FINITE ELEMENT MODELLING OF DEFORMATION CHARACTERISTICS OF SOFT SOILS IN COLOMBO OCH PROJECT

DEGREE OF MASTER OF ENGINEERING

FOUNDATION ENGINEERING AND EARTH RETAINING SYSTEMS

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DEDICATION

Dedicated to

My beloved Parents and My Husband Prasanna

DECLARATION

I hereby certify that this dissertation does not incorporate any material without acknowledgement, and material previously submitted for a degree or diploma in any university to the best of my knowledge, and further I believe it does not contain any material previously published , written or orally communicated by another person except where due reference is made in the text

....

Signature of the candidate. Date

W.N.R.P.N. Nilminie

This is to certify that this thesis submitted by W.N.R.P.N Nilminie is a record of the candidate's own work carried out by her under my supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

UOM Verified Signature 21-12-2012

Signature of the Supervisor Date

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ABSTRACT

In Sri Lanka, currently many development projects such as major highways are being constructed over soft soil deposits of low bearing capacity and excessive settlement characteristics, mainly due to unavailability of good land and high cost involved in land acquisition. The Colombo Outer Circular Highway (OCH) is one such infrastructure development project, being constructed with the objectives of encouraging the development of current or future growth centers connected by radial routes, and diverting through traffic from the center of the city.

Deformations, stability and time required for consolidation are major considerations in the design and construction of embankments over soft sub-soils. The sub-soil of OCH Southern section consists of peat, organic and inorganic-clay and loose sand. Therefore countermeasures are required to control the settlement of underlying deep and extensive layers of soft soil. One method adopted is to install pre-fabricated vertical drains (PVD) into the underlying soft soils, and place earth embankments on top, partly as necessary substructure of the highway, and partly as preload to accelerate the settlement of soft soils beneath.

This work presents a numerical simulation of the deformation of the earth embankments and soft soil underlying the Colombo Outer Circular Highway. Finite Element analysis software Plaxis 8.2(2002) is used to model the long-term creep deformation behavior of soft soil loaded by embankments, with pre-fabricated vertical drains installed in the soft soil strata. Two constitute models are used for the analysis; Mohr-Coulomb Model to represent the earth embankment and Soft Soil Creep model to simulate the soft sub soils.

A major effort was needed to determine appropriate material parameters for input to the selected constitutive models, and the final selection was made based on empirical considerations. The actual three-dimensional problem domain is converted to equivalent two-dimensional plane-strain domain. The equivalence between the plane-strain and axi-symmetric analyses were established by a permeability matching procedure. All field conditions including the load incrementing sequences are simulated, and coupled consolidation/creep analysis is performed to predict the settlement behavior. Numerical predictions are compared with observed field settlement records, and agreement is seen between the predicted results and the observed field measurements, indicating the feasibility of using the numerical model for predicting purposes, and the empirical method need to determine the applicable material parameters for the selected constitutive models.

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Weerawarna Nilaweera Ran Patabandighe Nadeeka Nilminie

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B - Half width of plane strain cell

b_s - Half width of the smear zone

b_w - Half width of the drain

C -Cohesion

C_c -Compression Index

C_r -Recompression index

C_α -Coefficient of Secondary Compression

D- Influence zone

d_w - Equivalent diameter of band drain

E- Young's modulus

E_s -Static deformation modulus

e_{int} -Initial voids ratio

k_{hp} - Plane Stain horizontal permeability

k'_{hp} -Smear zone horizontal permeability

k_h - Vertical permeability

k_s -Smear zone permeability

k_v - Horizontal permeability

k_x -Plane strain Horizontal permeability

k_y - Plane strain Vertical Permeability n- Spacing ratio

q_z -Equivalent plane strain discharge capacity

R- Radius of axisymmetric unit cell

r_s - axisymmetric radii of smear zone

r_w - axisymmetric radii of drain

s- Drain spacing

$\bar{s}^2$ - Mean square distance of flow net

T- Ultimate Tensile Strength

T_{hp} - Time factor in Plane strain

U -Overall degree of consolidation

U_r - Average degree of consolidation due to radial drainage

U_v - Average degree of consolidation due to vertical drainage

$\bar{U}_h$ - Average degree of consolidation for axisymmetric

$\bar{U}_{hp}$ - Average degree of consolidation for equivalent plane strain condition

$\bar{u}$ - Pore pressure at time t

$\bar{u}_0$ - Initial excess pore pressure

ϕ - Internal friction Angle

Ψ-Dialatancy Angle

v- Poisson's ratio

γ_{sat} - Saturated Unit weight

γ_{unsat} -Bulk Unit weigh