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Soil Stabilization Using Polypropelene

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Abstract

Rapid improvements in the engineering world have influence a lifestyle of human beings in ultimate extends but day to day activities of mankind are augmenting risk in the environment in the same proportion. Soil stabilization helps to reduce the risk of natural destruction which is caused due to rainfall or other aspect. The main objective of this study is to identify the soil properties and strength by using polypropylene in geotechnical application and determine the comparisons of the original soil's and altered soil properties by laboratory result on the soil sample that we obtain from Soft Soil From Research Centre For Soft Soil (Recess), University Tun Hussien Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia. Polypropylene strips obtained from waste plastic were mixed randomly with the soil. A series of Direct Shear Stress tests were carried out on randomly reinforced soil by varying percentage of polypropylene with same lengths and proportions.The result obtain are compared with the original soft soil and with altered soft soil using polypropylene.The results and conclusion were summed up which shows that use of polypropylene in soil in an appropriate amount really aids in improving the strength of soil and also helps in modification of soil properties.

Key-word: - soil stabilization, polypropelene

1. Introduction

For any land based structure, the foundation is very important and it has to be strong to support the entire structure. In order, the foundation to be strong, the soil which holds the foundation on top of it plays a vital role. Some parts of the soil structure may contain soil's which is not suitable for a foundation to put on. To overcome this

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situation, soil stabilization helps to achieve the required properties in soil needed for a construction work. Ancient civilization of the Chinese, Romans and Incas utilized various methods to improve soil strength. The method used to improve the properties of the soil by soil stabilization. Soil stabilization is the process of altering some soil properties by different method, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties. In this project, soil stabilization is done with additive method with randomly distributed polypropylene fibers. Polypropylene is made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids. The improvement in the shear strength parameter has been stressed upon and comparative studies have been carried out using different method of shear resistance measurement.

2. Problem Statement

Soil has an important role in holding a load like any structures on the soil. It only happens when the soil is stable. Soil stabilization is the process of altering some soil properties by different method to improve the stability or strength of the soil which is unstable. Clays are generally regarded as problematic soils due to their adverse consolidation settlement and volumetric change characteristics,(Mahmood R. Abdi1, Ali Parsapajouh, Mohammad A. Arjomand,2008). Low permeability clays are commonly used in construction of environmental barriers usually compacted for improved performance. The hydraulic properties of such soil-based structures can be affected by the formation of desiccation cracks which can result in the loss of effectiveness of the containing system as an impermeable barrier. Cracks increase the matrix hydraulic conductivity allowing contaminated fluids to migrate at a much greater rate than the surrounding matrix as well as reducing soil strength. Many researchers have investigated the problem of desiccation cracking by employing surface moisture barriers for decreasing the cracking potential of the soil. Bosscher and Connell reported that jointing in desiccated clays had significant effects on the hydraulic conductivity, shear strength, compressibility and slope stability of these soils. Al-Wahab and El-Kedrah studied the effect of polypropylene fibers to reduce tension cracks as well as the amount of shrink/swell in compacted clays. Soils used had a liquid limit of 54%, plastic limit of 28%, plasticity index of 26%, and an optimum moisture content of 21%. Fiber contents of 0.2, 0.4, and 0.8% of dry weight of soil with optimum fiber length of 12.7mm were used. Results showed that fiber content had no effect on maximum dry density and optimum moisture content, but reduced the amount of shrink/swell and crack index defined as the area of cracks deeper than 2mm to the total surface area of the soil sample. Nataraj and McManis studied the strength and deformation characteristics of clay soils reinforced with randomly distributed fibers as compared to natural soils. Fibrillated polypropylene fibers approximately 25mm in length were used as reinforcement with weight percentages of 0.1, 0.2 and 0.3% of the dry weight of soil. Their results indicated that the addition of fibers to the clay increased the peak shear strength, peak friction angle, cohesion, and compressive strength. The study also showed that reinforced soil was able to hold together for more deformation and therefore higher stress at rupture **(**Mahmood R. Abdi1, Ali Parsapajouh, Mohammad A. Arjomand,2008). Therefore, in this research Polypropylene is use to improve the strength of the clay. Polypropylene 1%, 3% and 5% are added to oven dry clay and laboratory test are carry out to identify the soil properties and strength.

3. Objective and Literature Review

To identify the soil properties and strength by using polypropylene and to determine the comparisons of the original soil's and altered soil properties by laboratory result. The term soil stabilization means the improvement of the stability or bearing power of the soil by the use of controlled compaction, proportioning and or the addition of suitable admixture or stabilizer. The basic principles in soil stabilization may be stated as follows evaluating the

properties of the given soil, deciding the method of supplementing the lacking property by the effective and economical method of stabilization, designing the stabilized soil mix for intended stability and durability values and considering the construction procedure by adequately compact the stabilized layers. Polypropylene is a polymer substance. In other words, it is a macromolecule or a very large molecular formed by repetition of one structural unit of propylene several times. The small molecules of propylene are bonded with each other by the means of covalent type of chemical bonds. Polypropylene is a kind of polymer which gets transformed into liquid when it is heated. And when frozen, it turns into a glassy state. The polymer that shows these properties is known as thermoplastic polymer.

Figure 1 Polypropylene (PP) in the dried soft soil

4. Methodology

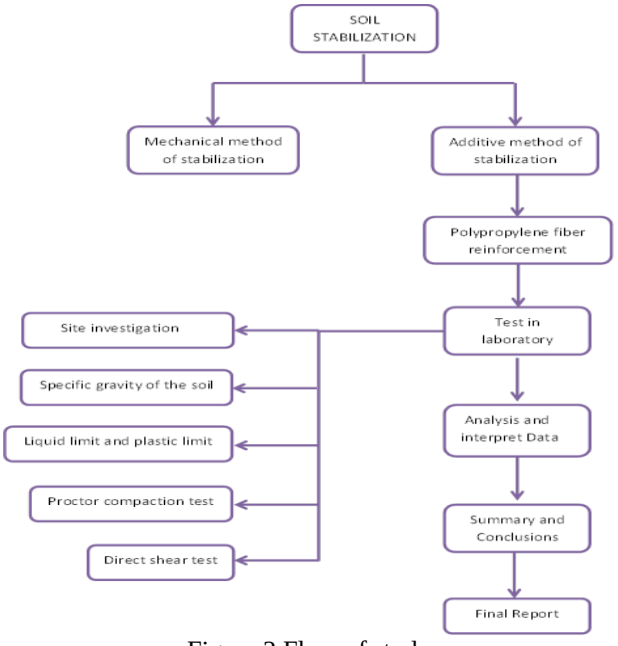


Figure 2 Flow of study

5. Site Investigation and Drill the Sample

Drill out the soil by using hoe to 1m depths and bring back about 5 kg soils as disturb soil.

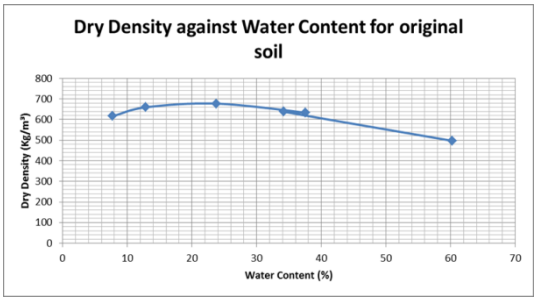
Sampeling tube for undisturb sample

Connecting sampling tube which cut from a 2inch PVC pipe for the length of 120mm to connecting rod. Press down soil sampling PVC tube into base of the hole.

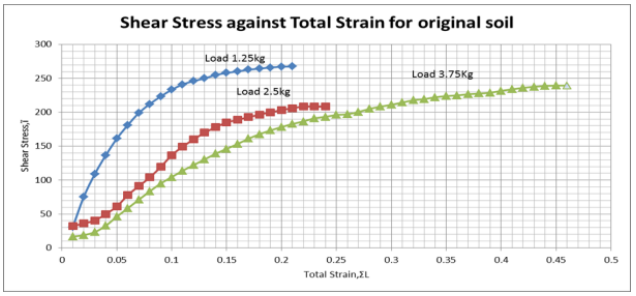
Take 5 nos of soil sample tube from the hole as a undisturbed soil.

The 5 nos was waxed and sealed, before putting the soil into sampling bag.

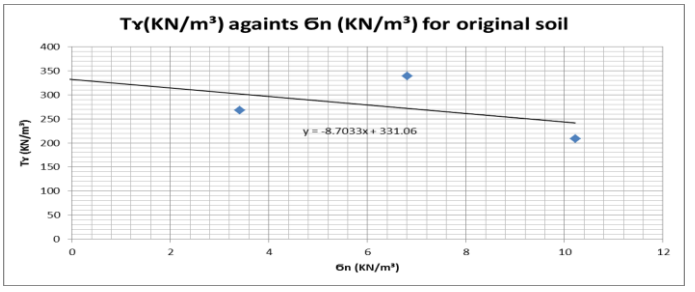
6. Data Analysis – Original Soil



Graph 1 Dry Density against Water Content for original soil



Graph 2 Shear Stress against Total Strain for original soil

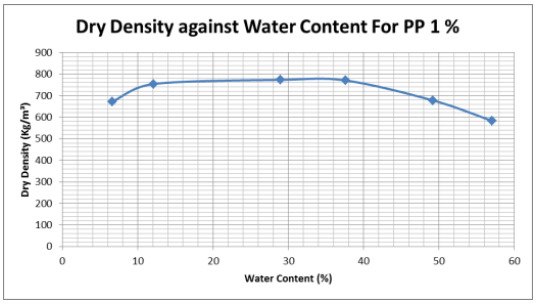


Graph 3 Shear stress (KN/m³) against Normal stress (KN/m³) for original soil

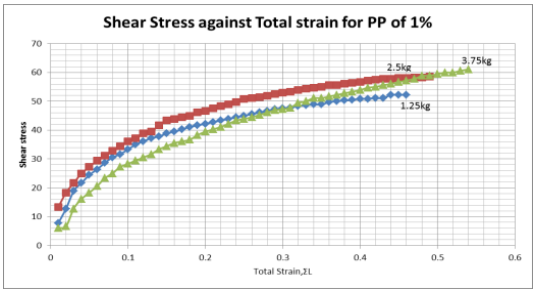
Table 1 The analysis of result for original soil.

Bulk Density, pb	1910.82 Kg/m³	
Specific Gravity	2.15	
Liquid limits	59	
Plastic limits	33.81	
Plastic index	25.19	
Based Plasticity Chart	MH & OH	
Compaction	Optimum water content (%)	Dry density,pd (kg/m³)
	23.79	677.68
Direct Shear	ø	c
	-83.45°	331.06

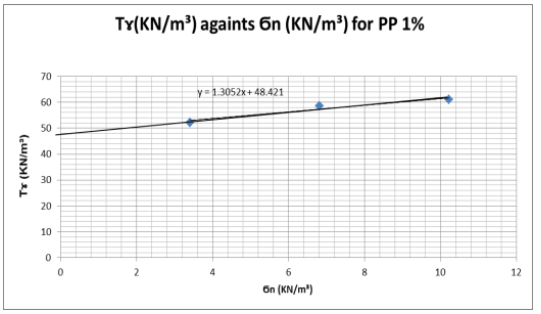
7. Data Analysis – PP 1%



Graph 4 Dry Density against Water Content for PP 1%

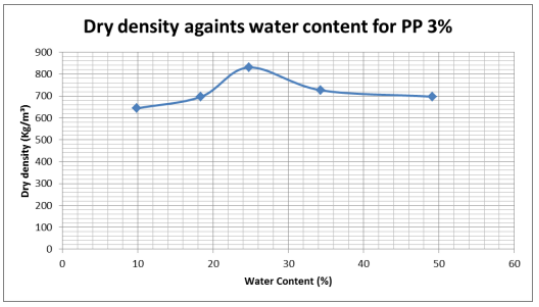


Graph 5 Shear Stress against Total Strain for PP 1%

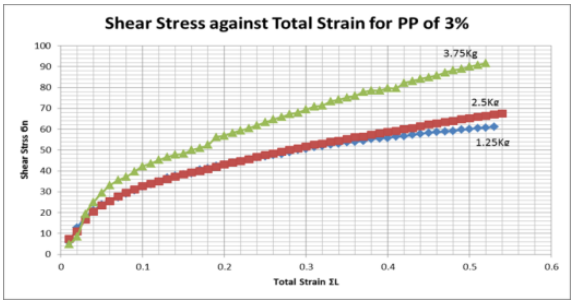


Graph 6 Shear stress (KN/m³) against Normal stress (KN/m³) for PP1%

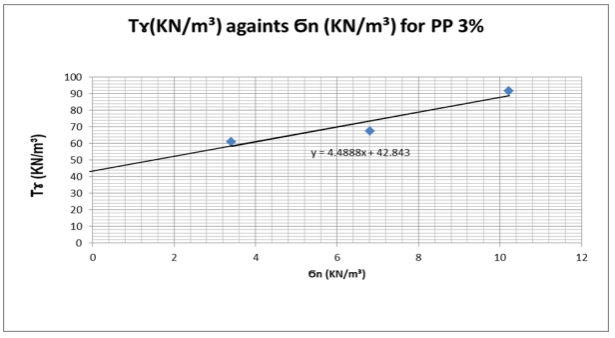
8. Data Analysis – PP 3%



Graph 7 Dry Density against Water Content for PP 3%



Graph 8 Shear Stress against Total Strain for PP 1%

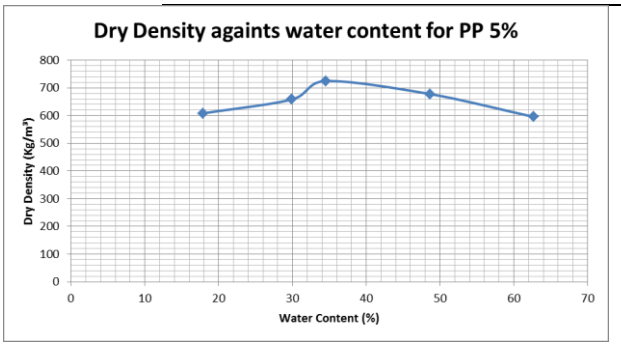


Graph 9 Shear stress (KN/m³) against Normal stress (KN/m³) for PP 3%

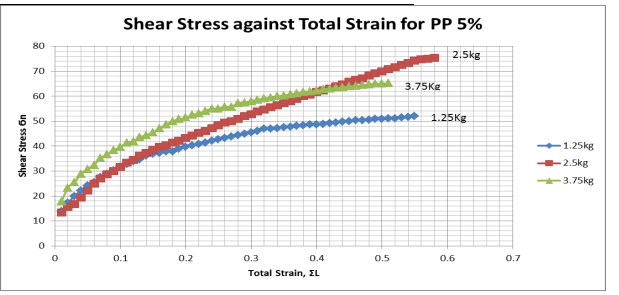
Table 2 The analysis of result for PP 3%

9. Data Analysis – PP 5%

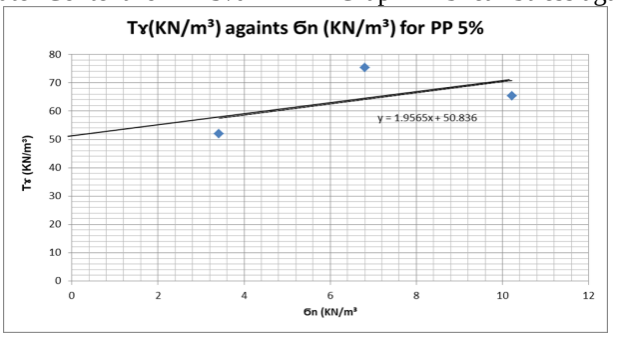
Liquid limits	**73**	
Plastic limits	47.18	
Plastic index	25.82	
Based Plasticity Chart	MH &OM	
Compaction	Optimum water content (%)	Dry density,pd ,kg/m^3
	24.75	830.37
Direct Shear	ø	c
	77.44	42.84



Graph 10 Dry Density against Water Content for PP 5%



Graph 11 Shear Stress against Total Strain for PP 5%



Graph 12 Shear stress (KN/m³) against Normal stress (KN/m³) for PP 5%

Table 3 The analysis of result for PP 5%.

Liquid limits	**42**	
Plastic limits	31.62	
Plastic index	10.38	
Based Plasticity Chart	MH & OL	
Compaction	Optimum water content (%)	Dry density,pd ,kg/m³
	39.42	724.54
Direct Shear	ø	c
	62.93	50.84

Discussion

The Original soil from Soft Soil from Research Centre For Soft Soil (Recess), University Tun Hussien Onn has the bulk density of 1910.82Kg/m³ and the specific gravity of the soil is 2.15. The atterberg limit test that we carry out is to find the liquid limit which is 59, plastic limit is 33.81 and the plastic index is 25.19 which is medium plastic. Based from the plasticity index chart, it shows the original soil is High plasticity Silt and High Plasticity Organic .The optimum Water Content is 23.79% for original soil with maximum dry density of 677.68Kg/m³. The friction angle of the original soil is -83.45˚ with cohesion 331.06 kN/m². After added PP in various percentage, the results shows that , The original soil which is weak in strength has improved as the value is in the range without too much of differences since adding the PP. The adding of 3% of polypropylene has a show a good grade compare to the other percentages as the readings and data increase gradually and does not drop like other percentages.

Conclusion

The study on the strength and deformation characteristics of clay soil reinforced with different percentage of Polypropylene, can be concluded as follow: The results indicated the addition percentage of PP to the clay increased the dry density and friction angle of the soil. The study also showed that reinforced soil was able to hold together for more deformation and therefore higher stress at rupture.

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