



ESTEEM

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ENGINEERING



Geotechnical Properties of Alor Setar Clay Along Jalan Kuala Kedah-Hutan Kampung

*Mohd Farid Ahmad
Damanhuri Jamalludin
Eliyani Yazreen A.Rani
Tuan Juliana Tuan Sulong*

ABSTRACT

This research paper is to study the geotechnical properties of clay soil at Alor Setar. The main purpose of this study is to obtain design parameters for Alor Setar clay soil. Based on the study, a local database of design parameters characteristics are presented with some empirical or analytical correlation established to estimate SPT value, index properties and mechanical properties of Alor Setar clay. The data were analyzed and the correlation of each parameter with depth were obtained. Conclusions have been made based on the evaluation and the Alor Setar clay were found to have high moisture content, plastic limit, liquid limit and compression index. The soft clay depth generally down to 8 meter. From the OCR value the clay was found to be lightly overconsolidated. Based on Cc value, the compressibility potential of Alor Setar clay is high. It is hoped that the outcome from this research work can contribute for future reference.

Keywords: *Alor Setar clay, Geotechnical properties.*

Introduction

Overview

Site investigation aims to determine the nature and behavior of all aspects of a site and its environments that could significantly influence or be influenced by a project. Whenever intend to plan an engineering structure,

geotechnical properties have been identified as the important information. Poorly determined parameters of soil can affect the safety and economic viability of a project with difficult subsoil condition.

This study is intended to provide geotechnical properties of Alor Setar clay soil. The main goal of this research is to understand the geotechnical properties of clay soil found in Alor Setar. The objectives of this study are to research on the index properties and mechanical properties of Alor Setar clay soil.

Method of Data Collection

The sources of geotechnical data were collected from IKRAM and the data were the secondary data that are already available and can be used as a reference for a case study. Thus, the analysis of geotechnical properties was made by chart in Excel program. Microsoft Excel contains special statistical functions and procedures that help in the analysis of data, reprogrammed procedure that extend the functionality of the Excel program. These features help to construct statistical solutions in Excel program and simplify its uses.

General Geology of Alor Setar, Kedah

The town of Alor Setar is located at the NorthWest of Peninsular Malaysia. Generally, the site is located on marine and continental deposits of Quaternary age that was formed in Holocene period about 15000 years ago (Hussein, 1997). Malaysia soft clays are formed in marine and brackish environments. In Peninsular Malaysia, the marine clay is placed at both east and west coasts and at the southern tip, as shown in Figure 1.

Ramli (1994) has stated that the mineralogy of marine clay in Peninsular Malaysia can vary with the geographic location. The marine clay in Peninsular Malaysia is typically dark grey silty clay with little sand content. However, the color of the clay can be different compared to the other areas.

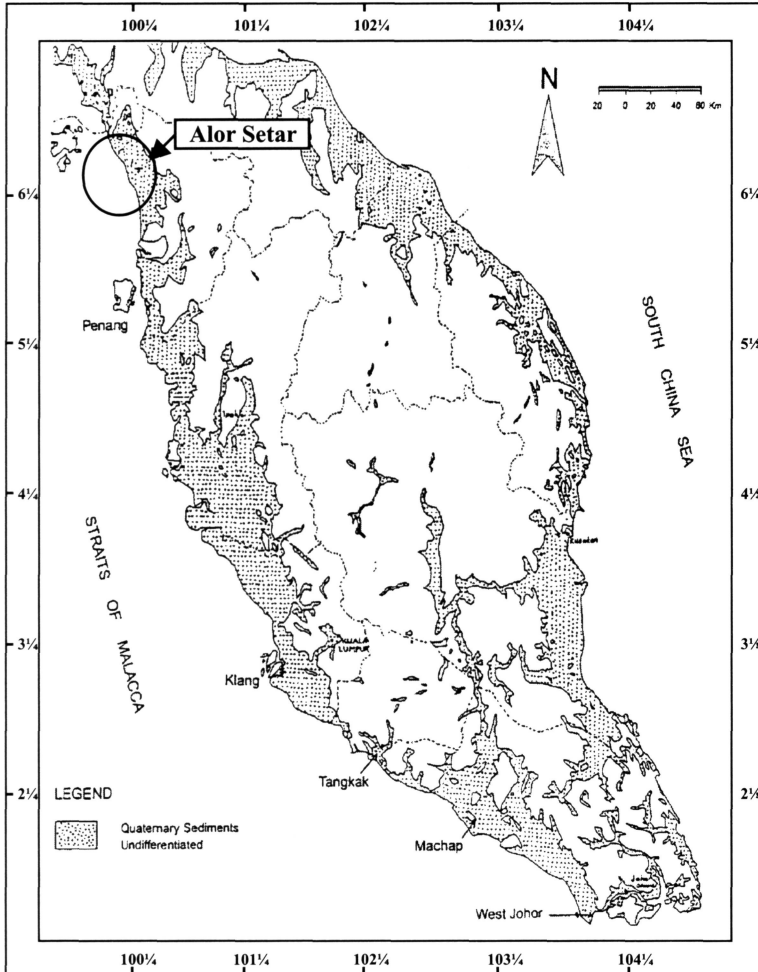


Figure 1: Unconsolidated Quaternary Sediment in Peninsular Malaysia (After Stauffer, 1973)

Geotechnical Properties

There are two properties that have been investigated, which are the mechanical and index properties. These results have been obtained from the data collected from 9 boreholes within 8 kilometers of Jalan Kuala Kedah – Hutan Kampung, Alor Setar.

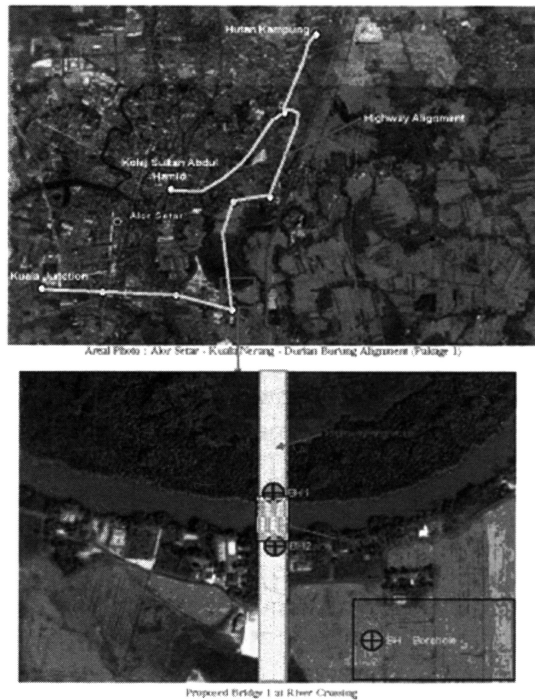


Figure 2: The Aerial Photo Showing the Location which the Sample are Taken

Particle Size Distribution

Generally Alor Setar soil includes the marine clay that consists of mixture of clay, silt and little sand content. Based on this study, the average of size particle of **clay is 57.1%**, **Silt 33.9%**, **sand 8.2%** and **gravel 0.8%**. This confirmed the typical Malaysian clay that ranges between 50% to 60% of clay content (Ramli 1999).

Bulk Unit Weight

The marine clay has variable bulk unit weight (γ_b) and typically ranges from 13 to 16.5 kN/m³ (Ramli, 1994). At Alor Setar, the bulk unit weight was in range of **13.5 to 15.8 kN/m³**. From Figure 3, there is general tendency for an increased in density with depth. The bulk unit weight depends on the water content. From the data, the increased of bulk unit weight value is because of the increased of water content.

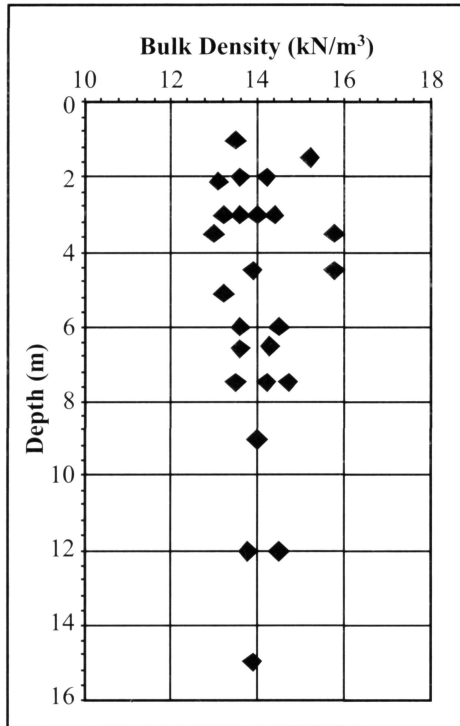


Figure 3: Bulk Unit Weight (kN/m³) Versus Depth (m) for Alor Setar Clay

Moisture Content

The moisture content for Alor Setar ranges between **22% to 133%**. From the data, the moisture content is decreased_with depth. These confirm the finding by Ramli, 1999, that the moisture content for marine clay in Peninsular Malaysia is in the range between 12% to 175%.

Liquid Limit (LL)

The liquid limit for Alor Setar was in range between **40% to 119%**. From the data, 20% of the liquid limit value is more than 100%. These shows Alor Setar clay has some organic content that the presence of organic content will increase the liquid limit

Plastic Limit (PL)

Marine clay is well known for its high to extremely high plasticity. The plastic limits for Alor Setar was in range between **20% to 79%**. When the plastic limit decreases, it indicates that there is a presence of organic matter in Alor Setar marine clay.

Plasticity Index (PI)

Alor Setar clay has a high plasticity index (PI) and the range was between **20% to 78%**. This indicates that the Alor Setar clay has a high amount of clay content. Plasticity index for deeper clay layer is lower.

From Atterberg Limit determinations, most of marine clay is of silty clay with high to extremely high plasticity. Majority of the data are plotted above A-Line as shown in Figure 4, however, 24% of the data are plotted below it. From Figure 4, it also indicate that the Alor Setar clay has plasticity in the ranges of **Immediate Plasticity Clay to Very High Plasticity Clay and Very High Silt to Extremely High Plasticity Silt.**

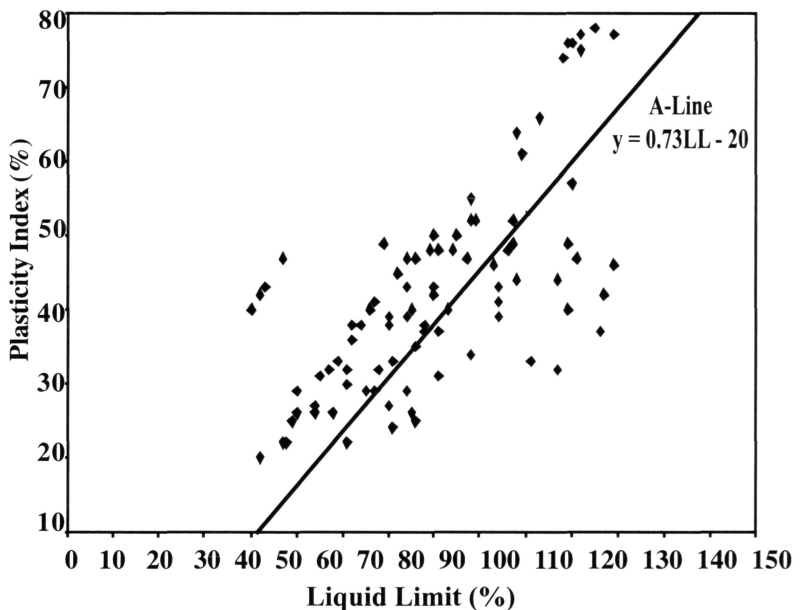


Figure 4: Correlations between Liquid Limit (%) and Plasticity Index (%) for Alor Setar Clay

Compression Index (Cc)

Ramli (1994) stated that the compression index (C_c) of clays varies with location. This may be due to the environmental of deposition and subsequent geological history. From Figure 5, 80% of the data that were collected from Alor Setar area shows a normal result that the value of C_c is in range between **0.2 to 1.5**. However, 20% of the data show the value of C_c in the range between **1.5 to 2.5**. The higher value of C_c is due to the data, which are located on the paddy field area that contribute a high settlement of clay. The lower of C_c values are located in town area where the settlement of the soil has already occurred and its values are decreasing. This shows that Alor Setar has a very high value of compressibility and may posses large settlement behavior. The trend of the Compression Index is decreasing with depth.

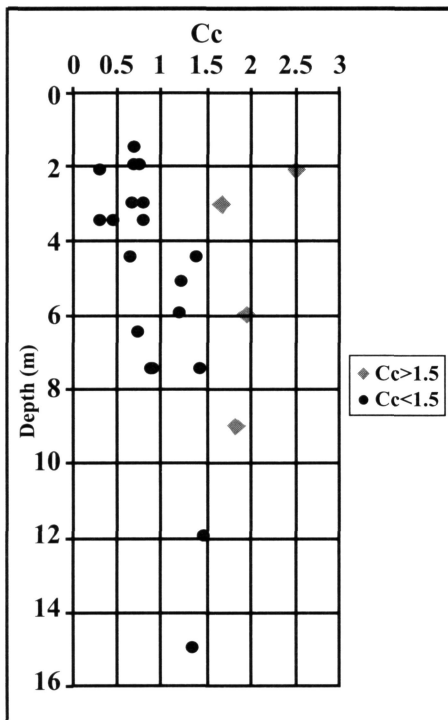


Figure 5: Compression Index versus Depth (m) for Alor Setar clay

Preconsolidation Pressure (Pc)

Data from Alor Setar clay shows that the preconsolidation pressure (Pc) is in range between **17 kPa to 90 kPa**. The preconsolidation pressure can be varied with depth but usually increased with depth.

Preconsolidation pressure (Pc), are required to calculate the Overconsolidation ratio (OCR) as shown in Equation 1

$$\text{OCR} = P_c/P_o \quad \text{(Equation 1)}$$

where; OCR = overconsolidation ratio

Pc = preconsolidation pressure

Po = effective overburden pressure

Overconsolidation ratio (OCR) is one of the important parameter for geotechnical design on soft clay. Underestimating OCR will cause large consolidation settlement. Figure 6 shows OCR for Alor Setar clay and is decreasing with depth. From the data, 86% of the OCR values are less than two. It indicates Alor Setar clay is of **lightly overconsolidated**.

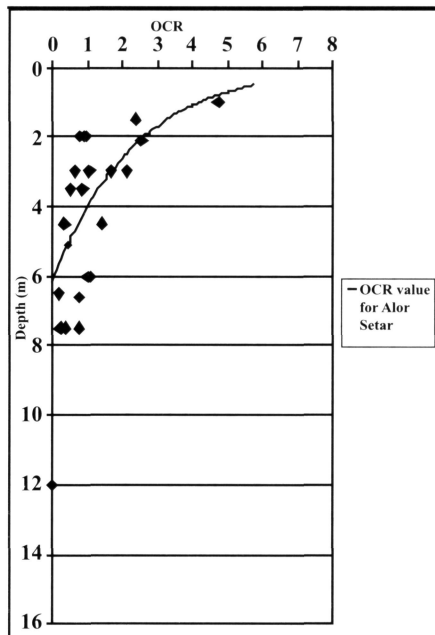


Figure 6: Overconsolidation Ratio (OCR) Versus Depth (m) for Alor Setar Marine Clay

The over consolidation are occurred because of the relative high clay content. This indicated that the Alor Setar clay has been subjected to consolidation stress greater than the present stress. Under undrained conditions the tendency to dilate causes the decrease in pore pressure and the effective stress is increased.

Summary and Conclusion

Based on this study, the clay soils in Alor Setar have high moisture content, plastic limit, liquid limit and compression index compared to other area in Malaysia. This indicated that the soil is highly compressible. From the OCR values, the clay is known as lightly overconsolidated.

As a result, construction works carried out in the area should be given in more attention due to large consolidation settlement of the clay soil. The geotechnical engineers are faced big challenge in clay area due to large settlement. It also causes differential settlement, cracking on drain and flows and cavity below structures.

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