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Faculty of Engineering and Quantity Surveying

A STUDY ON ENGINEERING PROPERTIES OF SOIL USING FLY ASH STABILIZER

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SUPERVISOR'S DECLARATION

This project report entitled A Study on Engineering Properties of Soil Using Fly Ash Stabilizer is prepared and submitted by Foong Kah Seng I12001296 as partial fulfilment of the requirement for Bachelor of Engineering (HONS) in Civil Engineering, INTI International University.

APPROVED BY DATE

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STUDENT'S DECLARATION

I hereby declare that the final year project is based on my original work except for quotation and citation, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any degree at INTI INTERNATIONAL UNIVERSITY or other institution.

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ABSTRACT

Chemical stabilization has been extensively used for the improvement of weak soil, in improving the shear strength as well as limiting the deformation behaviour of the ground. Plenty of researches regarding the effectiveness of using industrial waste as a chemical stabilizer are also increased rapidly. The aim of this research is to evaluate the engineering properties of Nilai weak soil mixed with fly ash which is an industrial waste. This research present the stabilization of Nilai weak soil using Class C fly ash at varying stabilizer contents (5%, 10%, 15%, 20% and 25%). Classification of soil such as Liquid Limit test, Plastic Limit test, Sieve Analysis and Standard Proctor test were carried out to determine the properties, optimum moisture content and maximum dry density of the untreated soil. The basic properties of soil such as Unconfined Compression test (UC) and California Bearing Ratio test (CBR) were used to gauge the behaviour and the performance of the stabilized soil. From the analysis of the results, the addition of fly ash increase the shear strength of the soil. The carried out tests gave some indication that the unconfined compressive strength (UCS) and the California Bearing Ratio (CBR) increase with the increase of percentage of stabilizer and curing period of 3 and 7 days. As a conclusion, the results show that the stabilized soil sample achieved its optimum strength at 20% of fly ash content with 7 days of curing period. At 25% of fly ash content the strength begin to drop as fly ash not a very strong stabilizing agent.

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This research is carried out to enter the geotechnical, physical and mechanical characteristics of the soil that collected from Nilai, Negeri Sembilan. Moreover, there are plenty of geotechnical parameters such as grain size distribution and shear strength of soil were determined. All the testing results will be used to classify the type of soil.

In general, a high permeability, low void ratio, low compressibility, high shear strength and high unconfined compressive strength of soil is needed for every construction. Nevertheless, it is not all the construction site having these good condition of soil thus Engineer have to come up with many solutions in order to solve the weak soil problem by carry out soil modification to build a good foundation.

1.2 Problem Statement

A good construction site required a good quality of soil and a good quality of soil is defined as a soil that is having a greater shear strength and able to support the load applied. One of the construction site at Nilai has been selected as a research area. The existing soil over there is considered as weak soil as the contractors are using conventional method which is trying to remove the top soil and replace it with a stronger soil. Weak soil consist mainly of fine grained particles which is not good for construction. It is because fine grained soil are having low permeability, poorly drained and highly compressibility properties. In this research, modern method which is chemical stabilization has been proposed to stabilize the weak soil in Nilai, Negeri Sembilan where this method is saving time and cost as compare to other method. The stabilizer that proposed to improve the strength of Nilai soil is fly ash. Fly ash is an industrial waste that act as binding agent to the soil to improve the soil shear strength. Therefore, the characteristic of soil has to be determined and the effect of chemical stabilizers is being study for soil strength improvement in this study.

1.3 Objectives

This research is conducted in order to acquire understanding on properties of soil that collected from Nilai, Malaysia for strength improvement. The objectives of this study are as below:

i) To determine the physical and mechanical properties of soil for the soil classification.

ii) To obtain the optimum percentages of stabilizer using fly ash stabilizer with respect to different curing period.

1.4 Scope of study

In this research, the soil sample was collected from Nilai, Negeri Sembilan. The site was currently under cut and fill stage for the construction of multi-stories building, the soil existing underneath was considered as unsuitable soil for the construction to take place. This soil sample was taken from the site in order to study on the basic properties of soil. There are two type of test to be conducted for the soil classification. There are physical test and mechanical test. For physical properties tests, it includes of moisture content test, standard proctor test, sieve analysis test and Atterberg limits test. For mechanical properties test, the tests involve are Unconfined Compression Strength test and California Bearing Ratio test. Stabilizer selected which is fly ash was introduced into the soil sample to increase the shear strength of the soil. The percentages such as 5%, 10%, 15%, 20% and 25% of stabilizer are added into the soil sample respectively so that the maximum shear strength of the soil to support the foundation can be achieved.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are many problems that can be happened in the construction site that may affect the construction design. One of the most frequent problem faced in selecting construction site is due to the weak soil, same problem faced in one of the construction site at Nilai. Malaysia, the site is encountering a major weak soil problem. The most common solution used when dealing with unsuitable soil is by remove the weak soil and replace it with a stronger material. However, the replacement cost was very high and it is not a contractor-friendly solution. There are many others alternative methods that may be used to overcome this problems such as using chemical to stabilize the weak soil, using recycle and reused material to stabilize the weak soil (Edil *et al.*, 2007).

In general, the engineering properties of Nilai soil sample was having low shear strength which are strongly not suitable for building a foundation. Thus action must be taken to overcome this problem. There are actually two general methods that used to stabilize the weak soil. The methods are mechanical and addictive. The effectiveness of soil stabilization is usually determined by the content of stabilizing required as well as the condition encountered by the project itself. Therefore, this chapter is to show the Literature Review to provide clear overview about this study based on the previous researcher (Fauzi *et al.*, 2010).

2.2 Soil Classification

According to AL-Malack *et al.,* (2013), four test were carried out to classify the soil type. The test included Soil Compaction test, California Bearing Ratio (CBR) test, Unconfined Compressive Strength test and Durability test. The compaction test was carried out in accordance with the modified Protor test (ASTMD 1557). It was used to calculate the ultimate dry unit weight and the optimum moisture content of the soil. California Bearing Ration test were conducted according to (ASTMD 1883). Before testing, soil sample were need to cover by plastic sheet and let it cure for one week in room temperature. Unconfined Compression (UC) test was a test that used soil compaction. It was performed according to the (ASTMD 2166). After the soil compaction, the soil sample has to be kept into a room temperature for 3,7,14 and 28 days before testing. The last but not least is durability test. It was conducted under (ASTMD 559) and it was also need to be cure for 7days before testing.

In other research, three samples were prepared to conduct a soil classification test in Virgina, America. The basic properties and the types of soil were identified after conducted the test. The tested soil sample was sandy lean clay which get it from an alluvial deposited area. It belongs to a "fine to medium" sand and trace subrounded gravel with an orangish red color. Based on the soil classification test result, this soil was classified as A-6 according to the AASHTO system. The plasticity index of this soil is 20 and the moisture content of this soil 20.2%. This soil sample is classified as clayey soil due to its specific gravity is lie between the range of 2.7 and 2.9. Table 2.1 below shown the soil classification result for these three soil samples (Geiman, 2005).

Table 2.1: Soil classification result that obtained after the test (Geiman, 2005).

Sample	**Moisture content (%)**	**Atterberg Limits (NP=non plastic)**				**Clay (%)**	**Gs**	**Organic content (%)**	**Sulfate content (%)**	**pH**
		LL	**PL**	**PI**	**Fines (%)**					
Nova Clay	18.4	40	20	20	66	32	2.80	2.7	8.8	4.4
Staunto Clay	24.2	53	25	28	84	9	2.74	3.7	8.5	4.3
Lynchburg Sand	13.8	31	NP	NP	23	3	2.73	2.5	23.7	5.9

2.3 Soil Improvement

A worse soil condition can lead to a construction failure. In order to reduce the risk of construction failure due to the worse soil condition, a study on soil improvement is indeed important in geotechnical engineering. The reason of carry out a soil improvement is to enhance the characteristic of soil so that it can provide a safer foundation of every projects. There are plenty of methods that can be used to improvement the weak soil. For example, surface compaction method, drainage method, vibration method, chemical stabilization method and so on. These methods provides a same function to the problematic soil. There are used to enhance the shear strength, reduce the compressibility, reduce the permeability as well as increase the arte of consolidation of soil so that the soil can become safer (Kirch and Moiseley, 2015).

There were actually plenty of methods that can be applied to a project that deal with soft ground or weak soil. In order to choose the most appropriate method to stabilize the soil, several investigation has to be carried out. Soil stabilization is a method that emphasizes on modified the soil properties so that the problematic soil can reach the specific engineering requirements in term of the shear strength, compressibility as well as permeability (Kirch and Moiseley, 2015).

2.4 Stabilization Method

There are a lot of methods can be used to improve the weak soil. These methods either used to remove and replace the weak soil with a better soil or using soil stabilization method. Soil stabilization methods basically include chemical stabilization and mechanical stabilization. Both methods can be used to enhance geotechnical properties of the weak soils such as the strength and stiffness by treating it in-situ. These two methods probably consist of densifying treatments such as compaction and pre-loading.

Mechanical stabilization can be used to enhance the shear strength of soil as well as improving the strength and stiffness of the weak soil. One of the mechanical stabilization is called effective soft ground improvement in situ deep mixing. This method used to pile columnar inclusion into the soft ground to composite ground. It is a popular solution that mostly

used in South East Asia. Ordinary Portland cement and Lime were mostly used. It was because the mechanism of the stabilization for both stabilizer was well understood by people (Ma Cong *et al.*, 2014).

On the other hand, the chemical stabilization of the weak soil has also been commonly used. In comparison with others soil stabilization method, chemical stabilization will easily get more attention. It is because the techniques that chemical stabilization used are very cheap and convenient. Besides, chemical stabilization are most commonly used in a huge volume of soil improvement. There is plenty of researchers has completed the study on the application of different stabilizer on varies types of weal soil. Summary of previous studies are shown in Table 2.2 (Latifi *et al.*, 2013).

Table 2.2: Comparative studies of stabilization methods for different kinds of weak soils proposed by previous researcher. (cont'd)

Author	**Stabilizer**	**Problematic Soil**	**Efficiency**
Azhani Zukri , 2013	Hydrated Lime	Soft Clay	The lime percentage increase from 2% to 10%. The optimum unconfined compressive stress (UCS) is obtain by adding 6% lime water into the soil sample.
Achmad Fauzia *et al.* 2013	Recycling and Reused Materials- Fly Ash	Clayey soil	The Fly Ash content is increased 0% to 12%. At 12% of fly ash content, the optimum CBR value is obtained.