UNIVERSITI TEKNOLOGI MARA

HYDRAULIC CONDUCTIVITY OF LATERITE SOIL MIX WITH GEOPOLYMER IN DESIGNING A MODIFIED SOIL LINER

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ABSTRACT

Soil liners are commonly used in the base of waste containment facilities and it has been used for many years. A low hydraulic conductivity is a key parameter in the design of liner to prevent the downward migration of contaminants into aquifers. The previous studies revealed that the soil liner should have a hydraulic conductivity lower than $1x10^{-9}$ m/s. Laterite soil is a main material used for soil liner. However, the use of laterite soil associated with difficulties in compacting to achieve the acceptable hydraulic conductivity. It is hypothesized that incorporating fly ash based geopolymer in soil liner would ease compacting and enhance compaction parameters of laterite soil. In this study, laterite soil was modified with chemical stabilizer which is fly ash based geopolymer. Laterite soil was mixed with different percentages of geopolymer which are 5%, 10%, 15% and 20% by weight. The laterite soil was collected at Damansara Perdana area. Sodium hydroxide (NaOH) was purchased from the supplier and the waste material which are fly ash was taken at Kapar Energy Ventures Sdn Bhd, Kapar Selangor. The NaOH in pellets form was added to water in order to obtain the alkali solution and fly ash was added to the solution to form a material in a binder state known as geopolymer. The soil properties were determined by conducting Atterberg limit, particle density, particle size distribution, pH and shrinkage limit test for all soil samples. Compaction test was carried out with three (3) different compaction energy which are Reduced British Standard Level (*RBSL*), British Standard Light (*BSL*) and British Standard Heavy (*BSH*). The hydraulic conductivity of soil was determined by using falling head permeability test subjected to *BSL* test only. All compacted samples was performed at dry, optimum and at wet of optimum moisture content. The compaction test and falling head permeability test were applied to all soil samples which mix with and without different percentage of geopolymer. The hydraulic conductivity for soil sample that compacted with *RBSL* test and *BSH* were determined by using Benson and Trast's formula. The formula was selected because the hydraulic conductivity values obtained were found to be closest to those obtained from the actual of laboratory works. According to the results, it was found that the soil mixture with 15% of geopolymer gives the best value of maximum dry density, optimum moisture content and hydraulic conductivity of the soil. Subsequently, models of estimating hydraulic conductivity, *k* from an empirical formula based on soil parameter measured in the laboratory were established. The models were developed by using MINITAB software. There are a few parameters that were used in developing the models. A model was developed based on physical properties parameters to predict the hydraulic conductivity of the modified soil based geopolymer. The accepted zone was also successfully developed corresponding to physical, engineering properties and hydraulic conductivity with respect to different percentage of geopolymer. The soil mix with 15% of geopolymer showed the large area of acceptance zone compared to those made of other percentages of geopolymer. Large area of moisture content was obtained to achieve maximum compaction for the same soil mix. The soil amended with 15% of geopolymer can be compacted using 5% to 15% of water content to produce the required hydraulic conductivity. Further adding geopolymer in the soil mixes was found decreased the hydraulic conductivity of the resulted liner.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Landfills are the place where waste materials are collected and discarded. It is also a site where most types of waste materials including hazardous, non-hazardous, or inert may be disposed of (Chew and Karunaratne, 2005). Increase in population leads to the growing numbers of generated waste material (Emy, Ajitha and Sheela, 2013). Therefore, landfill sites must be constructed and operated which strictly adhered to requirements set by technical standards. Modern landfill consists of primarily a composite liner, leachate collection, removal system, gas collection, control system and final cover (Saravanan, Kamon, Faisal, Katsumi, Akai, Inui and Matsumoto, 2006). Based on Masirin, Ridzuan, Mustapha and Adon (2008), there are about 230 landfills found in Malaysia. In designing the structure of modern landfill, there are some criteria needed to be considered. The design measures that commonly adopted for landfill are as indicated in Table 1.1.

Table 1.1:
Design measures and purpose of engineered landfills

Design measure	Purpose
Low permeability lining system	To minimize leachate egress and prevent ground pollution. Typical forms are clay mineral liners, geomembrane liners and bentonite-enriched soil liners.
Underdrainage/ leachate detection system	To detect any leachate that has reached the liner and to allow for its subsequent control. It is placed beneath the lining system.
Leachate drainage and control system	To ensure the maintenance of a low head of leachate above the liner and to allow