STRENGTH OF SOFT CLAY EMBEDDED WITH SINGLE CRUSHED POLYPROPYLENE (PP) COLUMN

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Thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor in Civil Engineering

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JUNE 2016

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Civil Engineering.

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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LIST OF SYMBOLS

Ac	Area of column
As	Area of sample
c	Cohesion
Cc	Compression index
Cc	Coefficient of gradation
Cu	Uniformity coefficient
e	Void ratio
ε	Strain
Gs	Specific gravity
Hc	Height of column
Hs	Height of sample
i	Hydraulic gradient
k	Permeability coefficient
m	Moisture content
Se	Elastic settlement
Sc	Primary consolidation settlement
Ss	Secondary consolidation settlement
ST	Total settlement
Pc	Maximum pressure the soil has been subjected to in past
ρd	Dry density
ρd-max	Maximum dry density
ρd-min	Minimum dry density

LIST OF ABBREVIATIONS

ABS	Acrylonitryl Butadien Styrene
AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
BS	British Standard
BSCS	British Soil Classification System
CL	Clay low plasticity
CH	Clay high plasticity
EPR	Ethylene-propylene rubber
FYP	Final Year Project
HDPE	High-density polyethylene
HPP	Homo-polymer Polypropylene
LL	Liquid limit
LDPE	Low-density polyethylene
MDPE	Medium-density polyethylene
MH	Silt high plasticity
ML	Silt low plasticity
MPMA	Malaysian Plastics Manufacturer Association
NP	Non-plastic
PC	Polycarbonate
PE	Polyethylene
PI	Plasticity index

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ABSTRACT

Stone column could be used as a ground improvement technique where a portion of soft soil is replaced with granular material such as stone or sand. The benefit of using stone columns in low strength soil has been proved as an efficient method to improve bearing capacity and reduce settlement of soft soils. This study was aimed to investigate the improvement in shear strength of soft clay by embedded with a group of pellet polypropylene column (PP column). This paper was done by determine the effect of area replacement ratio and height penetration ratio of a single PP column on shear strength characteristics. Unconfined Compression Triaxial Test (UCS) was conducted for 7 batch kaolin samples including control sample in order to determine the shear strength. The research variable are diameter and height of polypropylene column which under a concept of critical length of column. The increment of shear strength by embedded with PP column are 58.23%, 47.50% and 48.93% with 10.24% area replacement ratio at column penetration ratio of 0.30, 0.50 and 0.80 respectively. Meanwhile, having 25% area replacement ratio, the improvement of shear strength are 91.24%, 42.78% and 25.30% at column penetration ratio of 0.30, 0.50 and 0.80 respectively. From the result obtained, the relationship of the increment of shear strength with the various column penetration show different pattern.

ABSTRAK

Medan batu boleh digunakan sebagai teknik pembaikan tanah di mana sebahagian tanah lembut diganti dengan butiran bahan seperti batu atau pasir. Manfaat menggunakan tiang batu di tanah yang kekuatannya rendah telah membuktikan sebagai satu kaedah yang berkesan untuk meningkatkan keupayaan galas lapisan dan mengurangkan penyelesaian tanah lembut. Tujian kajian ini adalah untuk menyiasat peningkatan kekuatan ricih tanah liat lembut yang tertanam dengansekumpulan pelet polipropelin tiang (PP Tiang). Kajian ini telah dilakukan oleh menentukan kesan kawasan nisbah gantian dan nisbah penembusan lajur PP single mengenai ciri-ciri kekuatan ricih. Ujian Triaxial mampatan unconfined (UCS) telah dijalankan untuk sampel kaolin batch 7 termasuk sampel kawalan bagi menentukan kekuatan ricih. Pembolehubah kajian adalah garis pusat dan ketinggian tiang yang polipropelin yang di bawah konsep tempoh kritikal lajur. Kenaikan kekuatan ricih dengan tertanam dengan kolum PP akan 58.23%, 47.50% dan 48.93% dengan 10.24% kawasan penggantian nisbah dengan nisbah penembusan tiang 0.30, 0.50 dan 0.80 masing-masing. Sementara itu, mempunyai nisbah gantian kawasan 25%, peningkatan kekuatan ricih adalah 91.24%, 42.78% dan 25.30% dengan nisbah penembusan tiang 0.30, 0.50 dan 0.80 masing-masing. Daripada hasil yang diperolehi, keputusan yang didapeti ada hubungan antara kenaikan kekuatan ricih dengan penembusan lajur pelbagai menunjukkan pola yang berbeza.

CHAPTER 1

INTRODUCTION

1.1 Background of Research

Construction industry consume substantial amount of raw materials in the process and the output is obviously the product and most importantly the waste material. Other than that, construction industry is well known as one of the worst environment polluters (Kamal, 2009). The environment is the main issue nowadays that affects everyone life and the level of awareness is steadily increasing as people become better informed to recognize the influence of both global and local environmental impacts on their quality of living. There are several methods to cover up the endanger that created by negative impact of construction industry. Government has introduced awareness program to cultivate about the non-renewable natural material and the production of waste from construction factory, which are endanger the earth in indirect way. In order to sustain the environment, 3R (Reduce, Reuse, Recycle) concept is much important to control the waste from natural material and by-product from industrial.

According to Municipal Solid Waste (MSW), increasing population and urbanization growth and other factor influence directly the MSW generation in

Malaysia. The solid waste composition in most Asian countries is highly biodegradable with high moisture contents such as food waste, plastic, plastic foam, agricultural waste, rubber, wood, metal, glass and textiles (Tarmudi, 2009). In order to reduce the solid waste, plastic, paper and glass are among three types of waste identified as main potential for recycling. To control the plastic waste, Asian countries are running the "No Plastic Day" activity to reduce the usage of plastic every weekend. In Year 2000, plastic waste in Kuala Lumpur was 24.4% by weight from MSW and most of the waste is still being disposed into landfills (Zhila, 2012).

There are many industries categorized under petrochemical and one of them is the plastic industry. As of today, the plastics manufacturing industry has become a major supporting industry of the electronics, packaging and automotive industries. The plastics industry has shown a very positive growth and have good prospect for the future. There is few major plastics resin being consumed by the Malaysian plastics manufacturing industries such as: Polyethylene (PE), Polypropylene (PP), Polystyrene (PS), Polyvinyl Chloride (PVC), Acrylonitrile-Butadiene-Styrene (ABS) and Polyethylene Terephthalate (PET).

One of the most popular plastic products is Polypropylene (PP), which is a polymer prepared catalytically from propylene. Polypropylene is a translucent material with excellent mechanical properties and it had gradually replaced the polyethylenes for many purposes. Polypropylene plastic have consistency enjoyed a very rapid growth globally since it was commercially produced. The major global products and markets for polypropylene are Flexible and Rigid packaging (37%), Automotive, Electrical & Electronics and Appliances (21%), Textile applications (18%), and others (24%) (Zaki, 2008).

Polypropylene is a thermoplastic polymer produced from propylene gas and used in an extensive variety of applications. Loop reactors are widely used in large-scale polymerization industries because they offers low capital and maintenance cost, high production rate, high heat removal, and maintain homogeneous temperature,

pressure and catalyst distribution. Homopolymers, random copolymers and impact copolymers are three basic categories of polypropylene resins. Polypropylene homopolymers exhibit high stiffness, high temperature resistance and excellent chemical resistance. Polypropylene homopolymers are used to produce such as oriented film, thermoformed deli containers, appliance parts and closures (Equistar, 3000). Polypropylene does not have a good characteristic while at low temperature. The way to improve the impact of strength of polypropylene at low temperature is to add second component, ethylene. Polypropylene impact copolymers provide the highest level of impact in strength. Since polypropylene has various types of requisites, process upgrading is very essential in ensuring good quality and decreasing the producing of off spec product.

In term of physical properties, polypropylene (PP) is a linear hydrocarbon polymer and the typical density of the PP is $0.9g/cm^3$. The products based on PP are very significant commercial due to the advantages of being low in both density and the cost. Besides that, its crystalline structure and high melting point results in resistance to solvent and high temperature (Galpaya, 2009). However for the chemical properties, polypropylene is suitable used in application which high speed fine denier fiber production. Polypropylene having a high melt flow that reached 230˚C and tensile strength reached 330 kg/cm^2 (Titan, 2015).

Look into other perspective, soft clay is known as problematic soils. Soft clay deposits are widespread, they present special problems. The characteristics of soft clay are low strength and high compressibility. As a material, soft clay is a challenging type of soil for engineers. The engineers must use very low factor of safety and the decision he made can have a large economic consequences for the project. Ground improvement technique is needed to improve the bearing capacity; however the settlement and consolidation can be reduce if the soft soil is used in construction process. Some of the preferred techniques are cylindrical sand drains, prefabricated vertical drain (PVD), sand compaction piles and stone columns.