SOFT SOIL STABILIZATI

ND POLYPROPYLENE

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ABSTRACT

The use of crushed glass and polypropylene as raw nurses are encouraged in construction. Furthermore, these materials are easy to find because it is a waste product. This method is also capable of reducing solid waste that cannot be eliminated, especially plastic. However, the utilization of these materials in civil engineering construction applications has just received some attention within the last decade. This aim of this Final Year Project is to determine the strength improvement of soft clay mixed with crushed glass and polypropylene. The optimum moisture content obtained from the standard compaction test on sample taken from Kampung Tg. Medang, Pekan Pahang. The percentage of crushed glass and polypropylene mixed with soft soil were 10%, 15%, 20% and 25% by weight of sample. Soil samples were tested in laboratory to determine their basic properties of soil. The soil sample undergo unconfined compression test before and after being treated with crushed glass and polypropylene to determine their shear strength. After undergo unconfined compression test before and after the sample being treated, the value of stress for the sample before being treated with crushed glass and polypropylene was 647.02 kN/m^2.The value is calculated from the average of 4 specimens. There are differences between shear strength of the sample taken from Kg Tg Medang before and after being treated with crushed glass and polypropylene. The shear strength increase by 2.21% for additional of 5% polypropylene plus 5% crushed glass, 13.29% for additional of 5% polypropylene plus 10% crushed glass, 6.92% when added with 5% polypropylene plus 15% crushed glass and lastly increase by 5.5% when mix with 5% polypropylene plus 20% of crushed glass. The optimum content of additive is 5% polypropylene plus 10% of crushed glass which will increase the shear strength of the soft clay by 13.29% from 647.02 kN/m^2 up to 733 kN/m^2.

ABSTRAK

Penggunaan kaca hancur dan polipropilena sebagai suatu kaedah bagi merawat tanah dalam pembinaan sangat digalakkan. Tambahan pula, bahan-bahan ini mudah didapati kerana ia merupakan bahan buangan. Kaedah ini juga mampu mengurangkan sisa pepejal yang tidak boleh dihapuskan, terutamanya plastik. Walau bagaimanapun, penggunaan bahan-bahan ini dalam aplikasi pembinaan kejuruteraan awam baru sahaja menerima perhatian sejak dekad yang lalu. Projek Tahun Akhir ini bertujuan untuk menentukan peningkatan kekuatan tanah liat lembut bercampur dengan kaca hancur dan polipropilena. Kandungan lembapan optimum yang diperolehi daripada ujian pemadatan piawai ke atas sampel yang diambil dari Kampung Tg. Medang, Pekan Pahang. Peratusan kaca hancur dan polipropilena dicampur dengan tanah lembut adalah 10%, 15%, 20% dan 25% daripada berat sampel. Sampel tanah telah diuji di makmal untuk menentukan ciri-ciri asas tanah. Sampel tanah menjalani ujian mampatan tak terkurung sebelum dan selepas dirawat dengan kaca hancur dan polipropilena untuk menentukan kekuatan ricih. Selepas menjalani ujian mampatan tak terkurung sebelum dan selepas sampel yang telah dirawat, nilai tekanan untuk sampel sebelum dirawat dengan kaca hancur dan polipropilena adalah sebanyak 647,02 kN/m². Nilai ini diambil daripada purata 4 spesimen. Terdapat perbezaan antara kekuatan ricih sampel yang diambil dari Kg Tg Medang sebelum dan selepas dirawat dengan kaca hancur dan polipropilena. Kekuatan ricih tanah meningkat sebanyak 2.21% apabila tambahankan sebanyak 5% polipropilena dan 5% kaca hancur, 13.29% apabila ditambahankan sebanyak 5% polipropilena dan 10% kaca hancur, 6.92% apabila ditambahkan dengan 5% polipropilena dan 15% kaca hancur dan akhir sekali peningkatan sebanyak 5.5% apabila bercampur dengan 5% polipropilena dan 20% daripada kaca hancur. Kandungan optimum bahan yang perlu ditambahan adalah sebanyak 5% polipropilena dan 10% kaca hancur yang merekodkan peningkatkan kekuatan ricih tanah liat lembut sebanyak 13.29% iaitu daripada 647.02 kN/m² sehingga ke 733 kN/m².

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LIST OF SYMBOLS

ρ_d Dry density
ρ Bulk density
w Moisture content of soil
S_G Specified gravity
D Diameter
S Shear strength
σ Stress
ε Strain
S_u Undrained Shear Strength

LIST OF ABBREVIATIONS

AASHTO - American Association of State Highway and Transportation Officials
BS - British Standard
UCT - Unconfined Compression Test
LL - Liquid Limit
PL - Plastic Limit
PI – Plastic Index
FYP - Final Year Project

CHAPTER 1

INTRODUCTION

1.1 Background

Quality of soil-subgrade determines the pavement performance. A stable soil-subgrade and properly draining pavement helped to produce a long-lasting pavement. Subgrade soil provides support to the remainder of the pavement system. The quality of the subgrade would be greatly influence the pavement design and the service life of the pavement. The failures of pavement, in form of heave, depression, cracking and unevenness are caused by the seasonal moisture variation in the subgrade soil. To overcome this problem, the soil properties need to be improved.

Soil improvement is interpreted as a technique to improve the engineering properties of soil by cooperating certain materials with some desired properties which does not consist of or contain least in the soil to evolve the parameters such as shear strength, hydraulic conductivity, compressibility and density. Clay is one of the most important minerals used by the manufacturing industry and the environment. The term "clay" is applied to a material having a particle size of less than 2 micrometers (25,400 micrometers

= 1 inch) and the family of minerals having the same chemical composition and crystal structure of the usual features (Velde, 1995). Thus, clays may be composed of mixtures of finer grained clay minerals and clay-sized crystals of other minerals such as quartz, carbonate, and metal oxides. Clays and clay minerals are found mainly on or near the surface of the Earth. Houses, offices, schools, and factories built on soils containing swelling clays may be subject to structural damage caused by seasonal swelling of the clay portion of the soil. Thus, these types of soil need treatment to improve its properties.

There are many alternative ways to treat this type of soil (clay). Crushed glass and plastic is one of material that can be used to treat this soil. Glass is a hard material normally fragile and transparent common in our daily life. It is composed mainly of sand and an alkali. Once it is broken it is regarded as useless and so discarded constituting a nuisance in the community. This broken/crushed glass fragments that cannot be reused by bottle manufactures is what is referred to as glass cullet. The material is typically collection schemes and from premises handling large quantities of containers or other products. The physical properties of the glass are that they exhibit high permeability, high crushing resistance, and small strain stiffness. These properties of glass make it suitable to be treated with weak soil at Kg Tg Medang, Pekan, Pahang and as such could improve its geotechnical properties which will enhance its usage in geotechnical engineering works for construction of roads, buildings, embankments etc.

1.2 Problem Statement

Geotechnical is one of important term, especially when associated with natural disasters. Malaysia recently surprised by some natural disaster involving geotechnical problems. First, the catastrophic collapse of Block 1 of the Highland Tower Condominium in Hulu Klang, Selangor in December 1993. This disaster not only destroys things, but dozens of lives were lost. Second, slope failure at Mahameru Highway near National Forestry Department. Incident on May 8, 2013 has caused traffic congestion but no lives were lost. Finally, the incident that occurred on December 6, 2008 has shocked the world because it involves the loss of property, approximately 20 houses were destroyed and the number of victims is very high. Most of the disasters that have been mentioned above happen due to down poured for a few hours that causing the changes of soil strength.

Weak soil is not suitable for development, this is because, this type of soil give trouble to the developer as well as take a huge risk for structural failure of the building that will be built later. Among its effects is the deposition of soil that led to the structural failure of the building, such as cracks and so on. Therefore, the use of crushed glass and plastic as raw nurses are encouraged. Furthermore, these materials are easy to find because it is a waste product. This method is also capable of reducing solid waste that cannot be eliminated, especially plastic.

Solid waste can be defined as the useless and unwanted products in the solid state derived from the activities of and discarded by society. Solid waste is one of the three major environmental problems in Malaysia. It plays a significant role in the ability of Nature to sustain life within its capacity. As of the year of 2008, 23,000 tonnes of waste is produced each day in Malaysia, with less than 5% of the waste is being recycled. Currently, over 23,000 tonnes of waste is produced each day in Malaysia. However, this amount is expected to rise to 30,000 tonnes by the year 2020. The amount of waste generated

continues to increase due to the increasing population and development, and only less than 5% of the waste is being recycled.

1.3 Objective of Study

The objectives of the research are:

i. To determine the soil sample characteristic before being treated with crushed glass and polypropylene.
ii. To determine the shear strength of the soil sample after being treated with crushed glass and polypropylene.
iii. To determine the differences between shear strength of the soil sample before and after being treated with crushed glass and polypropylene.

1.4 Scope of Study

The testing will use the soil at Kampung Tg. Medang, Pekan Pahang (03°33'41.3"N 103°20'26.1"E). The soil will be tested first through experiments to make sure it is weak soil (clay) that need to be treated. The crushed glass in this work was obtained from premises handling large quantities of containers or other products near Kuantan area. The crushed glass and polypropylene was mixed with weak soil obtained to form three different mixtures with 10%, 15%, 20% and 25% of crushed glass and polypropylene contents. This is to find how much the amount needed to improve the soil properties

1.5 Significance of Study

Despite the massive amount and complexity of waste produced, the standards of waste management in Malaysia are still poor. These include out-dated documentation of waste generation rates and its composition, inefficient storage and collection systems. In order to reduce the waste volume and scale down environmental issue, recycling is the best way to manage the waste production rather than incineration. However, when the quantity of solid material that cannot be eliminated increase from year to year, it leads to other problems.

Nowadays, Malaysia face problems in managing solid waste from recycle especially plastics and glass. Government has taken many initiatives to solve this problem such as increasing the size of the landfill and campaigns to reduce the use of plastic bags. However, the best way to overcome this problem is to think of something that can be made using that kind of materials, such as use it for something beneficial.

There are many researchers who have been thinking about this idea to be implemented into items applicable for development, construction and housing. One of the deliberations to meet this is to transform these plastic and glass as this material can be used to treat soil ground.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In general, the clay gives more trouble to the development. It often contributes to the failure of the work of road pavement that leads to increase the annual road maintenance spending cost. For soft soil structures that also involve a high amount of weight applied requires a very high expenditure. Soil improvement technique is the best solution because it does not involve high costs. The introduction to the use of plastics and crushed glass in order to treat the soft clay can reduce potential failure of the road surfacing failure. Addition of crushed glass and polypropylene can improve the physical and chemical properties and also strength of soft clay.

2.2 Soft Clay

Soft soil or soft clay is not suitable for construction work. This is because soft soil is very high compressibility, low shear strength and low permeability. All of these characteristics will lead a big problem in construction by reducing the bearing capacity and excessive settlement problem. Soft clay is classified as soil that has particle sizes less than 0.002mm or easily break down to this size (Liu & Evett, 2005). Clays are mostly flake shaped microscopic and submicroscopic particle of mica, clay minerals, and other minerals. Particles are classified as clay on the basis of their size. Clay is defined as those particles which develop plasticity when mixed the limited amount of water (Grim, 1953). Table 2.1 shows the clay classification according to their compressive strength.

Table 2.1 Clay Classification

CLAY TYPE	UNCONFINED COMPRESSION STRENGTH (qu, kN/m^2)
Very Soft	< 25
Soft	25 ~ 50
Medium Stiff	50 ~ 100
Stiff	100 ~ 200
Very Stiff	200 ~ 400
Hard	> 400

Clayey soil is generally referred to a composed mass of fine clay mineral particles. Fine clay material consisting of montmorillonite, kaolinite and illite. Table 2.2 show general characteristic of clay

Table 2.2 General Characteristic of Clay

CLAY MINERAL	Kaolinite	Illite	Montmorillonite
Typical thickness (nm)	50 - 2000	30	3
Typical diameter (nm)	300 - 4000	10000	100 - 1000
Specific surface (m^2/g)	10 - 30	50 - 100	200 - 800
Cation exchange capacity (meq/100g)	3	25	100
Activity (PL/%clay)	0.3 - 0.5	0.5 - 1.3	1.5 - 7
Swell potential	Low	Medium	High

2.2.1 Compressibility of Clay

Geological history, mineralogical composition, amount of clay fraction, structure, distribution and texture of the grains are factors that affect the compressibility of clay. The main parameter required is the compressibility of the soil which is the coefficient of volume compressibility. It is a measure of the amount by which the soil will compress when loaded and allowed to consolidate (Head, 1988). The increasing of depth will decrease the porosity, plasticity, and water content of clay due to it is geological age.

2.3 Solid Waste

Now days, the creation of non-decaying waste materials combined with a growing consumer population has resulted in a waste disposal crisis due to many of the wastes produced and will remain in the environment for hundreds thousands of years. The solutions to this crisis lie in recycling and reused waste into useful products. In general the engineering properties of soil subgrade were high plasticity material were improved by using waste material as stabilizer. Soil reinforcement with randomly distributed fiber is

another approach which may improve soil properties by increase the internal cohesion of soil, improved the shear strength parameter, compressive strength and bearing capacity.

2.3.1 Properties of Plastic Solid Waste

Most plastics in use today are thermoplastics, which mean that the material can be melted and re-shaped. These plastics have the simplest molecular structure, with chemically independent macro-molecules. This type of plastic is in solid form at ambient temperature and becomes deformable at elevated temperatures, and the process of hardening at low temperatures and softening at high temperatures is reversible. By heating, they are softened or melted, then shaped, formed, welded, and solidified when cooled. Multiple cycles of heating and cooling can be repeated without severe damage, allowing reprocessing and recycling. Plastic waste constitutes the third largest waste volume in Malaysian municipal solid waste (MSW), next to putrescible waste and paper. The plastic component in MSW from Kuala Lumpur averages 24% (by weight), whereas the national mean is about 15%. The 144 waste dumps in the country receive about 95% of the MSW, including plastic waste. The useful life of the landfills is fast diminishing as the plastic waste stays un-degraded for more than 50 years.

Recycling of plastic is only environmentally and resource sound if it is separated into its generic plastic types, which makes it possible to produce a recycled plastic with properties comparable to virgin plastic. However PSW is a mixture of several polymers and it is not practically possible to sort the polymers into its generic plastic form. This is due to several factors such as expensive sorting prices and the presence of different polymers in a single product. The production of raw polymeric materials from crude oil is relatively inexpensive. Given the cost of collecting, shipping, sorting, and cleaning recycled polymers, there is little financial incentive for manufacturers of polymer resins to recycle material.

Another factor that accounts for the existence problems is constructed from two (or more) different homopolymers. Homopolymer is a single monomer that polymerized into a macromolecule. Examples of this include some detergent bottles that made up with the body of HDPE and cap of PP. A possible strategy to overcome this dilemma is to recycle waste plastics as ''commingled or mixed plastics'', which means that the plastics are reprocessed without prior sorting according to plastic type. However the majority of plastic found in mixed plastic waste are immiscible, when melt blended, such plastic form complex dispersed morphologies and often have inferior mechanical properties, poor surface properties. This type of recycling is therefore sometimes referred to as ''down-cycling''.

2.3.2 Polypropylene

Polypropylene (PP) is a thermoplastic that compose of a linear structure based on the monomer CnH2n. PP is a by-product of oil refining processes and it is manufactured from propylene gas in presence of a catalyst. It has an intermediate level of crystallinity which is between low density polyethylene (LDPE) and high density polyethylene (HDPE). PP also has higher tensile strength and working temperatures than polyethylene. Table 2.3 show properties of different thermoplastic. From the table, PP has the lowest density