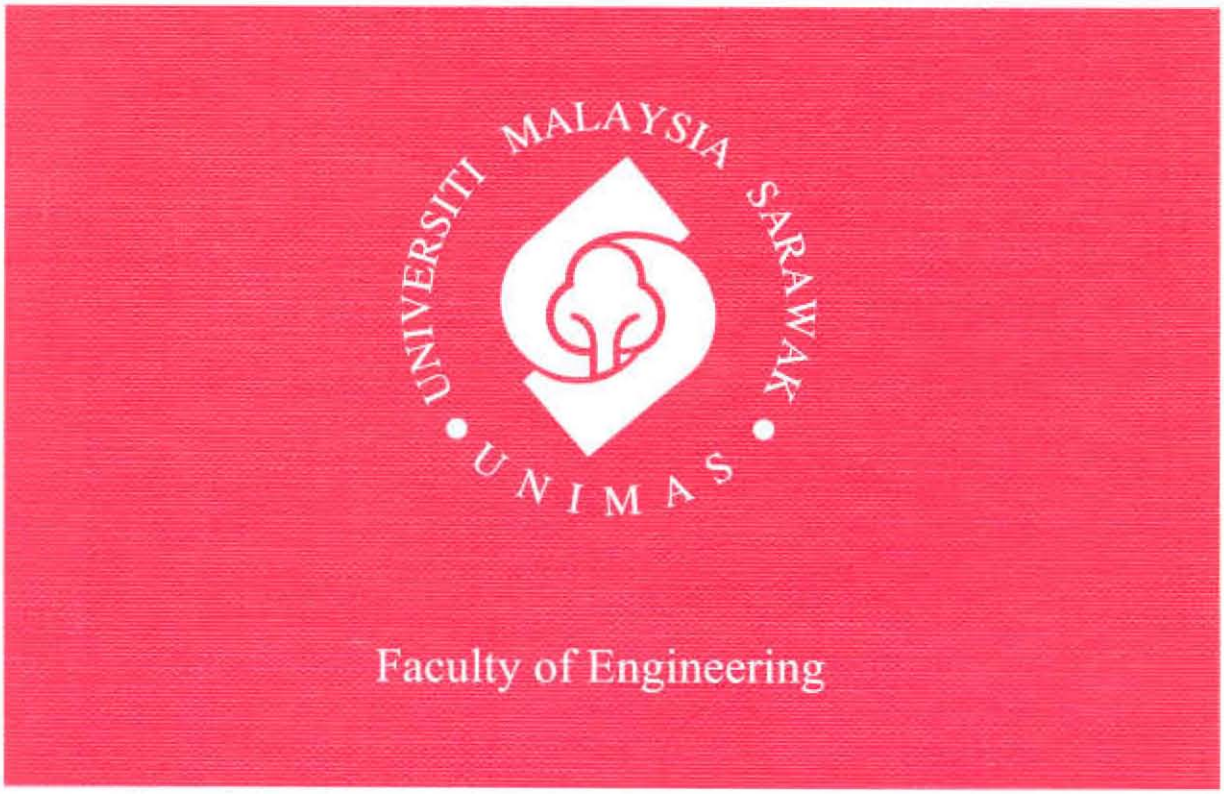

CHEMICAL STABILIZATION OF PRETREATED AMORPHOUS PEAT VIA CEMENT AND FLY ASH WITH LIME

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Bachelor of Engineering with Honours
(Civil Engineering)
2017

UNIVERSITI MALAYSIA SARAWAK

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CHEMICAL STABILIZATION OF PRETREATED AMORPHOUS PEAT VIA CEMENT AND FLY ASH WITH LIME

DAYANG IZZATIE BINTI AWG DAHLAN

The project is submitted in partial fulfilment of the requirement for the
Degree of Bachelor of Engineering with Honours
(Civil Engineering)

Faculty of Engineering
Universiti Malaysia Sarawak

2017

Dedicated to my beloved parents, Awg Dahlan Awg Rambli and Sabariah Mantaris, my siblings, lecturers and friends.

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ABSTRACT

Peat soil is one of the problematic soils known for being extremely soft and weak. However, ground improvement techniques can be opted to improve the strength of peat soil. There are various methods of ground improvement technique including chemical stabilization method. Since peat has a high organic and fiber content and acidic, it is difficult to achieve the expected strength after chemical stabilization. Due to that, the aim of this study is to improve the compressive strength of amorphous peat through pretreatment and by using the most efficient chemical stabilizers. In this study, peat samples were collected from Kpg Meranek, Kota Samarahan and mixed at its natural moisture content with cement and fly ash plus lime at water to additive ratio of 3.0 and 3.5. The compressive strength of the samples was obtained by unconfined compressive strength (UCS) test. The results of the study have shown that the unconfined compressive strength values obtained after 28 days and 60 days curing period are insignificant. The peat samples that are pretreated and chemically stabilized using cement at 3.0 water to additive ratio recorded the highest value with UCS value of 16.042 kPa after 60 days of curing. The values obtained are very low compared to published data from other studies. However, the pretreated chemically stabilized peat samples have shown strength development compared to original peat samples without pretreatment and chemical stabilizers.

ABSTRAK

Tanah gambut merupakan salah satu daripada tanah bermasalah yang terkenal sebagai sangat lembut dan lemah. Walau bagaimanapun, teknik penambahbaikan tanah boleh dipilih untuk meningkatkan kekuatan tanah gambut. Terdapat pelbagai kaedah teknik penambahbaikan tanah termasuk kaedah penstabilan kimia. Memandangkan gambut mempunyai kandungan organik dan serat yang tinggi dan berasid, sukar untuk mencapai kekuatan yang diharapkan selepas penstabilan kimia. Oleh sebab itu, tujuan kajian ini adalah untuk meningkatkan kekuatan mampatan tanah gambut amorfus melalui rawatan awal dan dengan menggunakan kimia penstabil yang paling berkesan. Dalam kajian ini, sampel tanah gambut telah dikumpulkan dari Kampung Meranek, Kota Samarahan dan dicampurkan pada kandungan kelembapan semula jadi dengan simen dan abu terbang ditambah kapur dengan nisbah sebanyak 3.0 air terhadap 3.5 bahan tambahan. Kekuatan mampatan sampel telah diperolehi dengan ujian kekuatan mampatan tidak terkurung (UCS). Hasil kajian telah menunjukkan bahawa nilai kekuatan mampatan tidak terkurung yang diperolehi selepas 28 hari dan 60 hari tempoh pengawetan adalah tidak penting. Sampel tanah gambut yang telah dirawat awal dan dikimiastabilkan menggunakan simen pada nisbah 3.0 air terhadap bahan tambahan mencatatkan nilai tertinggi dengan nilai UCS sebanyak 16,042 kPa selepas 60 hari pengawetan. Nilai-nilai yang diperolehi adalah sangat rendah berbanding data yang diterbitkan dari kajian lain. Walau bagaimanapun, sampel tanah gambut yang telah dirawat awal dan dikimiastabilkan telah menunjukkan pembangunan kekuatan berbanding sampel gambut asal tanpa rawatan awal dan kimia penstabil.

TABLE OF CONTENTS

		Page
Title		ii
Dedication		iii
Acknowledgement		iv
Abstract		v
Abstrak		vi
Table of Contents		vii
List of Tables		x
List of Figures		xi
List of Symbols		xiv
List of Abbreviations		xvi
List of Appendices		ix
CHAPTER 1 INTRODUCTION		
1.1	Background of the study	1
1.2	Problem Statement	3
1.3	Aim and Objectives of the Study	6
1.4	Scope of the Study	6
1.5	Significance of the study	7
1.6	Organization of Thesis	7
CHAPTER 2 LITERATURE REVIEW		
2.1	Definition and formation of peat	9
2.2	Distribution of peat	11
2.3	Properties of Peat	12
2.4	Common chemical stabilizer used for peat stabilization	16
2.5	Peat stabilization using cement	19
2.6	Peat stabilization using fly ash	20

Page

2.7 Peat stabilization using lime 23

2.8 Peat stabilization using combined chemical stabilizers 24

2.9 Peat stabilization after pretreatment 27

2.10 Comparison on Strength Properties from Various Peat Stabilization Studies in Sarawak 28

2.11 Peat stabilization in the field 30

2.12 Summary of literature review 31

CHAPTER 3 METHODOLOGY

3.1 Introduction 32

3.2 Materials 34

3.2.1 Cement 34

3.2.2 Fly Ash 35

3.2.3 Lime (CaO) 35

3.3 Peat sampling 36

3.4 Field Vane Shear Test 37

3.5 Degree of humification 38

3.6 Geotechnical properties of peat 38

3.6.1 Moisture content 38

3.6.2 Loss on Ignition and Organic content 39

3.6.3 Fiber Content 40

3.6.4 Specific gravity 40

3.6.5 pH 41

3.6.6 Liquid Limit 42

3.6.7 Linear shrinkage 42

3.7 Determination of Unconfined Compressive Strength (UCS) 43

3.7.1 Preparation of sample 43

3.7.2 Testing the sample using UCS test 44

Page

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Mix Design 46

4.2 Geotechnical Properties of Peat 47

4.3 Field Vane Shear Test 50

4.4 Unconfined Compressive Strength (UCS) test 51

4.5 Failure condition of pretreated and chemically stabilized peat samples 57

4.5.1 Failure condition of pretreated peat samples stabilized using cement 57

4.5.2 Failure condition of pretreated peat stabilized using fly ash plus lime 60

4.6 Summary of Results 62

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions and achievement of objectives 63

5.2 Recommendation 64

REFERENCES **65**

APPENDICES **68**

Appendix A: Physical Properties of Peat 68

Appendix B: UCS test results after 28 days curing period 71

Appendix C: UCS test results after 60 days curing period 83

Appendix D: Failure condition of first trial 94

Appendix E: Moisture content of samples after stabilization 95

LIST OF TABLES

		Page
Table 2.1:	Division of peat area distinguish by countries	11
Table 2.2	Degree of humification based on Von Post 1920	14
Table 2.3:	Malaysian Soil Classification System for Engineering Purposes	15
Table 2.4:	Categories of Fly Ash	17
Table 2.5:	Comparison of previous studies on peat stabilization in Sarawak	29
Table 3.1:	Physical Properties of Type 1 OPC	34
Table 3.2:	Chemical compositions of CMS Sdn Bhd Type 1 OPC	34
Table 3.3:	Chemical compositions of fly ash from Sejingkat Power Station	35
Table 3.4:	Physicochemical information of CaO	36
Table 4.1:	Peat stabilization with cement	46
Table 4.2:	Peat stabilization with fly ash and lime	47
Table 4.3:	Basic Properties of Kampung Meranek, Kota Samarahan	48
Table 4.4:	Comparison between untreated and chemically stabilized peat and pretreated and chemically stabilized peat after 28 days	54
Table 4.5:	Comparison between untreated and chemically stabilized peat and pretreated and chemically stabilized peat after 60 days	56

LIST OF FIGURES

Page

Figure 1.1:	Global Peatland Distribution	2
Figure 1.2a:	Typical section of a housing estate on peat immediately after completion of construction	3
Figure 1.2b:	Typical section of a housing estate on peat several years after completion of construction	3
Figure 1.3:	Settlement at housing area in Sibu, Sarawak	4
Figure 1.4:	Ground settlements at commercial lot in Sibu, Sarawak	4
Figure 2.1:	Stages of peat formation	10
Figure 2.2:	Major peat lands areas in Sarawak	12
Figure 2.3:	Graph of UCS values against Percentages of Fly Ash	21
Figure 2.4:	Graph of UCS Values against Curing time (days)	21
Figure 2.5:	Graph of UCS values against Percentages of Fly Ash	22
Figure 2.6:	Graph of CBR values against Percentages of Fly Ash	22
Figure 2.7:	Graph of UCS values against Percentages of lime	23
Figure 2.8:	Graph of UCS values against Percentages of lime	24
Figure 2.9:	Graph of UCS values against different percentages of Fly Ash cured for 7 days	25
Figure 2.10:	Graph of UCS values against different percentages of Fly Ash cured for 14 days	25
Figure 2.11:	Graph of UCS values against different percentages of Fly Ash cured for 28 days	26
Figure 2.12:	Graph of UCS values against different percentages of Fly Ash and Quicklime	26

Page

Figure 2.13: Graph of UCS values against curing period (a) untreated peat (b) treated peat using OPC 27

Figure 2.14: Graph of UCS values against curing period (a) untreated peat (b) treated peat using FA 28

Figure 2.15: Kipali roundabout 30

Figure 2.16: DSM process 30

Figure 3.1: Flowchart summary of methodology of the study 33

Figure 3.2: Sampling Location 36

Figure 3.3: Field Vane Shear Test 37

Figure 3.4: Von Post Classification Test 38

Figure 3.5: 50ml glass bottle filled with peat and kerosene 41

Figure 3.6: Cone penetration test 42

Figure 3.7: Compressed and levelled peat sample 44

Figure 3.8: Samples sealed airtight for curing 44

Figure 4.1: Von Post Classification test 48

Figure 4.2: Vane shear strength profiles 50

Figure 4.3(a): Unconfined compressive strength of untreated and chemically stabilized peat at 28 days 52

Figure 4.3(b): Unconfined compressive strength of pretreated and chemically stabilized peat at 28 days 52

Figure 4.4: Peat without stabilizer after 28 days curing 53

Figure 4.5: UCS values for untreated and pretreated peat, and chemically stabilized at 28 days 54

Figure 4.6(a): UCS values of untreated and chemically stabilized peat at 60 days 55

Page

Figure 4.6(b): UCS values of pretreated and chemically stabilized peat at 60 days 55

Figure 4.7: UCS test results for 3.0 W/A ratio samples after 28 days and 60 days curing 57

Figure 4.8: Failure condition of 3.0 W/A ratio pretreated and cemented peat after 60 days 58

Figure 4.9: UCS test results for 3.5 W/A ratio samples after 28 days and 60 days curing 59

Figure 4.10: Failure condition of 3.5 W/A ratio pretreated and cemented peat after 60 days 59

Figure 4.11: UCS test results for 3.0 W/A ratio samples after 28 days and 60 days curing 60

Figure 4.12: Failure condition of 3.0 W/A ratio pretreated and chemically stabilized peat using fly ash with lime after 60 days 60

Figure 4.13: UCS test results for 3.5 W/A ratio samples after 28 days and 60 days curing 61

LIST OF SYMBOLS

Al_2O_3	-	aluminium oxide
C	-	carbon
Ca	-	calcium
Ca^{2+}	-	calcium ions
CaCO	-	calcium carbonate
CaO	-	calcium oxide
$Ca(OH)_2$	-	calcium hydroxide
C-S-H	-	calcium sikicate hydrate
C_2ASH_8	-	stratlingite
C_4AH_{13}	-	tetra calcium aluminium hydrate
cm	-	centimeter
Fe_2O_3	-	iron oxide
g	-	gram
G_s	-	specific gravity
H_2O	-	water
ha	-	hectares
K_2O	-	potassium oxide
kg	-	kilogram
kN	-	kilonewton
kPa	-	kilopascal
l	-	liter
m	-	meter

mm	-	millimeter
MgO	-	magnesium oxide
MnO	-	manganese (II) oxide
NaOH	-	sodium hydroxide
Na_2O	-	sodium oxide
O	-	oxygen
pH	-	potential of hydrogen
P_2O_5	-	phosphorus pentoxide
SiO	-	silicon monoxide
SiO_2	-	silicon dioxide
SO_3	-	sulphur trioxide
TiO_2	-	titanium dioxide

LIST OF ABBREVIATION

ASTM	-	American Society for Testing and Materials
BS	-	British Standard
CBR	-	California Bearing Ratio
CMS	-	Cahya Mata Sarawak
DSM	-	Deep Soil Mixing
CBR	-	California Bearing Ratio
CMS	-	Cahya Mata Sarawak
FA	-	Fly Ash
FC	-	Fiber Content
LL	-	Liquid Limit
LOI	-	Loss on Ignition
OC	-	Organic Content
OPC	-	Ordinary Portland Cement
QL	-	Quicklime
UCS	-	Unconfined Compressive Strength
USCS	-	Unified Soil Classification System
W/A	-	Water to Additive

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Peat soil is one of the problematic soils known for being extremely soft and weak. It is also highly compressible and has a low bearing capacity. Due to its characteristics, peat soil is susceptible to excessive settlement when even moderate load increment is subjected to it (Huat et al. 2005). Consequently, it is considered as difficult ground conditions where construction of civil engineering structures can be quite challenging and tedious. Thus, constructions on peat or any other weak soil are usually avoided as much as possible to prevent any structure collapse or failure and to reduce the risk of harming people's lives.

Peat covers an extensive area around the world with Malaysia being the 9th country with the highest total area of peat (Adon et al. 2012); having peatland area of about 2.5 million ha (8%) of total land around the world as shown in Figure 1.1. According to Davies et al. (2010), the largest area of peat is located in Sarawak with about 1.7 million ha (69%), followed by Peninsular Malaysia with about 0.6 million ha (26%), then Sabah with about 0.1 million ha (5%). Since Sarawak holds the largest area of peat in Malaysia, construction on peat soil could not be avoided especially with the increasing demand of land due to development. Hence, ground improvement techniques are opted to improve the strength of peat soil.

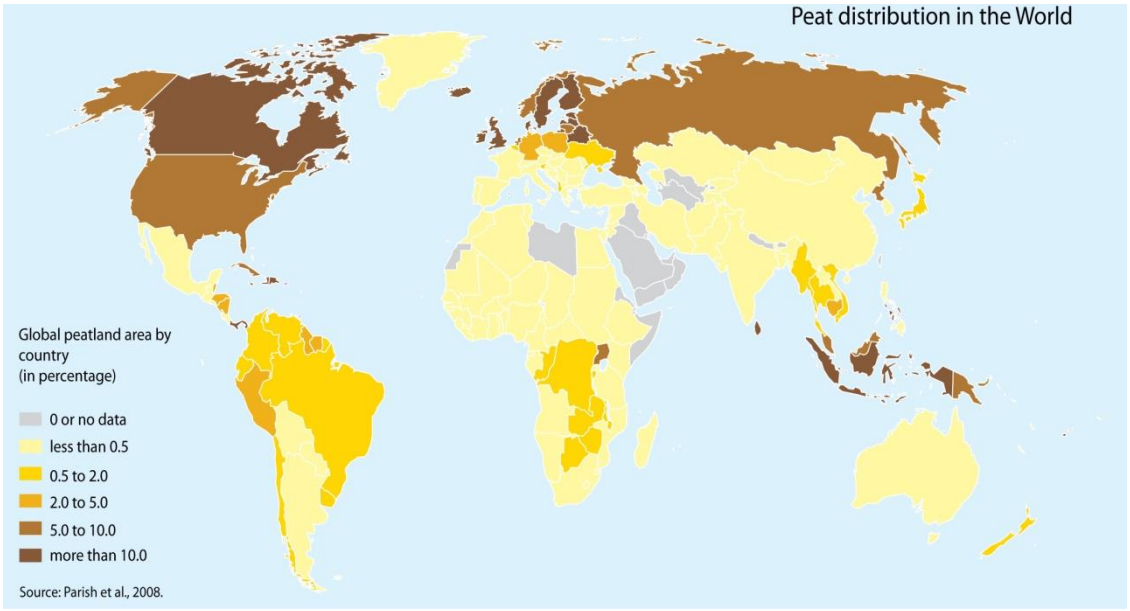

Figure 1.1: Global Peatland Distribution (Joosten, 2009)

There are various methods of ground improvement technique such as displacement and replacement method, preloading and surface reinforcement, deep stabilization method, pile support method, chemical stabilization, lightweight fill method and others (Huat et al. 2014). These methods are relatively expensive with chemical stabilization being the least expensive method to stabilize peat.

There are many researches on chemical stabilization of peat using different types of chemical stabilizers or additives to modify the geotechnical properties of peat and to increase its strength. Some of the researches are stabilization of peat using cement (Aminur et al. 2009; Boobathiraja et al. 2014; Huat et al. 2005; Kazemian et al. 2011; Sing et al. 2009b); fly ash (Kolay & Pui 2010; Rahman & Kolay 2011); lime (Boobathiraja et al. 2014; Huat et al. 2005) and combined additives (Aminur et al. 2009; Kalantari & Huat 2010; Kolay & Aminur 2011; Said & Taib 2009; Sing et al. 2009a)

1.2 Problem Statement

The stability of a structure depends on the stability of its foundation or the ground. It is crucial that the strength of the ground is sufficient to withstand the loads subjected to it. Soft or weak soils such as peat or any other organic soils are usually excavated and replaced with soil of a higher strength prior to construction or building of civil engineering structures. According to Huat et al. (2005), although the constructions of structures on peat soil are possible with the use of piles, the ground around the structures may still settle as shown in Figure 1.2.

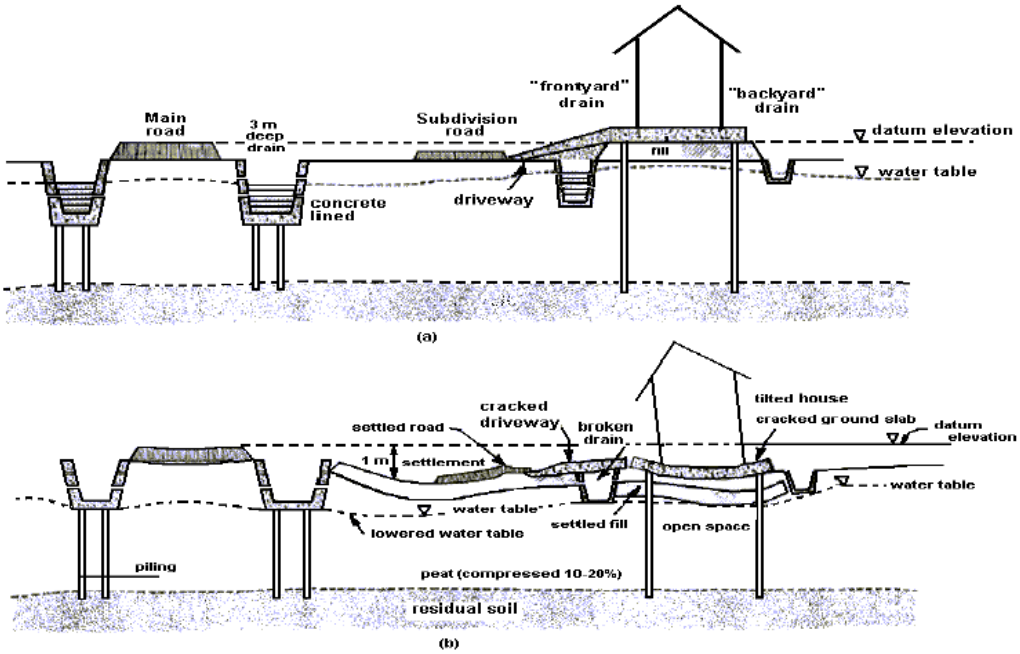

Figure 1.2: Typical section of a housing estate on peat (a) Immediately after completion of construction (b) Several years after completion of construction (Huat et al. 2005)

There are few cases of excessive settlement in Sarawak such as settlement at housing area and commercial lot in Sibu as shown in Figure 1.3 and Figure 1.4.

Figure 1.3: Settlement at housing area in Sibu, Sarawak (Adon et al. 2012; Kolay et al. 2011)

Figure 1.4: Ground settlements at commercial lot in Sibu, Sarawak (Kolay et al. 2011)

In Sarawak, the construction on peat soil could not be avoided due to its extensive area of peatlands and limitation of land with stronger soil. Replacing peat soil with any stronger types of soil can be quite expensive due to the large area of peat.

Therefore, ground improvement techniques are implemented as a solution to provide stronger foundations. Chemical stabilization is one of the techniques that have been garnering attention as this method was often successfully used to treat peat soil and the least expensive method to stabilize peat (Kolay et al. 2011).

However, peat has a high organic and fiber content and also acidic with pH levels as low as 3.5 (Davies et al. 2010) thus making it difficult to achieve the expected strength after chemical stabilization. The low pH level is caused by the high humic and fulvic acid content resulted from the humification of the plant remains (Lam, 1998).

According to Cook et al. (1998), humic acids are soluble in water under alkali condition while fulvic acids are soluble in water at both acidic and alkali condition. Thus, Kolay et al. (2011) used sodium hydroxide which is an alkali to reduce the acidity of peat prior to chemical stabilization of peat with different chemicals. From the study, the peat samples that were treated with sodium hydroxide showed better results than the untreated peat.

Fly ash is one of the additives that are often used in the studies of chemical stabilization of soil. It is produced from burning of coal ash or industrial wastes. The abundance production of fly ash can actually contribute to pollution. Therefore, utilizing fly ash in chemical stabilization of peat can be a mean of reducing the pollution.

1.3 Aim and Objectives of the Study

The aim of this study is to improve the compressive strength of amorphous peat by pretreating it with suitable alkali and by using the most efficient chemical stabilizers.

The specific objectives of this study are:

i. to analyse the geotechnical properties of pretreated chemically stabilized peat via UCS test,
ii. to compare the effect of various water to additive ratio on the pretreated chemically stabilized peat,
iii. to compare the UCS values between untreated chemically stabilized peat, and pretreated chemically stabilized peat.

1.4 Scope of the Study

This study concentrates on chemical stabilization of pretreated amorphous peat obtained from Kota Samarahan, Sarawak. The peat shall be pretreated using suitable alkali and chemically stabilized using the most efficient chemical stabilizers. An analysis of previous studies from other researchers has been done in order to choose suitable alkali and the most efficient chemical stabilizer with optimum mixing quantity. The peat shall be pretreated and chemically stabilized in a laboratory condition while maintaining the moisture content of the original peat sample. Therefore, the water to additive ratio will vary in the mixing. The geotechnical properties of the peat such as moisture content, specific gravity and dry density will be determined and utilized in performing the stabilization. The strength of the pretreated and chemically stabilized peat will be determined through Unconfined Compressive Strength (UCS) test.