INTI INTERNATIONAL UNIVERSITY

Faculty of Engineering and Quantity Surveying

INVESTIGATION OF SOIL IMPROVEMENT BY USING BITUMEN EMULSION FOR SUBGRADE

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SUPERVISOR'S DECLARATION

This project report entitled Investigation of Soil Improvement by Using Bitumen Emulsion for Subgrade is prepared and submitted by Keshantran A/L Murugan I14004778 as partial fulfillment of the requirement for Bachelor of Engineering (HONS) in Civil Engineering, INTI International University.

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STUDENT'S DECLARATION

I hereby declare that the final year project is based on my original work except for quotations and citation, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at INTI INTERNATIONAL UNIVERSITY or other institutions.

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ABSTRACT

Soil is significant material found in amplitude by nature, which makes up the base of any construction that is executed. The types of construction carried out are always dependent on soil. Subgrade soil is the most important part of a road pavement. Stabilization is commonly needed if strength of soil is poor. Increase in subgrade strength may lead to economy in the structural thicknesses of a pavement. The main objective of this experimental study is to improve the properties of the clay soil by adding bitumen emulsion (RS1) and to achieve the optimum percentage of bitumen emulsion required to obtain minimum strength required for subgrade layer as set by JKR. An attempt has been made to use bitumen for improving the strength of clay soil which expressed in terms of CBR and UCS values that may prove to be economical. In this study, the whole laboratory work revolves around the basic properties of soil and its strength in terms of CBR and UCS. This is followed by deciding with 0%, 1%, 2%, 3%, 4%, and 5% of stabilizer to show the variation in CBR and UCS value to achieve the best possible strength properties of clay soil with JKR specification. Based on the UCS analysis, 5% of bitumen emulsion stabilized with clay soil gives unconfined compressive strength of 985.91kN/m^2 and CBR analysis indicates that CBR value increased effectively up to 80% with increase percentage of bitumen emulsion from 0% to 5%. Hence, it has been observed that clay soil are suitable material to be use as subgrade layer by stabilized with bitumen emulsion.

Keywords: Clay soil, UCS, CBR, Bitumen emulsion

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AASHTO	American Association of State Highway and Transportation Officials
CBR	California Bearing Ratio
LL	Liquid Limit
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
PI	Plasticity Index
PL	Plastic Limit
PWD	Public Work Department
UCS	Unconfined Compressive Strength

CHAPTER 1

INTRODUCTION

1.1 General

Soil is eroded due to a particular strong binder between the particles forming soil is unable anymore to hold pressure on it. Loads may be in the form of striking or sparkling of rains fall to the soil surface because of friction caused by water flow on the soil surface. Generally, the soil has the capability to control the pressure on it but then due to the heterogeneous soil characteristics, there is a type of soil, which has insufficient capacity. Minerals from the soil consist of elements and chemical compounds that may react with other chemicals that mixed with it (Garber *et al.*, 2009).

1.1.1 Soil as Subgrade

Soil is significant material found in amplitude by nature, which makes up the base of any construction that is executed (Chauhan, 2010). The types of construction carried out are always dependent on soil. The long lasting performance of the pavement structure down the years is conditional on the durability and strength of the subgrade soils used. Subgrade in-situ is a material that placed below the pavement structure. Achieving the satisfactory performance by using subgrade in-situ at the traffic that will be loaded with increasing environmental demands seldom provides supports. Though it is proven by facts that stabilization is a conventional possibility to enhance the properties of soil engineering, however determination of properties from the stabilization relocate widely due to the chemical contrast in concoction interaction that

takes place between the soil and utilized stabilizer. The thought of site-specific treatment required for these properties is compulsory which is by testing of soil stabilizer mixtures. The pavement laid by an embankment or cutting on a soil foundation which is commonly known as subgrade is to acknowledge the flexibility or the rigidness of the particular pavement. A pavement is a layer that is compacted, universally existing inhabitant soil laid underneath the pavement crust and lay outs a strong standing substructure to the pavement. In conjunction to traffic loads, the subgrade undergoes a certain amount of minimum level of stress. For the optimum use of subgrade soil to hold out against the stress caused by the traffic loads for a particular pavement, it has to be of adequate quality and appropriately compacted. Besides that, the characterization of the subgrade soil for its strength depends on the motives of various designs of whichever particular pavement. Soil stabilization is made reference to the enhancement of soil engineering properties. There are a couple of techniques for soil stabilization, which are the mechanical procedure and the chemical procedure (Jones *et al.,* 2010). Among the earth materials, found abundantly, the soil serves a lot of purpose. Soil origins can be discovered instantly with force supplies in the field, which commonly is form from the breakdown of rocks.

Subgrade soil is referred as the supporting soil beneath the pavement. The soil underneath that is not disrupted is termed as regular subgrade soil. The constrained expansion of typical types of substantial compactors usually compacts the soil which is then named as the compacted sub grade soil. Nowadays, the stabilization strategies utilized in every road construction projects is based on one or two of them. The process of soil compaction which is by adding the cement, lime or bituminous is suggested being included material strategy for the soil stabilization is the most common type of mechanical soil stabilization. The soil classification system, which is precisely invented for the construction of highways and roads, is termed as the American Association of State Highway and Transportation Officials (AASHTO), which is commonly exploited by the transportation engineers (Verma, 2015). To classify the soil properties, this system uses the atterberg limits, such as liquid limits and plasticity index. Various kind of additive from different classes is accessible yet only some of the additives are appropriate to add into any kind of soil. In common words, an additive play the role of a binder, once affected by moisture that causes the density of the soil to rise. Portland cement, quicklime or hydrated lime, fly ash, calcium chloride are the sorts of the most commonly used additives (Sajja *et al.,* 2010). Mechanical soil stabilization suggests compacting. Amplification of categorized aggregate

materials is compaction followed by the mechanical remediation, which are the procedures established to accomplish mechanical stabilization. Being an uncertain component, soil persuades the proper completion of projects that comes under constructions. This is because a structure that is purely land-based solely sustain upon the features of its substructure. Throughout the whole construction process, among the raw materials used in earliest part of the foundation is the soil. The procedure of maximizing the CBR strength of soil, which particularly serves the purpose of construction, turns out to be the primary motive of soil stabilization (Verma, 2015).

1.1.2 Bitumen Emulsion for Soil Stabilization

Bitumen droplet that is suspended in water is contained by emulsified bitumen. Surface treatment makes use of most emulsions. The emulsion has a better spreading capacity and penetration due to the low viscosity of the emulsion. To recognize if an emulsion is anionic or cationic, emulsifying agents are used in the bituminous emulsion (Verma, 2015). Bituminous droplet has positive charge for cationic emulsion and has negative charge for anionic emulsion. To specify how instantly water detaches from the emulsion or settle down is dependent on their setting time. After that, cationic and anionic emulsions are break down into three categories. The three categories are rapid setting, medium setting, and slow setting (Jones *et al.,* 2010). Emulsion of rapid setting has a limited time before setting which makes it very dangerous to work with. For medium setting emulsion, it consumes approximately 6 hours, which offers sufficient time to appropriately place all the materials before setting which makes medium setting to be handled conveniently. The sort and portion of emulsifying agent performs as a controlling factor of the setting time. The significant difference that occurs in between a cationic and an anionic emulsion is that the anionic emulsion does not give up water as easily as compared to the cationic emulsion. In the long run, the asphalt stage would be separated from the water. The emulsion then breaks down inclusive of droplets that combine since Asphalt is insoluble in water.

The emulsion containing droplets of asphalt consist of small charges. An emulsifier and all ionisable segments that come with the asphalt itself are the wellspring of the charge. The two droplets hold fast to one another after they attain enough vitality to defeat the barrier and