FINITE ELEMENT MODELING OF HIGHWAY EMBANKMENTS OVER SOFT SUB-SOIL CONDITIONS

This thesis was submitted to the Department of Civil Engineering of the University of Moratuwa in partial fulfillment of the requirements for the Degree of Master of Science

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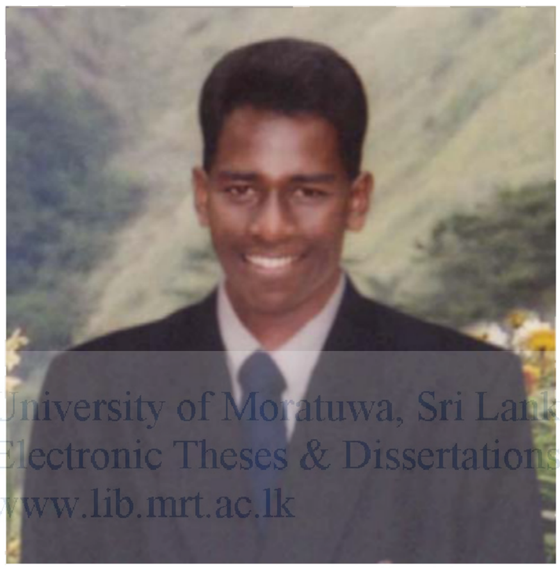
Dedication

14  27

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This thesis is dedicated to my brother Master.R.Thavaseelan (Sathees), the key person of our family, who died under tragic circumstances while I was involved in this work

DECLARATION

The work included in this thesis in part or whole, has not been submitted for any other academic qualification at any institution.

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Abstract

Several major proposed infrastructure development are being planned over areas underlain by weak or soft soils. One such project is the Colombo-Katunayaka Expressway (CKE). This passes over the peaty soils of Muthurajawela marshy areas, and requires extensive ground improvement techniques. Among such techniques used so far are the installations of Pre-fabricated Vertical Drains (PVD), preloading with or without PVD's and Sand Compaction Piles.

This research considers selected CKE embankment segments to be numerically modeled using a finite element software named 'Geo-Slope'. The simulations are done under plane strain conditions, and results are compared with field monitored data obtained by the RDA through instrumentation of the CKE embankment. A large scale laboratory test conducted by Kugan (2004), with and without a central PVD installed, is also modeled using axisymmetric finite element analysis by Geo-Slope.

The finite element simulations involve an accurate evaluation of material parameters for a finite element mesh representing the actual geometrical conditions of CKE embankment segments and the large scale laboratory consolidation tests on peat taken from CKE route. The preloadings in all cases have been in stages. An extensive FE analysis program is carried out to verify the most suitable constitutive model to represent the behaviour of peaty soil, and the parameter for proper representation of the prefabricated vertical drains. It is found that the modified cam clay model combined with linear elastic models give good comparison with observed data.

The influence of equivalent geometry, different soil models, Young's modulii, geo-textile, smear resistance and well resistance are taken into account for FE analysis. Here one segment is chosen for analysis as a section with composite soft ground treatment using vertical drains. Initial conditions are estimated by using the insitu analysis, and subsequent analysis is performed under different conditions to predict settlement behaviours, excess pore water pressure and Degree of Consolidation (DOC). The reported field and experimental data are compared with the predicated numerical results. Settlement characteristics, excess pore water pressure generation and dissipation and DOC are discussed in view of stage loading and the seepage of pore water.

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