Identification on the compressive strength of stabilized Compacted Soil by Using Traditional Admixture as Alternative Material in Industry

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Abstract: Soil is a complex material composed essentially of clay minerals and sand with organic and associated minerals which influence soil properties. The purpose of this study is to identify the soil as the alternative raw materials in construction by replacing concrete in retaining walls or foundation. The material that been used in this study were categorized as the main groups of crystalline materials that is residual soil, which are categorized in kaolinite group. Besides that, this material was stabilized using the traditional admixture which was lime and its properties were improved using the compaction method to produce the optimum compressive strength of soil. The compaction method used was the Standard Proctor Test, and the results from the unconfined compressive strength test showed that the compressive strength before and after using the stabilization admixture. The percentage of admixture was determined by the dry weight of residual soil that been used in this test. It also illustrated that residual soil has a potential to contact with cold-formed steel column after being stabilized with traditional admixture which is lime.

Keywords: Compacted Soil, lime, residual soil, Standard Proctor Test, unconfined compressive strength test.

1. Introduction

The excessive use of industrial materials had caused environmental destruction and global warming due to the increase demand for constructions. Therefore, the uses of non-industrial materials have been re-considered. The concept of non- industrial materials means materials manufactured using simple, quick process with low embodied energy, using raw materials, which is the residual soil. In order to minimize the uses of industrial materials, concrete will be replaced by the compacted soil in retaining walls structure and also in structure of foundation.

The type of soil that been used was residual soil and the main group of crystalline materials of this soil is Kaolinite. This type of soil will improved it's characteristics by compaction Budhu (2007).This technique improves the soil by reducing the quantity of voids between grains and thus gives a form of mixture thanks to cohesion. This technique also increases the strength, lowers the compressibility and reduces the flow rate of water (permeability) of soil by rearranging its fabric. The soil fabric is forced into a dense configuration by the mechanical effort used in compaction Gumaste et al. (2007). If a small amount of water is added to a soil which is then subjected to this technique, the soil will be compacted to a certain unit weight. If the moisture content of the same soil is gradually increased and the compaction is done in same way, the dry unit weight of compaction will gradually increase. This is because water behaves as a lubricant between the soils particles, and under compaction it helps rearrange the solid particles into a denser state (Hall and Allinson, 2008).The knowledge of the optimum water content and the maximum dry unit weight soils is very important for this technique as at this state the soils were at its maximum strength. The reason for choose kaolinite as our raw materials was because it is binder that can ensure strength and stabilization (Bui et al. 2008). Besides that, lime was used as an admixture in order to increase the strength of the residual soil. Lime is one of the additives, which is widely used in stabilization of fine-grained soils. Various forms of lime such as hydrated high-calcium lime

($Ca(OH)_2$), monohydrated dolomitic lime ($Ca(OH)_2 - MgO$), and dolomitic quicklime (CaO–MgO), have been successfully used as stabilizing agent for many years. Quick lime (calcium oxide) is delivered in the form of coarse-grained powder. It reacts quickly with water producing hydrated or slaked lime, generating heat and volume change.

Quick lime must be handled with care as its can burn the skin in the presence of moisture. It can also cause corrosion of equipment. The main contribution of lime to the strength of soil is from its ability to create cementation between soil particles. The higher the surface area of the soil, the more effective this process of lime cementation is (Kezdi, 1979).

2. Research Methodology

The main focus in this research were based on three laboratory tests. The first laboratory test is to determine the specific gravity of clay in order to ensure this type of soil was in the kaolinite group. This test was carried out by using the density bottle. The Second laboratory test for this research was standard proctor test, where this test also acted as standard laboratory test to evaluate the maximum dry unit weights and optimum moisture contents .This selected test was used to determine the maximum strength of this soil which has optimum moisture content and zero air void ratio.

Next, the optimum lime content was determined in order to have maximum strength of soil. The required amount of lime to be added to the soil depends on the application. For modification purposes, 2% to 3% lime by dry weight of soil is sufficient. For stabilization purposes, normally 5% to 10% lime by dry weight of the soil is suitable. To determine the optimum lime content for soil stabilization several methods have been suggested. The suggested equation for the optimum lime content (Hilt and Davidson, 1960).as below as the equation 1:

$$\text{Optimum Lime content by Weight} = \text{\% of clay by } \frac{\text{weight} + 1.25}{35} \quad (1)$$

Unconfined compression test was the last laboratory test in this research. The main purpose of this test was to determine the maximum compressive strength of residual soil. This test was carried out after the optimum moisture content of this soil has been recorded and the percentage of water for optimum moisture content was used as the sample for unconfined compression test. After that the unconfined compression test for the optimum lime content was carried out.

3. Results and Discussion

Based on the data for determine the specific gravity of this soil as shown in Table 1, the result of G_s was 2.46, which belongs to the group of mineral kaolinite (Braja, 2006).

Table 1. Results of Specific Gravity Test

Density bottle no.	1	2	3
Mass of dry soil used (gm)	9.5	8.5	9.0
Mass of water used (gm)	46.0	46.0	46.0
Mass of water to fill density bottle (gm)	49.5	49.5	50.0
Temperature (^0C)	27	27	27
Specific gravity (Mg/m^3)	2.71	2.43	2.25
Average specific gravity (Mg/m^3)	2.46		

Therefore, this soil is the exact material to be used in this research, as we need to use the soil from the kaolinite group. For the second laboratory test which was the standard proctor test, the results is shown in figure 1 below.

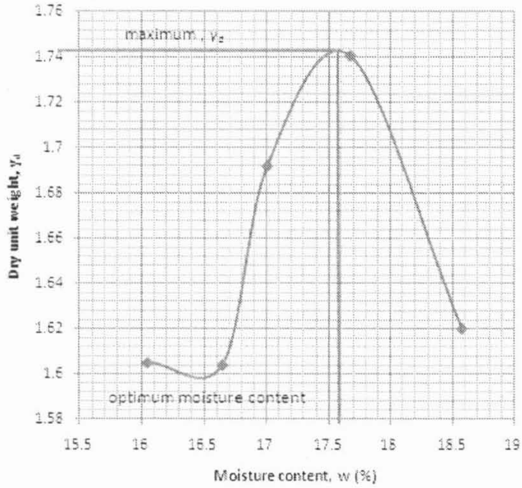

Fig. 1 Standard Proctor Test result for Kaolinite soil

By knowing the maximum dry unit weight and the optimum moisture content from the graph above, the maximum strength of this soil can be determined by obtaining the exact volume of water baesd of th result that we get uisng Eq 2.[1]

$$w = \frac{W_w}{W_s} \times 100\% \quad (2)$$

To determine the optimum lime content for soil stabilization, we can use the Eq. 1 as follow:

$$\text{Optimum Lime content by Weight} = \% \text{ of clay by } \frac{\text{weight} + 1.25}{35} \quad (1)$$

As a result, the volume of water needed to be added in 5.5kg of soil was approximately 924 ml, in order to have the optimum moisture content and the maximum dry unit weight of this clay, to determine the unconfined compressive strength of the soil with the optimum moisture content. Futhermore, the volume of lime need to be added in 5.5 kg of dry soil was approximately 550ml of lime in order to have the optimum moisture content.

The result for the unconfined compressive strength test using the 38 mm diameter X 88 mm specimen is shown in the figure 2 below.

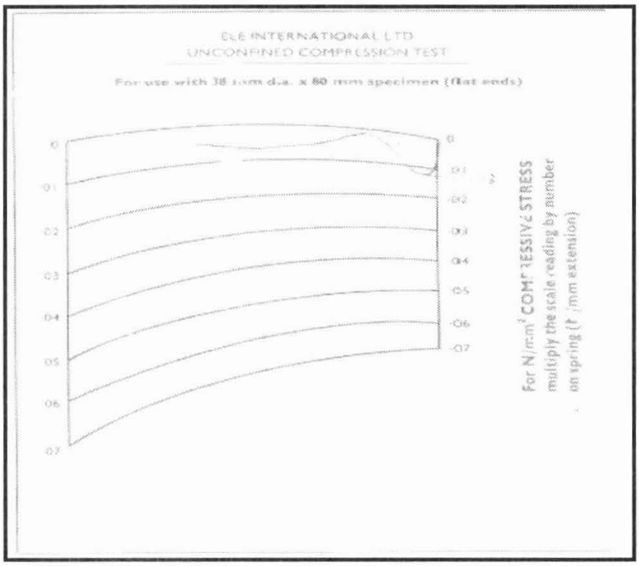

Fig. 2 Unconfined Compressive Stress Test

From the figure 2 above, 0.013 will be multiplied by 6 as the coeficient of the spring and the result of the unconfiend compressive strength was 78KN/m^2 which is in the range of 48-96 KN/m^2 for the medium consistency.

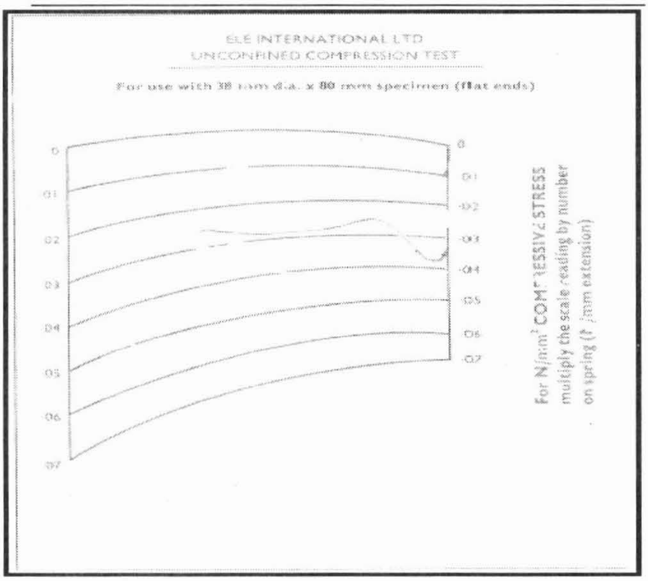

Fig. 3 Unconfined Compressive Stress Test with Lime

From the figure 3 above, 0.038 will be multiplied by 8 as the coeficient of the spring and the result of the unconfiend compressive strength was 304KN/m^2 which is showed the strong consistency.

4. Summary

To conclude, the objective of this research was achieved as we can conclude the value of the compressive strength of Kaolinite residual soil in optimum moisture content and maximum dry unit weight condition without lime and with lime. Futhermore, this is the breaking point for the future research in the uses of this non-industrial materials as it has a quite high compressive strength as shown in table 2 below :

Table 2. Compresive Strength of Residual Soil

PROPERTIES	RESIDUAL SOIL	RESIDUAL SOIL+ ADMIXTURE LIME
Compresive strength	78KN/m^2	304KN/m^2

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