THE POTENTIAL OF KAOLINITE AS A LANDFILL LINER MATERIAL

AIMI JEHAN BINTI HAMZAH

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ABSTRACT

Leachate virtually is one of the problems in landfill system. The landfill liner with different types has widely been used in modern landfill to overcome the problems. Bentonite and Kaolinite are a clay mineral that can be used as landfill liner material. Bentonite is better to be a landfill liner because it have the lowest permeability compare to Kaolinite. But Bentonite has the highest swell-shrink potential because of the highest plasticity index that can be determine from Atterberg Limit. Kaolinite helps to reduce the permeability and swell-shrink potential of Bentonite when they are mixed together. Seven different ratios are tested to determine the effectiveness ratio of Bentonite and Kaolinite which are 100:0, 50:50, 40:60, 30:70, 20:80, 10:90 and 0:100. The tests involved are Atterberg limits, Specific Gravity, Permeability test and Oedometer test. Too much Bentonite will cause a higher swell-shrink potential but low permeability while too much Kaolinite causes a lower swell-shrink potential but high permeability. Oedometer test is conducted to determine the coefficient of consolidation in order to determine how much time needed to complete the consolidation settlement. From the results, the permeability for landfill liner are obtained where Bentonite is impermeable than Kaolinite and after it mixed the ratios become more impermeable. The ratio Bentonite:Kaolinite, 30:70 is chose to be an effective ratio to be used as a landfill liner material. This because of it low coefficient of permeability and at the same time has a stability of plasticity index and consolidation.

ABSTRAK

Air sampah merupakan salah satu masalah di dalam sistem tempat pembuangan sampah. Pelbagai jenis lapik digunakan di tempat pembuangan sampah moden untuk mengatasi masalah ini. Bentonit dan Kaolinit adalah mineral tanah liat yang boleh digunakan sebagai bahan lapik. Bentonit sesuai digunakan untuk lapik di tempat pembuangan sampah kerana ia mempunyai ketelapan yang rendah daripada Kaolinit. Tetapi Bentonit berpotensi tinggi dalam pembengkakan dan penyusutan kerana ia mempunyai indeks keliatan yang tinggi yang boleh ditentukan dari Had-Had Atterberg. Kaolinit boleh mengurangkan ketelapan dan pembengkakan-penyusutan Bentonit setelah dicampur . Tujuh nisbah diuji untuk menentukan keberkesanan nisbah Bentonit dan Kaolinit yang terdiri daripada 100:0, 50:50, 40:60, 30:70, 20:80, 10:90 dan 0:100. Ujikaji yang terlibat adalah Had-had Atterberg, Graviti Tentu, Ujikaji Ketelapan dan Ujikaji Oedometer. Terlalu banyak Bentonite akan menyebabkan pembengkakan-penyusutan yang lebih tinggi tetapi ketelapan yang rendah sementara terlalu banyak Kaolinit menyebabkan pembengkakan-penyusutan yang lebih rendah tetapi ketelapan yang tinggi. Ujikaji Oedometer boleh menentukan pekali pengukuhan bagi mendapatkan masa yang diperlukan untuk pengukuhan pengenapan. Daripada keputusan, kebolehtelapan untuk lapik di tempat pembuangan sampah didapati di mana Bentonit ialah tidak telap daripada Kaolinit dan setelah dicampur, ia menjadi makin tidak telap. Nisbah Bentonit:Kaolinit, 30:70 sesuai digunakan untuk bahan lapik. Ini, kerana ia mempunyai pekali kebolehtelapan yang rendah dan indeks keliatan dan pengukuhan yang stabil.

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LIST OF ABBREVIATIONS

C&DD	-	Construction and Demolition Debris
GCL	-	Geosynthetic Clay Liners
HDPE	-	High-Density Polyethylene
LFG	-	Landfill Gas
LL	-	Liquid Limit
MHLGM	-	Ministry of Housing and Local Government Malaysia
MSW	-	Municipal Solid Waste
PE	-	polyethylene
PI	-	Plasticity Index
PL	-	Plastic Limit
PVC	-	Polyvinyl Chloride

LIST OF SYMBOLS

a	-	Area Cross-Section of Glass Tube, (m^2)
A	-	Area of Mould, (m^2)
C_v	-	Coefficient of Consolidation
e	-	Void Ratio
G_S	-	Specific Gravity
h_1	-	Initial Head (m)
h_2	-	Final Head (m)
Kt	-	Coefficient of Permeability, (m/s)
Kt_1	-	Coefficient of Permeability for Tube 1(6 mm), (m/s)
Kt_2	-	Coefficient of Permeability for Tube 2(7 mm), (m/s)
Kt_3	-	Coefficient of Permeability for Tube 3(8 mm), (m/s)
L	-	Length Of Sample, (m)
L_0	-	Initial Length
L_D	-	Oven-Dried length
m	-	Moisture Content
M_A	-	Mass of pcynometer filled with water
M_B	-	Mass of pcynometer filled with water and soil

M_O	-	Mass of dry soil
P	-	Pressure
r	-	Radius of Glass Tube
t	-	Time for measuring a fall of head from h_1 to h_2 (s)
W	-	Mass of Sample
W_s	-	Mass of Dry Sample
W_w	-	Mass of Wet Sample

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CHAPTER 1

INTRODUCTION

1.1 Background of the project

As long as human live on this earth then there has been the need to dispose of their waste. Traditionally, various wastes were thrown into the rivers and lakes while solid wastes were burned, buried, or dumped into the ocean. At this time, the population of the earth was relatively small and these methods provided the most efficient, as well as moderately safe for waste disposal. Now that the uncontrolled population growth has increased dramatically, the lakes and rivers can no longer support the excessive wastes produced by humans day by day especially in industrializing countries. The solid waste generation is increase with population, where the population grows at a rate of 2.6% per year. It has been observed that the solid waste generation in Malaysia has increased concurrent with the development of the country.

Furthermore, the traditional method can contaminated the environment and health such as air pollution by open burning, water pollution by throw the rubbish into the ocean and give the bad aesthetic value to the country. At present, Malaysian household generate an average rate of 0.8kg of rubbish daily and the rate reaches up to 1.5kg per capita daily in urban areas. In year 2005, Malaysia produces about 7.34 million of solid waste. The increase of waste in Malaysia has lead to a strong uses on landfills for our means of disposal.

Then the conventional landfills are introduced to support our waste and it's often uses in some countries because of its low initial cost and easy to construct. It is the oldest landfill method of disposing solid waste which is still applies in this country nowadays. The shortcoming of conventional landfill is where it gave the bad effects to our country which is it can lead to the production of leachate, methane gas, bad odours, flooding, anaesthetics environment and health hazard to the waste management workers, scavengers and to those who live close to the landfill areas. Furthermore, this landfill attracts numerous birds that feed on the wastes, which can make them more serious disease vectors than files or rodents.

Nowadays, in developed nation, modern landfills or sanitary landfill take place which is the conventional landfills is upgrade becoming an engineered landfill. Modern sanitary landfills differ from the conventional landfill where sanitary landfills use high technology to contain the waste. Everyday, the trash or waste by human is brought to the landfill. It is unloaded, spread in a layer and covered with soil. This soil will cover and eliminates odours and discourages scavengers such as birds and rodents. The sites choose for this landfill also must environment friendly which not harm the people nearby. The American Society of Civil Engineers in 1959 published the first guidelines for a "sanitary landfill" that suggested compacting waste and covering it with a layer of soil each day to reduce odours and control rodents. Modern landfills are specifically designed to protect human health and the environment. It will control the water and air emissions which is very dangerous to human health known as leachates and methane gases. The function of engineered landfills are to contain leachate, preventing the infiltration of precipitation that generates leachate after closure of the landfill, and collecting landfill gas that can be used as an energy source or destroyed.

1.2 Problem Statement

From 177 landfills in Malaysia, only 6% of it is sanitary landfill. Since most of the current landfills in Malaysia have a poor code of landfill practice, it is important for the authorities to improve the current state of landfilling practice. Sanitary landfills are very important to Malaysia which it can protect human health and the environment. This is because the conventional landfill uses produces leachate and methane gas which next can contaminate the groundwater and air. Sanitary landfill is still the most cost-effective and appropriate method for waste disposal because it can prevent or decrease the leachate from seep to the groundwater.

Leachate consists of water and water soluble compounds in the refuse that accumulate as water moves through the landfill. This water may be from rainfall or from waste itself. Leachate could seep directly through the soil and into the groundwater, polluting the surrounding water supply, with the old landfills. Run-off of leachates and other toxins could eventually reach and contaminate nearby surface water as well. Once these water sources are polluted, there are extremely expensive to clean thus presenting a risk to human and environmental health. Water is very important to human, and they need a fresh and clean water to live because people everywhere need it for drinking, agriculture, transportation, industry, hydroelectric power and more. Water makes up more than two thirds of the weight of the human body, and without it, we would die in a few days. The human brain is made up of

95% water; blood is 82% and lungs 90%. Water is important to the mechanics of the human body. The body cannot work without it. Since water is such an important component to human physiology, it would make sense that the quality of the water should be just as important as the quantity. Drinking water should always be clean and free of contaminants to ensure proper health and wellness.

Groundwater also had been taken as an alternative clean water supply for human needs. Groundwater makes up about twenty percent of the world's fresh water supply Groundwater is very important to the human, thus it is important to ensure its quality is high all the time so that the consumer health is not compromised. The activity of waste disposal in open municipal landfills is one of the factors that could cause the groundwater pollution. Therefore, the proper engineered landfill system is needed to protect the soil and groundwater from pollutions.

1.3 Objective

The objectives of the study are as follows:

1. To determine the coefficient of permeability of landfill liner material.
2. To determine the effective ratio of Bentonite:Kaolinite to be used as landfill liner material.

1.4 Scope of Study

The study limits its scope on the laboratory test only. There are several basic properties that need to be tested in this study such as Plastic Limit (PL), Liquid Limit (LL), Plasticity Index (PI), Shrinkage Limit (SL), Moisture content, Specific Gravity and Coefficient of Permeability. PL is the change of consistency from brittle/crumbly to plastic while LL is the change of consistency from plastic to liquid. PI is the range of water content over which a soil has a plastic consistency.

The laboratory tests that involve in this study are Atterberg Limit which is to determine PL, LL, PI, SL and moisture content of the clay mineral. Falling Head Permeability Test is used to determine the coefficient of permeability of clay. One-D Consolidation Test (Oedometer Test) is used for the determination of the consolidation characteristics of soil for low permeability. In this study there are two types of clay mineral used for test which are Bentonite and Kaolinite. This clay are mix together with 7 types of ratio and each of this types need to determine their PL, LL, PI, SL, moisture content, specific gravity, consolidation and coefficient of permeability.

There are 7 types of ratio uses for mixture of Bentonite:Kaolinite. The ratio are 100:0, 50:50, 40:60, 30:70, 20:80, 10:90 and 0:100. The bentonite-kaolinite mixtures were prepared by adding particular amounts of bentonite and kaolinite with different proportions which have been fixed. The mixes are blended to form a homogenous mix. In theory, 1 foot of clay is enough to contain the leachate.

1.5 Significance Of Study

In nature, clay mineral can be obtained easily in Malaysia especially bentonite and kaolinite which present in many natural clay soils. There are abundant and the advantage of this natural source can be taken for the good application and uses. In addition, to kaolinite which is being widely distributed clay mineral that has low chemical reactivity and good dimensional stability during moisture changes. For example this clay mineral can be used as liner material at landfill systems.

Clay mineral can give the good effect to the world, where it helps to reduce groundwater contamination, where it use as barrier at the bottom and cover system of landfill. Their functions are to prevent leachate to seep through the groundwater and to prevent the rainwater leach through the landfill which can increase the generation of leachate. Apart from that, the human health also can be guaranteed which they can drink fresh water supplied from the groundwater and live in clean and fresh atmosphere.

This study is carried out with intention to know the basic properties of clay mineral, kaolinite and bentonite as landfill liner. About 6% of the landfill in Malaysia that uses sanitary landfill with engineered system and mostly is crude dumping landfills. Through this study, it is hope that the authorities would increase this percentage to increase the usage of liner in Malaysia's landfill thus it can reduce the community's health problems due to air and water pollution by landfill. The weakness and advantages of Bentonite:Kaolinite proportions can then be verified through the study outcome. Hopefully the study will achieve its objective with methodology and good delivery.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Many cities in developing Asian countries face serious problems in managing solid wastes. The annual waste generation increases in proportion to the rises in population and urbanization. The more waste generate by human days by days, the more they have to dispose of. Some methods of waste disposal will release air pollutants and greenhouse gases into the atmosphere. The most common disposal methods which are more environmentally friendly are landfill. Municipal Solid Waste (MSW) in Malaysia involves the disposal of approximately 98% of the total waste to landfills.