UNIVERSITI TEKNOLOGI MARA

MODELLING ON COMPACTION AND HYDRAULIC CONDUCTIVITY FOR SEDIMENTARY RESIDUAL SOIL-BENTONITE MIXTURE AS COMPACTED LINER

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PhD

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The compaction characteristics and hydraulic conductivity of compacted soil are important criteria as soil liner in landfill construction. The key parameter for liner design is to have a lower hydraulic conductivity of less than $1x10^{-9}$ m/s to prevent the seepage of contaminants into aquifers. However, the feature to control hydraulic barrier construction soils is usually based on some compaction criteria. A detailed study on the compaction and hydraulic conductivity for sedimentary residual soil mixed with bentonite was carried in this study. The sedimentary residual soil sample was used and collected in sedimentary residual formation area in Salak Tinggi, Malaysia, and named as Salak Tinggi soil. Laboratory tests were conducted on the soil samples mixed with bentonite to demonstrate some significant considerations in the design of compacted sedimentary residual soil mixed bentonite as a compacted soil liner. The residual sample was mixed with different percentage of bentonite at (5%, 10%, and 15%) and the selection of bentonite percentage was based on previous research studies. Previous research studies showed, the bentonite between 2.5% and 15% were giving the best percentage mixed with residual soil and after 20% bentonite mixed with soil it shown the significant crack. The physical properties testing was conducted on mixed soils samples such as particle size distribution, *pH*, specific gravity, plastic index (*PL*), liquid limit (*LL*), plasticity index (*PI*) and linear shrinkage (*LS*). A compaction test was conducted on mixed soil samples using four different compactions energies namely Reduced British Standard Light (RBSL), British Standard Light (BSL), West African Standard (WAS), and British Standard Heavy (BSH). The results showed the addition of bentonite into the Salak Tinggi residual soil was changed the physical properties of soil and these changes showed an improvement to the characteristics of mixed samples use as soil liner. Meanwhile, the compaction result showed a slight decrement in the maximum dry density (*MDD*) at all mixed soil samples at entire compaction energies. However, the *MDD* values can be enhanced by increasing the compaction energy applied to mixed soil samples. Then, the permeability testing to determine the hydraulic conductivity (*k*) was conducted using a triaxial permeability machine. The permeability testing was conducted on the entire mixed soil samples at *MDD* condition for every compaction effort at effective confining stress of 100 kPa, 200 kPa, and 300 kPa. The result showed a decrement of hydraulic conductivity value less than $1x10^{-9}$ m/s for Salak Tinggi residual soil mixed bentonite significantly. This decrement of hydraulic conductivity is aided by the effect of the effective confining stress. Besides that, the result showed the higher compaction energy required for low bentonite content, whereas for large amount bentonite content only requires low compaction energy. The multiple regression analysis result showed there is significant evidence for the relationship between the physical properties of the *OMC* and *MDD*. The *OMC* and *MDD* model developed shows a regression models with R^2 more than 50% and the relationship between the predicted model and empirical model were giving R^2 more than 50%. Meanwhile, there is also a significant relationship between compaction characteristics and hydraulic conductivity with the R^2 more than 50% for regression model and the relationship between predicted model and empirical model also given R^2 more than 50%. The model developed provide a good prediction for dry density, optimum moisture content, and hydraulic conductivity for sedimentary residual soil mixed bentonite that to be used as compacted soil liner in the landfill.

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TABLE OF CONTENT