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A Study on the Unconfined Compressive Strength (UCS) of Peat Stabilization Admixed with Ceramic Dust

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Abstract:
Peat soil is categorized as the challenging soil due to its high compressibility, high in natural moisture content and low shear strength. Various alternatives were proposed for construction on peat soils. The present study deals with the effect of additives on the strength of the peat stabilized with ceramic dust. Peat sample wascollected from Air Baloi, Pontian, Johorand were mixed with ceramic dust from 2%, 4%, 6%, 8% and 10% by dry weight of peat. The development of unconfined compressive strength (UCS) strength of stabilized peat admixed with ceramic dust over a curing period of 3days, 7days, 14days and 28days was studied. From the analysis of test results it was found that (UCS) increased with an increased in ceramic dust content. From this finding, it was found that ceramic dust up to 8% can be increased the strength of peat.

Keywords: *Peat stabilization, ceramic dust, unconfined compressive strength*

1. Introduction

Peat is generally defined as a soil which has accumulated partially decomposed plant and animal residues under anaerobic condition (Cayci*et al*., 2011). Peats are found in many places around the world. In Malaysia, peat soil areas represent 2.7 million ha and this value is 8% of the total area of Malaysia (DIDS, 2008). The distribution of peat soils is mostly situated near to coastal areas of Johor, Pahang, Selangor and Perak while the largest section of peat soil in Malaysia was found in Sarawak that covers 1.66 million ha, representing 13% of the state area (Said and Taib 2009). It is a mixture of finely divided particles with organic matter, in some

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instances visible fragments of partly decayed vegetable matter, and shells are also present in the organic matter (Edil, 2011; Z. Adnanz et al, 2016). Stabilization of soil is one of the most important criteria that should be considered for construction on soft soil. It is well known that stability of ground will affect the stability of the structure above it and there are many types of soil to deal with, depending on the area, its location, its surroundings and various other factors (Noraiin et al., 2016 ;Azura and Adnan,2019 and Adnan et al., 2019). Stabilization of peat soil focuses on increasing the strength of this soft and highly compressible soil. It is done to improve the ability of the soil to perform well by increasing its strength and decreasing the excessive settlement when soil is subjected to loads (Said, and Taib, 2009; Ikeagwuani and Nwonu, 2019; Nazatul et al, 2019).

This research is in line with the government's aspiration as mentioned in the 11th Malaysian Plan under the 4th Strategic Thrust to pursue green growth for sustainability and resilience by reusing ceramic waste from tile production plants and construction industries for stabilization of peat. This will promote greener and sustainable soil improvement method for Malaysian peat. Concurrently, this study also will be in accordance with 5th Strategic Thrust to strengthen infrastructure to support economic expansion. By improving engineering properties and having a better understanding of Malaysian peat, it will help authorities and geotechnical engineers improve designs for long-lasting infrastructures on peat area.

Development is growing day by day, there is a lot of waste from the site being dumped and not reused. CIDB estimates that construction and demolition work represents more than 30 percent of total waste in Malaysia. Therefore, in order to avoid this, ongoing studies have been conducted on material waste from industry to evaluate the characteristics of material waste. The material of broken ceramic tiles collected from a demolition site and this material cannot reuse. It is not only to improve the strength of the peat soil, but has also a positive environment impact.

Recently, tiles have been presented as ecologically agreeable soil stabilizers to fathom the developing issue of waste material and produce an engineered soil that can withstand the substantial loads. In the case of ceramic tiles, the waste sum to 7% during generation process, which causes water, air and soil pollution if not utilized. The utilization of ceramic tiles in the stabilization of peat soil will considerably help resolve the previously mentioned contamination issue (Al-Bared *et al*., 2018).

2. Material and Method

The material that was used in this study included ceramic dust that was used as the primary stabilizer which was an industrial waste used as respective admixture. The peat used for the study collected from Air Baloi, Pontian Johor. The properties of the peat were tested in the laboratory and the results are summarized in the Table 1.

Table 1. Properties of Pontian Peat

No.	Properties	Value
1.	Degree of humification	H8 (Amorphous peat)
2.	Moisture content	794.7%
3.	pH	3.1 (acidic)
4.	Specific gravity	1.38
5.	Organic content	97.69%
6.	Fibre content	27.98% (Amorphous)
7.	Liquid Limit	188%
8.	Optimum Moisture content	67.5%
9.	Maximum dry Density	606.0kg/m^3

The broken/ waste ceramic tiles used in this study were collected from a local supplier in Johor. These tiles were broken into a small pieces by using a rubber hammer. The smaller pieces were put into a Los Angeles Abrasion Testing Machines to make it further smaller (dust). Table 2 presents the properties of the ceramic dust that used in this study.

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Table 2. Properties of Ceramic Dust

No.	Properties	Value
1.	Liquid Limit	19.5%
2.	Maximum Dry density	17.32kN/m^3
3.	Optimum Moisture content	13.51%

For conducting the different test, the peat was mixed with the different percentage of ceramic dust from 0%, 2%,4%, 6%, 8% and 10% (by dry weight). In total 6 mixes were prepared. For each mix, cubic samples were tested to determine the compressive strength at 3, 7, 14, and 28 days of curing. A standard Proctor compaction testwas conducted to prepare the sample and meanwhile the Unconfined Compression Strength was conducted accordingly with British Standard (BS) code.

3. Results and Discussion

The experimental investigation was done to determine the unconfined compressive strength of peat soil mixed with different ratios of 0%, 2%, 4%, 6%, 8% and 10% ceramic dust. The compressive strength was obtained at 3 days, 7 days, 14 days and 28 days of different samples of peat soil.

3.1Relationship between Unconfined compressive stress and vertical strain of stabilized peat of different percentage ceramic dust in comparison to curing day

Studied was carried out to examine the effect of ceramic dust on the unconfined compressive strength of the peat sample namely to examine the effect of percentage ceramic dust and curing period.The sample prepared by compaction test with the modified proctor with mixing, the optimum moisture content of 67.5%.

The plot of unconfined compressive strength with 0%, 2%, 4%, 6%, 8% and 10% percentage of ceramic dust was presented in Figure 1, 2, 3, 4, 5 and 6 respectively. The results show that with increasing of percentage of ceramic dust in the peat soil sample, the unconfined compressive strength of peat sampleis increased. The highest strength is obtained from a sample that have seen cured for 28 days compared with 3, 7 and 14 days cured samples.

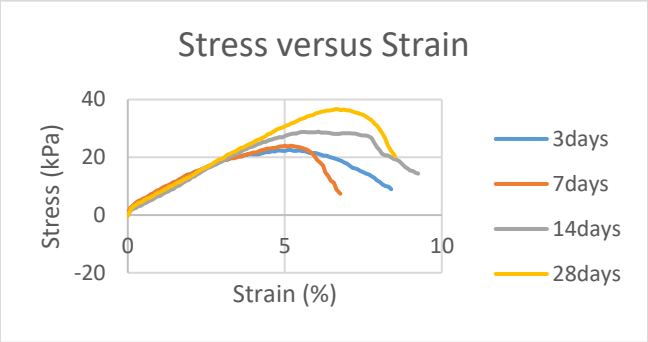

Figure 1. Comparison of 0% ceramic dust with 3,7,14 and 28 days curing

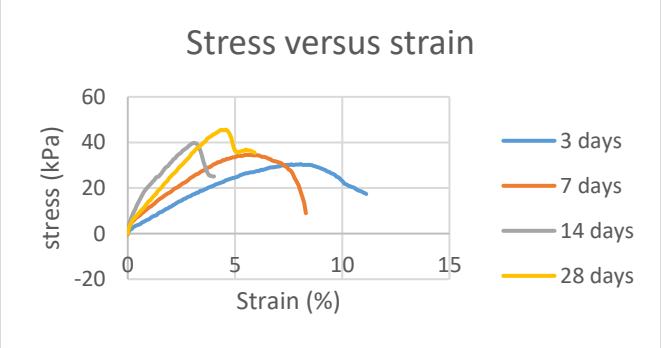

Figure 2. Comparison of 2% ceramic dust with 3,7,14 and 28 days curing

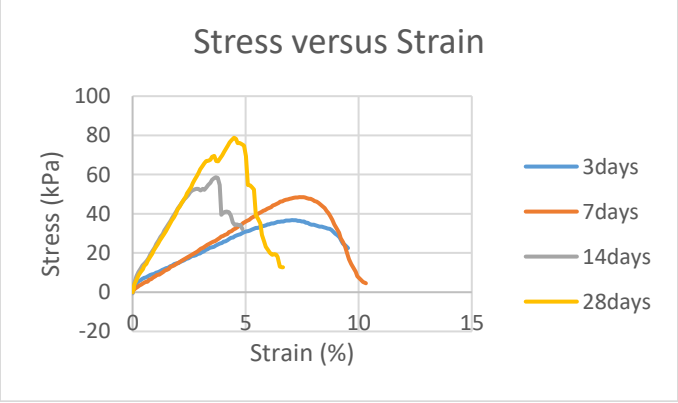

Figure 3. Comparison of 4% ceramic dust with 3,7,14 and 28 days curing

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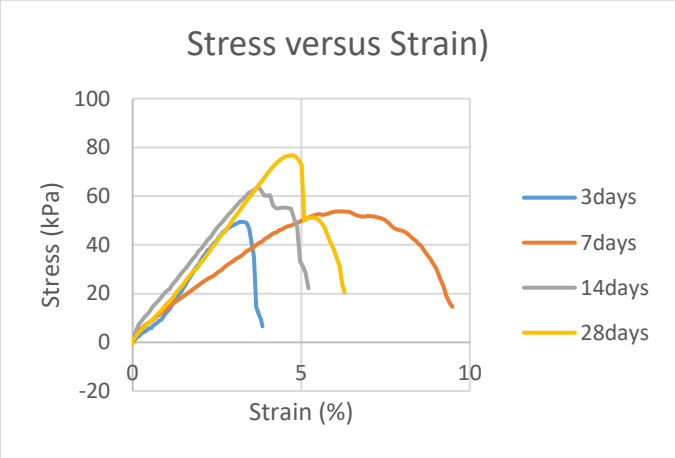

Figure 4. Comparison of 6% ceramic dust with 3,7,14 and 28 days curing

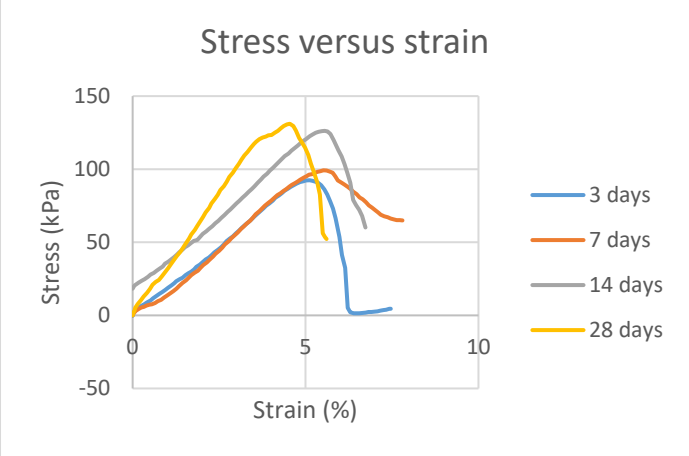

Figure 5. Comparison of 8% ceramic dust with 3,7,14 and 28 days curing

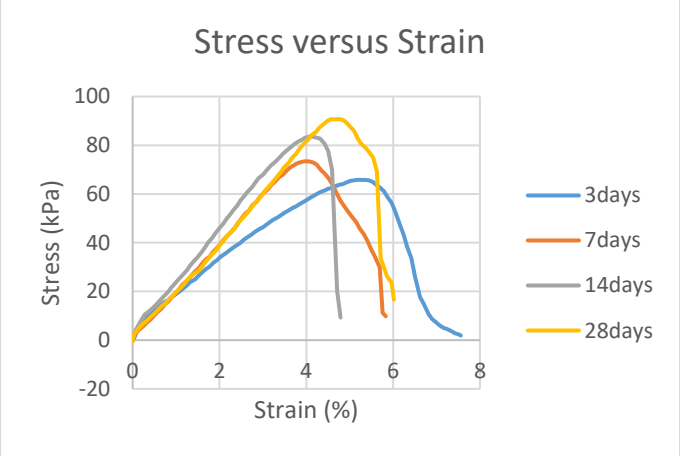

Figure 6. Comparison of 10% ceramic dust with 3,7,14 and 28 days curing

3.2 Relationship between unconfined compressive strength and vertical strain of stabilized peat of curing period in comparison to percentage of ceramic dust

The results of unconfined compressive strength tests on peat soil sample with different percentage of ceramic dust are shown in Figure 7, 8, 9 and 10. Initially, the unconfined compressive strength of peat soil was increased with the increases of the percentage of the ceramic dust as a stabilizer. However, the strength was considerably decreased after the ceramic dust percentage increases more than 8%.

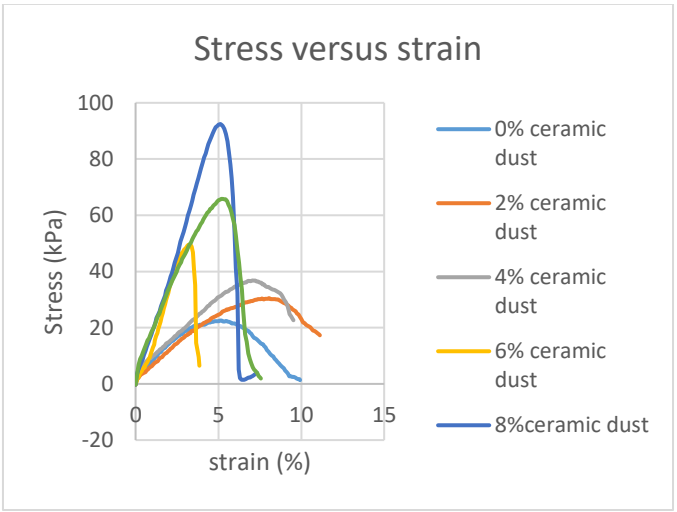

Figure 7. Comparison of 3 days curing with 0,2,4,6, 8 and 10% ceramic dust

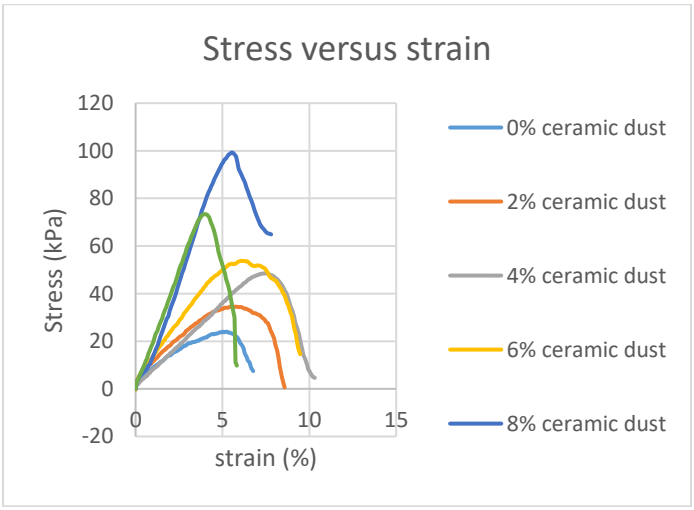

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Figure 8. Comparison of 7 days curing with 0, 2, 4, 6, 8 and 10% ceramic dust

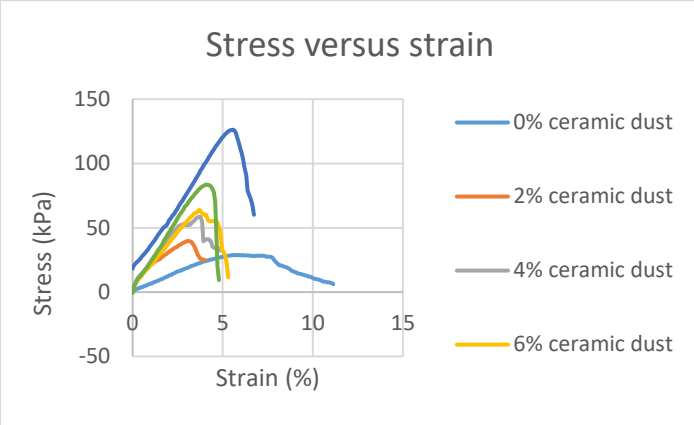

Figure 9. Comparison of 14 days curing with 0, 2, 4, 6, 8 and 10% ceramic dust

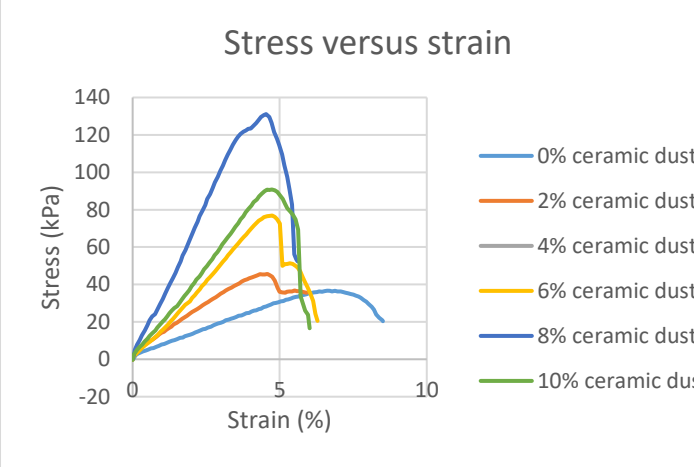

Figure 10. Comparison of 28 days curing with 0, 2, 4, 6, 8 and 10% ceramic dust

3. Conclusion

The possibilities of using ceramic waste dust as a stabilization of peat soil were investigated in the present study. The addition of the ceramic waste with different percentages into the soil were performed. The compaction and UCS test where indicated by the increase in the unconfined compressive strength. It is also found that with the reasonable amount of ceramic waste were mixed, the treated peat soil can apparently achieve higher strength. By this study, it is also help to solve the disposal problem of these ceramic tiles which is also hazardous to the environment.

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