZ is characterized by low strength and high compressibility. The paper presents the results of two-dimensional axisymmetric numerical analyze that were carried out using PLAXIS 2D 2017, for the modeling of an embankment supported by stone columns on Sabkha soil. The study focuses on the evaluation of the maximum bulging of the stone column and on the settlement of the embankment. It has been demonstrated that Ordinary Stone Columns (OSC) were ineffective due to excessive bulging (221.16 mm) caused by the lack of lateral pressure. On the other hand, the Encased Stone Columns (ESC) showed good behavior, namely a much reduced bulging (42.09 mm) and a reasonable settlement (0.962 m vs. 1.560 m for an OSC) so that it is possible to build safe very high embankments. The numerical analysis also shows that the length of the encasement should just be greater than the depth of the LWZ. Besides, an extensive parametric study was conducted to investigate the effects of the variations of embankment height, stiffness of geosynthetic, the depth of the locally weak zone, area replacement ratio (ARR), and the stone column friction angle, on the performance of the (ESC) - embankment composite in (LWZ). Some important guidelines for selecting the ideal encased stone column (ESC) to support embankments on over locally weak zone were established through this numerical study.

Keywords: Encased Stone Columns; Geosynthetic; Finite Element Modelling; Locally Weak Zone; Sabkha Soil.

1. Introduction

Nowadays, structures such as dams, road embankments and storage tanks, frequently have many problems with irregular, excessive settlements or overall stability due to geological situation and weak soil. Stone columns (likewise known as granular piles) are increasingly used as soft soil reinforcement to support a variety of structures [1], in other words, these are soft soil improvement techniques which are commonly and successfully used to reduce settlement, reduce the liquefaction potential, and to speed up the consolidation of soft soils [2–4]. When the stone columns (OSCs) are installed in extremely soft soils (cu < 15 kPa) such as peat soils, and marine clays, etc., the lateral confinement presented by the surrounding soil may not be sufficient to form the stone column. This may lead to the excessive bulging of stone columns, especially in the upper portion of the columns, which can significantly reduce their capacity

* Corresponding author: imadeddine.debbabi@univ-biskra.dz

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