STUDY ON THE PERFORMANCE OF PAD FOOTINGS ON SOFT SOILS IMPROVED WITH CONCRETE CYLINDERS AND CONTROLLED MODULUS COLUMNS (CMC)

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Abstract

In construction projects on soft soils, various methods for structural enhancement and ground improvement, such as micro-piles, concrete cylinders with filling materials, larger footings, and Controlled Modulus Columns (CMCs), are employed. However, there remains a limited understanding of the effectiveness of using concrete cylinders with filling materials. Despite increasing adoption in Europe, the performance of CMCS in building applications continues to be less studied.

This research investigated the structural and geotechnical performance of concrete cylinders with quarry dust filling and the CMC technique through three-dimensional (3D) finite element (FE) modelling using the MIDAS GTS-NX software. Soil layers are simulated, incorporating both Modified Cam Clay (MCC) and Mohr-Coulomb constitutive soil models, while all the structural elements were modelled using the elastic material model to examine both immediate and consolidation settlements. Validation of the models was carried out through a theoretical comparison, using field test data of Texas A&M University and Green Cove Springs, and through lab model tests conducted at the University of Moratuwa.

A comprehensive parametric analysis was carried out to assess the impacts of embedment depth of the footing, diameter, height, spacing, and the LTP thickness of the CMC on foundation settlement behaviour. Additionally, the impacts of concrete cylinders with the quarry dust fill were studied for various heights and diameters of the cylinders. The results showed that both methods significantly reduce both immediate and consolidation settlements, with some optimal design parameters.

This study provides a comprehensive understanding of the performance of these two techniques as an economic improvement for domestic construction on soft soils. Furthermore, the numerical models used in this research could serve as a foundation for further studies on various ground improvement techniques and will provide insights into the feasibility of these methods, supporting an economically and structurally sound foundation on soft soils.

Keywords: Footing, Consolidation Settlements, Bearing Capacity, Controlled Modulus Columns (CMCs), Concrete Cylinders, Finite Element Analysis, Soft Clay, Modified Cam Clay, Ground Improvement, Midas GTS NX

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Declaration

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning, and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or in part in future works (such as articles or books).

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