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Chemical Stabilization of Amorphous Peat Using Cement and Fly Ash at Different Water Additive Ratios

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Abstract: Peat is a very problematic soil as it is poor in strength. However, previous researchers have proven that the compressive strength of peat can be improved by using various methods of soil improvement including chemical stabilization method. In this study, cement and fly ash and lime were additives used and were mixed with amorphous peat at various water additive ratios. To replicate actual stabilization on site, water additive ratio is proposed as to allow stabilization to be performed at natural water content of the peat. Peat samples were collected from Kampung Endap, Samarahan and mixed at its natural moisture content with cement and with fly ash and lime at different water additive ratios of 3.0, 3.5, 4.0, 4.5 and 5.0. The compressive and bearing strengths of the samples were obtained by the unconfined compressive strength (UCS) test and California Bearing Ratio (CBR) test respectively. The results of the study have shown that there is marginal strength gained after 28 and 56 days of air curing period. The peat samples stabilized with cement at 3.5 water additive ratio recorded the highest value with UCS value of 69.48 kPa after 56 days of curing and 0.52 % for CBR test after 28 days curing period. These strength values obtained are lower compared to published data from previous studies. Different technique of mixing in the laboratory that is mixing peat at its natural water content with varied amount of additives at selected water additive ratio as opposed to mixing at maximum dry density and optimum moisture content that is mostly performed in laboratory contributes to the outcome. However, this study has proven that there is an increase in compressive and bearing strengths of stabilized peat in its natural water content compared to original peat without stabilizer.

Keywords: Peat, Soil Stabilization, CBR, UCS

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1. Introduction

Malaysia is one of the countries that has peatland area of about more than 8% of total land around the world. Davies et al. [1] indicated that about 2.45 million ha (7.45%) of total land area in Malaysia is covered with peat or organic soils and out of this, Sarawak holds the largest area with about 1.7 million ha (69%) peatland area, 0.6 million ha (26%) in Peninsular Malaysia while 0.1 million ha (5%) of peatland area in Sabah. With the large area of peat is located in Sarawak, development is inevitable in such area and therefore, improvements to peatland must be made.

Various methods are available namely displacement and replacement method, preloading, deep stabilization method, pile support method, chemical stabilization, lightweight fill method, thermal precompression and reinforced overlay [2]. There have been many researches on different types of chemical stabilizers or admixtures used to improve the strength

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of peat. Fly ash, pond ash, cement and lime are the common chemical stabilizers used. Several researchers have also studied the stabilization of peat using combined additives such as cement with lime [3], quicklime and fly ash [4] and also lime with rice husk ash [5].

Peat is very poor in bearing capacity and subject to long term settlement. Therefore, construction methods and improvement applied on peat must be able to counter such problem, though constructions in peat area can be avoided altogether. There is high demand for development in Sarawak and is unavoidable. One of the promising methods to solve this problem is to increase and improve the strength of peat via chemical stabilization by adding the most suitable and optimum mixing quantity. In addition, laboratory mixing should replicate field stabilization mainly done via deep mixing method, wet mixing method, dry mixing method and mass stabilization method. According to Makusa [6], stabilization method involves mixing procedures to improve soil on site which is by applying stabilizing agents without removing the bulk soil. To add, the abundance of fly ash produced from burning of coal ash or industrial wastes in Sarawak is another factor leading to the study due to the large amount of fly ash produced which cause disposal problems. Hence, fly ash is of interest in this study.

This study concentrates on the stabilization of peat obtained from Samarahan, Sarawak with cement and fly ash and lime at different water additive ratios to replicate field stabilization whereby the studied peat was stabilized in a laboratory condition, yet maintaining the moisture content of the original peat sample. As a result, the water to additive ratio is varied in the mixing (at maintained peat water content). The geotechnical properties of stabilized peat such as water content, specific gravity and dry density obtained were then utilized in performing the stabilization and later be tested in California Bearing Ratio (CBR) test and Unconfined Compressive Strength (UCS) Test.

2. Methodology

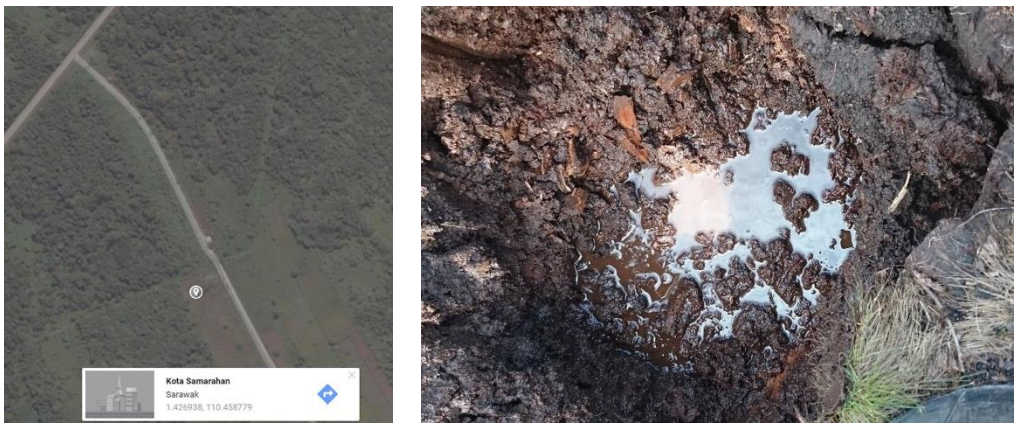
All experiments were conducted in the Geotechnical Laboratory, Faculty of Engineering, Universiti Malaysia Sarawak. The study begins with gathering information from the literature on peat stabilization, the behaviour of peat especially their physical properties and the best mix proportion based on the best strength results obtained in previous studies. Water additive ratios of 3.0, 3.5, 4.0, 4.5 and 5 were chosen for this study.

Before sampling, the vane shear test was conducted to obtain the undrained shear strength of peat at site. Then, the samples collected were classified based on the degree of decomposition by Von Post classification. The physical properties of peat were also determined including organic content, fiber content moisture content, liquid limit, specific gravity and acidity. After all the basic properties were known, Unconfined Compressive Strength (UCS) test and California Bearing Ratio (CBR) test were carried out. The tests conducted in this study are according to BS 1377 and ASTM standards.

2.1 Sampling

Location where the peat samples are collected is at Kpg. Endap, Kota Samarahan as marked in Fig. 1(a). The site was surrounded by bushes and some pineapple and bamboo plants. The condition of the ground was very soft and the ground water table was approximately 15 cm from the ground surface as shown in Fig. 1(b).

The samples were collected on a sunny day, 21st March 2016 at 2.00 pm. The proposed peat type was amorphous peat and a peat auger was used to sample the peat as shown in Fig. 2(a). Von Post classification test was conducted on site to determine the humification scale of the peat sample. After the area where the amorphous peat was identified, the samples were dug and filled into two garbage bins and were kept airtight (Fig. 2(b)) to be brought back to the lab.



(a) (b)

Fig. 1 – (a) Location of sampling, and (b) High ground water table at the site.