NUMERICAL ANALYSIS OF SUBGRADE STABILIZATION IN SOFT SOIL

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DEDICATION

To my beloved mother, *Raja Kamariah Binti Raja Kadir* and father, *Engku Ab Rahman Bin Ku Junoh*, my wife, *Hazlina Binti Mahfidz* and my daughter *Tengku Puteri Nur Aliyah, Engku Puteri Nur Ayesha and Engku Puteri Nur Afiqah.*

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ABSTRACT

Soft soil also well known in geotechnical properties where low bearing capacity, high water content, high compressibility, structural instability, lateral pressures, differential settlement and long term settlement. In situ subgrade often not provided the support required to achieve acceptable performance under traffic loading and environmental demand. Previous similar projects are importance to determine the suitable soil improvement method in relation to project. In this study, software application approach by PLAXIS 2D in order to evaluate the behaviour of the subgrade stabilization using an actual field data form Subsurface Investigation (S.I) work report and PLAXIS 2D Manual. The effectiveness of PLAXIS finite element to predict the settlement of soft soil base on different type stabilization are successfully performed related to this matter.

ABSTRAK

Tanah lembut dikenali dalam bidang kejuruteraan mekanik tanah dimana ia mempunyai keupayaan galas yang rendah , kandungan air yang tinggi , kebolehmampatan yang tinggi , ketidakstabilan struktur , tekanan sisi, dan pengukuhan yang pelbagai untuk jangka masa yang panjang . Lapisan subgred seringkali dikatakan tidak dapat untuk memberikan sokongan yang diperlukan agar mencapai prestasi yang boleh diterima semasa pembebanan lalulintas dan permintaan alam sekitar. Projek-projek terdahulu yang perlah dilaksanakan dan berada di dalam bidang yang ini amat penting bagi menentukan kaedah membaik pulih tanah yang sesuai sehubungan dengan sesuatu projek . Dalam kajian ini, dengan menggunakan perisian aplikasi PLAXIS 2D, kestabilan dan tingkah laku tanah yang berada di lapisan subgred dapat dianalisis berdasarkan data sebenar di lapangan yang diperolehi melalui kajian awal di tapak bina (SI). Keberkesanan perisian PLAXIS 2D dalam meramalkan kadar pengukuhan asas bagi tanah lembut melalui pelbagai kaedah kestabilan tanah telah berjaya menyelesaikan permasalahan ini.

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LIST OF SYMBOLS

$\varepsilon_x, \varepsilon_y, \varepsilon_z$	-	Normal strains
$\sigma_x, \sigma_y, \sigma_z$	-	Stress components
$\tau_{xy}, \tau_{xz}, \tau_{yz}$	-	Shear-stress components
$\gamma_{xy}, \gamma_{xz}, \gamma_{yz}$	-	Shear strains
σ'	-	Effective stress
σ	-	Total stress
u	-	Pore water pressure
φ	-	Friction angle
c	-	Cohesion
ψ	-	Dilatancy angle
E	-	Young's modulus
v	-	Poisson's ratio
E_o	-	Initial modulus
γ	-	Dry Unit Weight
x	-	Displacement
EA	-	Normal Stiffness
θ	-	Angle
ρ	-	Density

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In pavement engineering, either highway or runway as an infrastructure, a pavement encompasses three important part namely traffic load, pavement and subgrade. Pavement generally comprises granular materials with unbounded or bounded materials located between traffic load and subgrade, distributing the load to surface of subgrade. The construction of pavement on weak ground often requires the soil to be improved in order to ensure the safety and the stability.

Government of Malaysia had been promises to construct a new Borneo new link highway that can't avoid this such area Sarawak coastal area. The 'soft soil problem' such as the settlement of soft soil foundation has become one of the key problems for foundation design. When a road embankment is constructed over soft soil, there is a surcharges or an increase of stress in the soft ground including the strain or settlement. If the surcharge load due to filling and constructions traffic load is high near the ultimate bearing capacity of the supporting soft ground, excessive yielding or plastic deformation in vertical and lateral direction of the soft ground will occur and followed by tension crack, deep seated rotational slip when deformation is large and extensive.

In condition where problematic surfaces carry risks for engineering constructions, surfaces can be adapted as expected with various soil improvement methods. Bored pile, soil injection, stone column, vibro compaction, jet grouting dewatering, compaction, preloading with and without vertical drains, grouting, deep mixing, deep densification and soil reinforcement are common methods used for this

aim. Previous similar projects are of importance in order to determine the suitable soil improvement method in relation to project. By using PLAXIS 2D, with support by an actual field data form site investigation (S.I) work report can generate the best way of subgrade stabilization.

1.2 Problem Statement

Soft soil present several challenges for the geotechnical engineer as they pose problems related to stability and settlements. Soft soil covers the majority of West Coast and East Coast of Peninsular Malaysia and in Sarawak, the largest state in Malaysia, has the biggest reserve of soft soil such as peat land. For a several decades engineer try to avoid those such area but since the growth of population and development, the peat and soft soil has to be use for infrastructure such as housing estate and new roadway.

Sarawak has approximately 1,657,600 ha. of tropical peat that covers 13% or the total land area (12.4 million ha.). It is the largest area peat land in Malaysia. It constitutes nearly 63% of the total peat land of the country. More than 80% of the peat more than 2.5m depth (Khing, 2014).

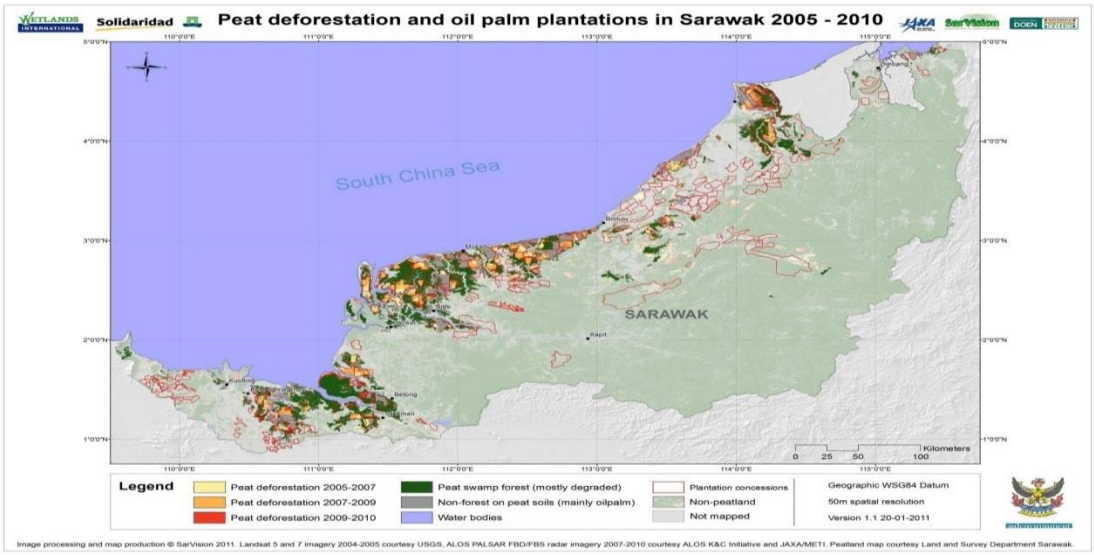

Figure 1.1: Distribution of peat in Sarawak (Land and Survey Department Sarawak, 2011)

Table 1.1: Areas under peat in the various administrative divisions in Sarawak sq. km (Singh et al,1997)

Division	Area (sq. km)
Kuching Administration Division	23,059
Samarahan Administration Division	192,775
Sri Aman Administration Division	283,076
Sibu Administration Division	540,800
Sarikei Administration Division	169,900
Bintulu Administration Division	146,121
Miri Administration Division	276,579
Limbang Administration Division	25,300
Total	1,657,600

With the rapidly development of highway and building construction, the settlement of soft soil foundation has become one of the key problems for foundation design. Construction over peat deposits always creates special problems due to the poor engineering properties of peat soil. Excessive settlements comprise the major problem associated with the highly compressible nature of peat soil. Low shear strength often causes stability problems in peat soils when they are subjected to external loading. Creep settlements that occur after the construction of the road pavement will lead to significant problems (Ismail Bakar, 2014).

Figure 1.2: Site Location Jalan Matang Baru, Phase 1,Kuching

Figure 1.3: Site Location Jalan Matang Baru, Phase 1,Kuching

Excessive and uneven settlement is very often to be characterizing by pavement rutting, distortion, undulation or lateral tilt, change of chamber or super elevation on road surfacing. Pavement distortion or localizes depression may result in pavement surface rutting and ponding. These problems can end up in damage in drains, culverts, buried utilities and traffic hazard to road user (Alvin Lopez, 2010).

Figure 1.4: Site Location Jalan Matang Baru, Phase 1,Kuching

Figure 1.5: Site Location Jalan Matang Baru, Phase 1,Kuching

1.3 Research Objectives

The aim of this research study is to identify the most suitable stabilization method for subgrade in soft soil which will be cost effective. There are three objectives proposed in this research study: -

i. To develop model of subgrade using PLAXIS 2D.

ii. To monitor the displacement and settlement of subgrade in soft soil.

iii. To propose ground improvement of subgrade and monitor the settlement.

1.4 Research Scope

This research based on the specific scope in order to ensure the precision of the research area and also to achieve research objectives. The site location limited for Jalan Matang Baru, Phase 1, Kuching, Sarawak. The input data, such as soil properties are based on site investigation (S.I) work report, sourced from the Central Material Laboratory, JKR Sarawak used to generate the best way of subgrade stabilization by PLAXIS 2D.

Figure 1.6: Arial view site location (Google Maps, 2014)

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