CHAPTER

4

MICROSTRUCTURE ANALYSIS OF ELECTRONICALLY STABILISED PEAT

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4.1 INTRODUCTION

Huat et al. (2004) noted that the organic matter in soils originates from living plants, organisms, and animals. In particular, marine plants and animals contribute a major amount to the formation of organic material in the soil. During the transformation processes of plants, organic products such as coal and peat are created. Peat is a mixture of fragmented organic materials formed in wetlands under appropriate topographic and climatic conditions and is derived from vegetation that has been chemically changed and fossilised. It is often referred to as problematic soil due to its high compressibility, low shear strength, and high water content. Primarily, peats are in an acidic condition and, in turn, the pH value often lies between 4 and 7. For example, West Malaysian peats have very low pH values, varying from 3.0 to 5.5. Also, in some cases where sulphide materials are found within the profile, pH values can even be below 3.0.

With the increase in urban construction and construction in mechanically substandard soils, new methods were required to stabilise soft soils with low permeability while minimising ground movements.

While conventional soil grouting can be used to stabilise soils with relatively high permeability (k typically greater than 10-5 m/s), other methods need to be applied to improve the strength of fine-grained soils with lower hydraulic conductivity values. These include hydrofracture grouting, artificial ground freezing, and induced consolidation either by applying electric fields or surcharging the soil. Electrokinetic (EK) stabilisation is a ground improvement method in which soils are treated without excavation (i.e. disturbing the soil). This is seen as an important advantage over traditional methods. Although electrokinetic injection technology has seldom been employed, the majority of applications have been successful and have proved an economic alternative to traditional ground improvement methods. It has been used in several soil improvement categories including consolidation, contaminant removal, dewatering, and stabilisation.

There are numerous studies on the strengthening of soft soils using the electro-grouting technique. Alshawabkeh and Sheahan (2003), stabilised soft soil by ionic injection under electric fields. The results of their study show that adding phosphoric acid increases the soil's shear strength by up to 560%. This research was later developed by Alshawabkeh et al. (2004), and this proved that the application of direct current fields to soft soils changes the soil in both its physical and mechanical properties. Shang et al. also investigated the electrochemical cementation of offshore calcareous soil. They used two chemical agents in their electrochemical stabilisation experiments. The result of their experiments reveals a 700% increase in the load capacity carried by the soil after 7 days of treatment with an applied voltage of 4V. Mohamed Elhassan et al. (2008) explored electrochemical stabilisation for offshore model caissons. They used calcareous sand and seawater from the coastline of Western Australia in the study.

As a result, the pull-out resistance of the caisson after the electrokinetic treatment was significantly increased. A study performed by Micic et al. (2003) focused on the electrokinetic improvement of marine deposits surrounding skirted footings of offshore structures. A comparison between the untreated and treated soil reveals that the treated soil has developed pre-consolidation pressures with an over-consolidation ratio of 3.7 to 5 within the treatment influence zone. The results of both the vane shear tests and the unconfined compression tests indicated increases of up to 700% in the undrained modulus.

In addition, EK injection has been established as an effective in situ ground improvement technique in fine soils, particularly where ground movements need to be minimised. Over the last 40 years, a few hundred different compounds of chemical grout have been introduced. However, the use of EK treatment was limited to a few soil types and chemical stabilisers. Therefore, this chapter aims to present the investigation of the changes in the microstructure (SEM graph and atomic composition) of possible peat stabilisation mixed with several types of chemical reagents. The stabiliser reagents were injected electrokinetically through the peat medium using low electrical energy. Notes that the scope of discussion only limits the summary of basic soil test characterisation and results of EK treatment. More details result of peat characterisation such as fibre content, humification level and etc are not included herein.

4.2 TEST EQUIPMENTS

All the subjected test equipment has been explained clearly in the next section.

4.2.1 Electrokinetic Set-up

A schematic view of the electrokinetic apparatus used in this study is presented in Figure 4.1. The electrokinetic cell consisted of an acrylic tube, 175 mm long and 80 mm in diameter, where the soil was moulded and connected at both ends to acrylic cylindrical chambers of the same diameter. As for the electrode, graphite was held inside the electrolyte chambers. The apparatus was designed following the criteria given by Burnotte et al. (2004).