

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of Study

Tanjung Bin coal-based power plant in Malaysia that generates tons of bottom ash daily without known economic value that ends up in the ash pond (Abubakar & Baharudin, 2013). It produced 1,620 tons as well as 180 tons of fly ash and bottom ash per day respectively (Abubakar & Baharudin, 2013). Disposing coal ash in ash pond is a conventional on-site dumping method. The way of disposal coal ash in ash ponds not only providing no commercialization purposes, but also causes environmental pollution, such as groundwater contamination. According to Lynch (2013), coal combustion waste was the second largest contributor to stream pollution in United State. The fatal failures of ash ponds happened in Tennessee and in North Carolina in the year of 2008 and 2014 respectively, result in people started to be aware about the dangerous of ash ponds. Due to the bad impacts to environmental and society, concern has now been concentrate on how to make use of coal ash.

Fly ash is a very fine powder that is carried with the stack gases; while bottom ash is much heavier and it is collected from the bottom of coal furnaces. By comparing the physical properties of fly ash and bottom ash, bottom ash is more suitable to use as sand in sand column in soft clay. As stated by Kumar & Stewart (2003), the physical properties of bottom ash were comparable to natural sand, as it had wider particle size distributions ranging from fine gravel to fine sand with low percentages of silt and clay-sized particles. By using bottom ash in deep foundation to bypass soft clay layer was more environmentally friendly and avoided the use of natural resources sand. It also will help to reduce the ash ponds disposal problems, provide a cheaper and sustainable construction.

Basically, sand column is designed to increase shear strength, and accelerate consolidation process, thus reduce soil liquefaction, as well as the compressibility of soil to provide a more stable foundation. Since the construction was on clayey soils, a suitable stabilization methods are needed to bring about improvement in the geotechnical properties of the soils. It is not effective to use better quality of soils to construct foundation instead of using additives such as quicklime for stabilize soft clay soils. Quicklime treatment can reduce settlement and increase the bearing capacity of the soil, as it was found that lime can diffuse into the surrounding soil from the bottom ash columns and it helped to increase the bonding between bottom ash particles.

On the word of Chand *et al.* (2008), several researchers have studied about strengthen engineering properties of fly ash by adding lime, for instance Usmen & Bowders (1990); Malhotra (1994); Ghosh & Subbarao (2001) and (2006b). On top of that, most of the literary works shown that the properties of fly ash had significant improvements when stabilized by mixing of lime. As said by Chindaprasirt *et al.* (2009), the chemical properties of bottom ash and fly ash were very similar, the main difference between them was the particle shape and size. Consoli *et al.* (2008), the use of bottom ash and carbide lime on the processed top layer improved the ultimate load capacity and reduced settlements of footings standing on processed cemented soil.

## **1.2 Problem Statement**

As mentioned above ash pond is an engineered structure for the disposal of bottom ash and fly ash which has its defects. An 81,000 m<sup>2</sup> area, 2.4 m deep ash pond which contained the deposits of fly ash and bottom ash was situated beside Sejingkat Coal Fired Power Station, Kuching Sarawak. The disposal of coal ash has reached to a worried condition, as with the present of water, toxic constituents tends to leach into ground waterways and into underground water supplies and cause contamination. Thus, the people who living next to a coal ash disposal site will have a higher risk of getting cancer. The utilization and recycling of coal bottom ash is one of the most effective way to minimize the environmental and social problems related to the disposal of bottom ash. The finer and lighter particles of coal ash escape with the flue gases is called as fly ash, meanwhile, bottom ash is collected at bottom of furnace. It is found that the sources of

natural sand are getting short in supplied, thus it is a foremost important task to find a by-product to replace sand. Bottom ash has the particle size ranges from fine gravel to fine sand addition with interlocking characteristics. It is lighter and more brittle as compared to natural sand. Consequently, there is a potential in using bottom ash as a substitute material in sand column. Sand column is a method being used to increase the bearing capacity, reduction in post-construction settlement and accelerating settlement rate on soft clay layers. Clayey soils are problematic soils for foundation construction. Soft clay soils have low shear strength and high possibility of compression. Stabilization using lime is a well know practice to improve the characteristics of soft clay soil, such as shear strength, compressibility, and the permeability. An experimental study was conducted to evaluate the strength of lime fly ash mixture, it is proved that shear strength, bearing capacity are increased, in contrast settlement is extensively reduced. After some time, lime from the bottom ash column is allowing to diffuse through the soil and further stabilize the soft clay soils. Since the chemical properties of bottom ash and fly ash is similar, it is expected the strength of lime bottom ash will be improved.

### **1.3 Objectives**

The purpose of this study is to investigate the improvement of undrained strength of soft clay reinforced with group encapsulated lime bottom ash columns. The objectives are shown at below:

- a. To determine the basic and mechanical properties of soft kaolin clay, quicklime and bottom ash.
- b. To determine the undrained shear strength of soft clay reinforced with group encapsulated lime bottom ash columns.
- c. To correlate the relationship of undrained shear strength with various dimension of group encapsulated lime bottom ash columns.

### **1.4 Scope of Study**

To specify the research become more specific, the results for this research was based on small scale laboratory tests. British Standard (BS) or the American Society of Testing Material (ASTM) was the reference standard for all the laboratory tests. Bottom