STABILIZATION OF SUBGRADE BY USING FLY ASH RELATED TO ROAD PAVEMENT THICKNESS DESIGN AT JALAN JAYA GADING

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ABSTRACT

This project aims to study the effectiveness of adding fly ash by percentage to the subgrade with increasing the California Bearing Ratio (CBR) value. The fly ash will be added to the plain soil (subgrade) by using 4% and 8% fly ash and tested by following ASSHTO as guidance steps. California Bearing Ratio (CBR) is a commonly used directly as to assess the stiffness modulus and shear strength of subgrade in pavement design work. If the CBR value is increasing by adding the fly ash to the soil, it's shown its effectiveness in increasing soil strength and vice versa. Overall, when California Bearing Ratio (CBR) value increases, the thickness of pavement design can be reduced and subsequently the road construction of the affected road section will be more economically.

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LIST OF SYMBOLS AND ABBREVIATIONS

AASHTO	-	American Association of State Highway and Transportation Officials
ADT	-	Average daily traffic
ASTM	-	American Society for Testing and Materials
CBR	-	California Bearing Ratio
CD	-	Consolidated drained
CU	-	Consolidated undrained
CU'	-	Consolidated undrained with pore water pressure measurements
ef	-	equivalence factor
ESAL	-	Total Equivalent Standard Axle Load
JKR	-	Jabatan Kerja Raya
LL	-	Liquid limit
n	-	Design period (years)
μ_{op}	-	Optimum moisture content
Pc	-	Percentage of commercial vehicles
PI	-	Plastic index
PL	-	Plastic limit
r	-	Estimate the rate of annual traffic growth
SSA	-	Specific surface area
T_A	-	Equivalent thickness
UU	-	Unconsolidated undrained
V_c	-	The total number of commercial vehicles
V_o	-	The initial yearly commercial vehicle traffic
$\gamma_{d.max}$	-	Maximum dry density

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Fly ash is a by-product of the pulverized coal combustion process usually associated with electric power generating plants. Fly ash is a fine grained dust and is primarily composed of silica, alumina and various oxides and alkalies. It is pozzolanic in nature and can react with hydrated lime to produces cementitious products. (Braja M.Das)

A certain type of fly ash is obtained from the burning of coal preliminary from the western United States to as "Type C" fly ash. It contains a fairly large proportion of free lime that, with the addition of water, will react with other fly ash compounds to form cementatious products. This may eliminate the need to add manufactured lime. (Braja M.Das)

The soil stabilization is the alteration of soil properties to improve the engineering performance of soils. The properties most often altered are density, water content, plasticity and strength. Modification of soil properties is the temporary enhancement of sub grade stability to expedite construction.

Fly ash can be an effective binder for stabilizing soils for highway bases. However, limited information exists on the reuse of high carbon off-spec fly ash in construction of highway pavements. This is particularly important when high carbon fly ash is non-cementitious and calcium-rich activators are required to generate pozzolanic reactions. Thus, there is a need to evaluate the strength and stiffness of base layers stabilized with high carbon fly ash.

Fly ash can be used to stabilize bases or subgrades, to stabilize backfill to reduce lateral earth pressures and to stabilize embankments to improve slope stability. Fly ash has been used successfully in many projects to improve the strength characteristics of soils. Typical stabilized soil depths are 15 to 46 centimeters (6 to 18 inches). The primary reason fly ash is used in soil stabilization applications is to improve the compressive and shearing strength of soils.

For fly ash stabilization, the selection of a mixture of soil, fly ash, and water usually depends on which one would provide the intended geotechnical properties on a short-term basis. The long-term performance of fly ash stabilized soils in the context of field environments after exposure to successive different weather cycles, such as wet–dry or freeze–thaw cycles is often ignored. The effect of weathering cycles on natural soils and soils stabilized with other cementitious materials, such as lime and/or cement, suggests that the weathering action might have a pronounced effect on the long-term performance of fly ash stabilized soils.

1.2 Problem Statement

In Malaysia, road is an important form of communication that connects to a destination to other destination. In this study case, I referred at Jaya Gading road because the road condition was very bad and not satisfactory. Because of that, we can see many accidents occur at Jaya Gading road.

Added the roads at Jaya Gading always have problems such as holes and damaged on the roads and cracking pavement. Poor maintenance of road such as potholes, water ponding debris on the road edges, drains are not properly maintained, poor construction, wrong design and poor road surface. Others, the consolidation of the soil also not good and have settlement at certain soil. That's all factors can cause drivers to make surprise manoeuvres and increase the risk of accident.

The poor condition of road could probably cause by the unstable sub grade. The engineering properties of sub grade need to be taken into consideration as it influence the ability of sub grade to resist force from the upper layer. The bad condition of road at Jaya Gading was the result from poor construction of the road. In site investigation of road, the most important thing is in determination of the engineering properties of soil. In this case study, the contractor need to confirm the soil classification in order to used the parameter for design. Poor classification could be the problem of the bad condition of road.

Commonly, the type of soil at Jaya Gading is soft soil. If the soil under the surface layer is not good, then the upper layer will be broken down. In any road in the world, especially at Malaysia (Jaya Gading), the sub grade layer is the critical part we must obtain their strength so that there are not have any problems to the users.

In order to avoid the surfacing course from damage easily, a good compaction for obtaining optimum moisture content (OMC) should be done. OMC of a soil would influence the percentage value of California Bearing Ratio (CBR). For this case study, it would come from a lower percentage value of CBR.

In other words, we must make sure that the soil under the road especially the sub grade must be strong and available to use and if the soil is not full fill of criteria of the JKR road, we must upgrade the soil with some method to make sure the soil is safe to be use as road base.

Figure 1.1: the damage of pavement

1.3 Objectives of Study

The objectives of this study are;

i. To identify the engineering properties of soil
ii. To know the relationship between percentage fly ash and CBR value.
iii. To determine the thickness and costing of the pavement.

1.4 Scope Of Study

This study is done based on the specific scope in order to ensure the precision of the study area. Besides, it is also done in order to achieve the objective of the study. Therefore, its limit has been specific to specific scopes which are:

i. Site Location

The location of the project site is limited for district of Jaya Gading road. Several sites which involved in soil embankment in Kuantan are being visited.

ii. Scope of work

In this project, sample are taken from the Jaya Gading site and tested at the laboratory in order to determine the engineering properties of the soil samples, laboratory testing such as particle size distribution, moisture content and atterberg limit will assessing the characteristic of the soil samples. Others laboratory test such as compaction and CBR are important in determined the thickness of pavement.

Figure 1.2: Site location

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

2.1.1 Soil Properties

Naturally occurring materials that are used for the construction of all except the surface layers of pavements (concrete and asphalt) and that are subject to classification test (ASTM D 2487) to provide a general concept of their engineering characteristics. (Gordon R. Sullivan, 1994)

People describe soil types in all kind of ways such as heavy, light, clay and loam, poor or good. Soil scientist describes soil type by how much sand, silt and clay are present. This is called texture. It is possible to change the texture by adding different things. Changing texture can help in providing the right condition needed for plant growth.

Sand is the largest particle in the soil. When you rub it, it feels rough. This is because it has sharp edges. Sand doesn't hold many nutrients. Silts are soil particle whose size is between sand and clay. Silt feels smooth and powdery. When wet, it feels smooth but not sticky.

Clay is the smallest of particles. Clay is smooth when dry and sticky when wet. Soils high in clay content are called heavy soils. Clay also holds a lot of nutrients but doesn't let air and water through it well.

Particle size has a lot to do with soils drainage and nutrients holding capacity. To better understand how this big three soil, we can imagine that if a particle of sand were the size of basketball, then silt would be the size of a baseball, and clay would be the size of a golf ball. Line them up, and we can see how these particle compare in size.

Construction of roadways over soft subgrade is one of the most common problems for highway construction in many parts of the world as well as in our country, Malaysia. The usual approach to soft subgrade stabilization is to remove the soft soil, and replace it with a stronger material of crushed rock. The high cost of replacement has caused highway agencies to evaluate alternative methods of highway construction on soft subgrade.

One approach is to use fly ash to stabilize the soft sugared. The strength values of the soil–fly ash mixtures were evaluated to characterize the performance of stabilized soil as a road subbase. Unconfined compression strength and California bearing ratio (CBR) tests were performed to determine the strength properties of the soil–fly ash mixtures and the optimum mixture contents for construction.

2.1.2 Additives

Manufactured commercial products that, when added to the soil in the proper quantities, improve some engineering characteristic, and plasticity (Gordon R. Sullivian, 1994). Additives addressed in this manual are limited and only focus on the fly ash.

2.1.3 Fly Ash

Fly ash is one of the most plentiful and versatile industrial by-products. It is generated in large quantities as a by-product of burning coal at electric power plants. Class C fly ash is usually recycled as an engineering material to take advantage of its pozzolanic characteristics.

This type of fly ash provides the opportunity for applications where other activators would not be required. It offers more economical alternatives for a wide range of soil stabilization applications. The potential for using fly ash in soil stabilization has increased significantly in Malaysia due to increased availability and the introduction of new environmental regulations that encourage the use of fly ash in geotechnical applications when it is environmentally safe. Results of various investigations showed that soil stabilization with Class C fly ash without any other activator is encouraging. The improved engineering properties of fly ash–stabilized soil are also reported (Edil et al., 2000, 2002; Senol et al., 2003; Turner, 1997).

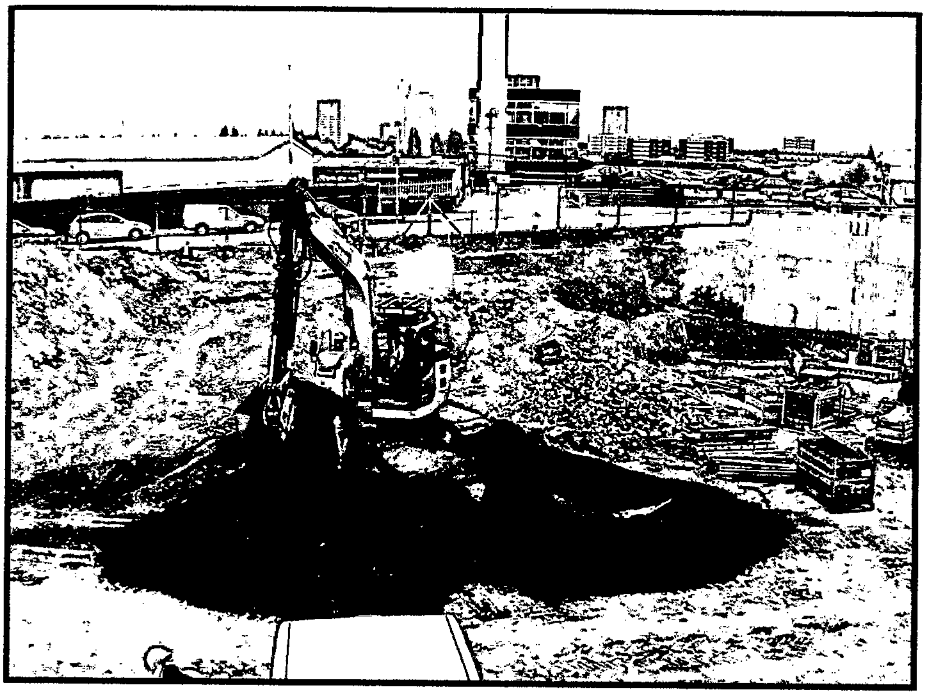

Figure 2.1: usage of fly ash at the construction site

Fly ash consists primarily of oxides of silicon, aluminum iron and calcium. Magnesium, potassium, sodium, titanium, and sulfur are also present to a lesser degree. When used as a mineral admixture in concrete, fly ash is classified as either Class C or Class F ash based on its chemical composition. Fineness of fly ash is most closely related to the operating condition of the coal crushers and the grind ability of the coal itself. A coarser gradation can result in a less reactive ash and could contain higher carbon contents. Limits on fineness are addressed by ASTM and state transportation department specifications.

2.1.4 Stabilization

Stabilization is the process of blending and mixing with a soil to improve certain properties of the soil. The process may include the blending of soil to achieve a desired gradation or the mixing of commercially available additives that may alter the gradation, texture or plasticity, or act as a binder for cementation of the soil. (Gordon R. Sullivan, 1994)

2.1.5 Modification

Modification refers to the stabilization process that results in improvement in some properties of the soil but thus not by design result in a significant increase in soil and durability. (William E. Wildman, 1981)

2.1.6 Mechanical Stabilization

Mechanical stabilization is accomplished by mixing or blending soil of two or more gradations to obtain a material meeting the required specification. The soil blending may take place at the construction site, a central plant, or a borrow area. The blended material is then spread and compacted to required densities by the conventional means. (Gordon R. Sullivan, 1994)

2.1.7 Additive Stabilization

Additive stabilization is achieved by the addition of proper percentage of cement, lime, fly ash, bitumen, or combination of these materials to the soil. The selection of type and determination of the percentage of additive to be used is depending upon the soil classification and the degree of improvement in soil quality desired (Gordon R. Sullivan, 1994).

Generally, smaller amounts of additives are required when it is simply desired to modify soil properties such as gradation, workability, and plasticity. When it is desired to improve the strength and durability significantly, larger quantities of additives are used. After the additive has been mixed with the soil, spreading and compaction are achieved by conventional means.

2.2 Soil Classification

Soil classification is a way of systematically categorizing soils according to their probable engineering characteristics. The classification of a soil is based on its particle distribution and, if the soil is fine-grained, on its plasticity (LL and PI). The most widely used classification systems used in road engineering are the unified soil classification system, AASHTO classification and British Standard Classification. Soil classification should only be regarded as a means of obtaining a general idea of soil behavior and it should never be used as a substitute for detailed investigation of soil properties. (Richard Robinson & Bent Thagesen, 2004)

2.3 Soil Engineering Properties

To have an understanding of soil action, an engineer must be familiar with certain basic soil properties. We are all familiar with the basic properties of other engineering materials, such as steel, wood, and concrete. A soil engineer must have familiar knowledge relative to soil (Paul H. Wright/Karen K. Dixon, 2004).

2.3.1 Atterberg Limits

The "liquid limit" may be defined as the minimum moisture content at which the soil will flow under the application of a very small shear force. At this moisture content the soil is assumed to behave practically as a liquid. The "plasticity limit" may be defined in general term as the minimum moisture content at which the soil remains in a plastic condition. This lower limit of plasticity is rather arbitrarily defined, and the plastic limit may be further describe as the lowest moisture content at which the soil can be rolled into a thread of 1/8 in. (3.2mm) diameter without crumbling. (Paul h. Wright/Karen k. Dixon, 2004)

The "plastic index" (PI) of a soil is defined as the numerical difference between the liquid and plastic limits. It thus indicates the range of moisture content over which the soil is in a plastic condition. Sandy soil and silts, particularly those of the rock-flour type, have characteristically low PIs, while clay soil shows high value of the plasticity index.

Generally speaking, soils that are highly plastic as indicated by a high value of the plasticity index are also highly compressible. It is also evident that the plastic index is measure of cohesiveness, with a high value of the PI indicating a high degree of cohesion. Soils that do not have a plastic limit, such as cohesionless sands, are reported as being non plastic (NP). (Paul h. wright & Karen k. Dixon, 2004)

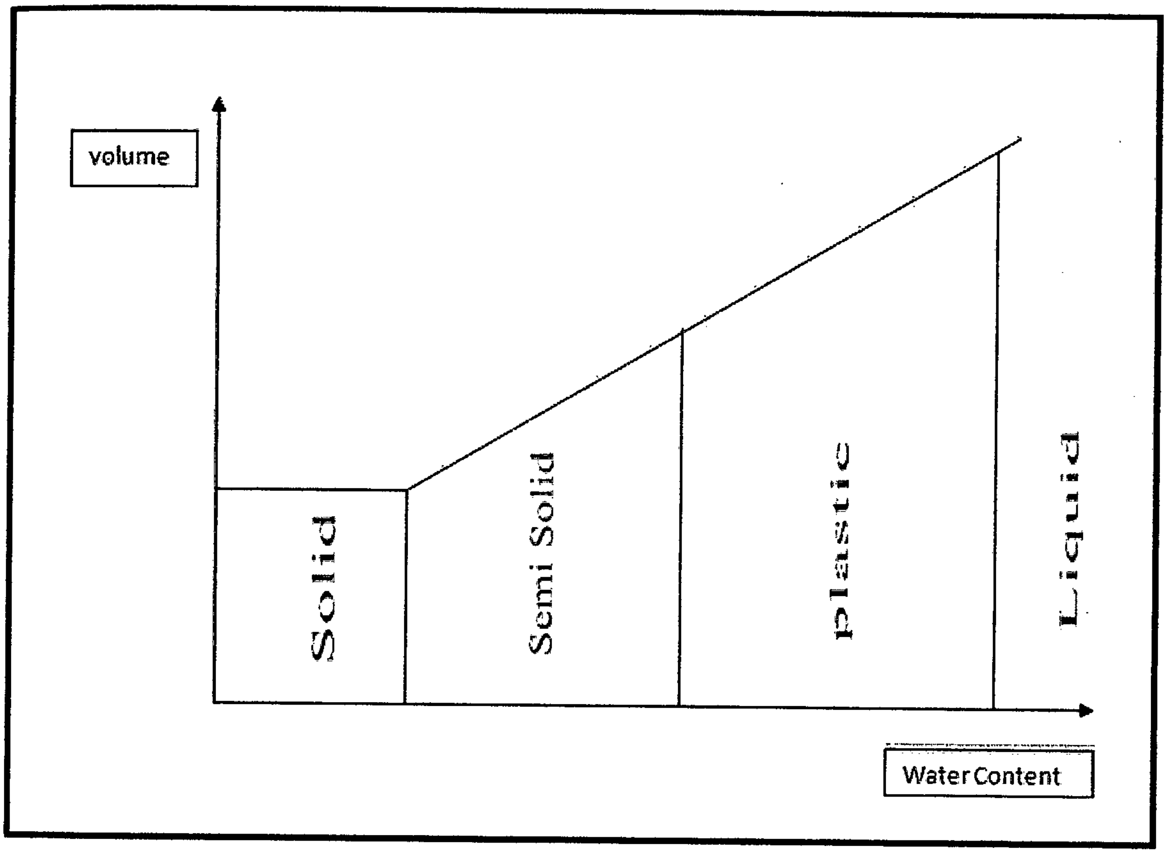

Figure 2.2: Atterberg Limit and soil volume relationship