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Correlation Study of the Cone Penetration Test in the Field with a Laboratory Test on Soft Soil in Banjarmasin

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ABSTRACT

The very soft soil commonly found in South Kalimantan, especially in Banjarmasin, with conditions of tidal swampy land, poses a challenge when it comes to the development of areas intended for medium-scale building construction. The demands of the population and the increasing need for housing necessitate the addition of residential levels, both by the government and private entities. This will undoubtedly open up new areas, and housing development will become a top priority in order to realize this. This research process is conducted in the field and in the laboratory, using soil material tested with the cone penetration test (CPT) method and data processing to identify the type and characteristics of the soil, ensuring they remain unchanged during the analysis of field data. Original samples are also taken for the purpose of analyzing the selection of foundation reinforcement types. Very soft clay soil is identified from the location of Gunung Meranti in Banjarmasin. This data is used for the analysis of bearing capacity, settlement analysis, characteristics, and identification, which will be correlated with the results of previous testing conducted in the laboratory using the Unconfined Compression Test (UDS) method in nearby locations. The results of field investigation data in the form of manometer readings are expected to assist the author as indicators in measuring and analyzing the type and characteristics of the soil, as well as the bearing capacity of the subgrade soil in the laboratory, based on the results of the CPT

INTRODUCTION

Banjarmasin City is located in the South Kalimantan region of Indonesia and generally has soft soil conditions. Soft soil is a type of soil with low density and bearing capacity, making it prone to deformation or changes in shape when subjected to a load. In Banjarmasin, many areas consist of clay or peat soil (Arianti, 2020). Clay soil contains a high percentage of fine particles and has the ability to retain water well. However, clay soil also tends to be soft and can become even softer if inundated with water for an extended period. On the other hand, peat is an organic soil type formed from naturally decomposed plant remains. Peat has a very loose structure and low density, making it highly susceptible to softness and incapable of supporting heavy loads such as tall buildings or large structures (Syarkani, 2021). The soft soil conditions in Banjarmasin pose a significant challenge to the planning and construction of buildings. The development of buildings in this area requires special attention to foundations and construction techniques to ensure that structures can stand safely and stably on the soft soil (Agnes, 2019).

The development of buildings in South Kalimantan, especially in Banjarmasin, is increasing both in quantity and size. This includes offices, residential areas, shops, restaurants, and industrial buildings (Bowles, 1992). To support these heavy structures, sturdy foundations are essential. A foundation is a component of an engineering system that transfers the weight of the foundation itself to the soil or rock beneath it. Given this, the planning of a foundation needs to consider the forces at play, the structural foundation's load-bearing capacity, as well as the soil's capacity to withstand the forces transmitted by the foundation (Rahardjo, 1992).

Foundations come in various forms, but generally, they can be categorized into two types: shallow foundations and deep foundations. The choice of foundation type depends on the type of construction to be built and also on the type of soil. In general, the foundation material widely used in the construction industry in Banjarmasin is galam wood.

To accurately determine the bearing capacity, a cone penetration investigation is required. The purpose of a cone penetration investigation is to ascertain the resistance of cone penetration and the cohesive soil friction, which indicates the soil strength at a specific depth. It can also determine the various soil layers' depth using empirical formulas.

Based on the background above, the author has chosen the title for this research as "Correlation Study of Cone Penetration Test in the Field with Laboratory Test on Soft Soil in Banjarmasin".

METHODS

In the implementation of this research, there are several stages of work, namely the collection of data to be studied, processing the collected data, and discussing to draw conclusions. The research study was conducted in Kuin Kecil Village, Aluh Aluh Subdistrict, Banjar Regency, South Kalimantan. The primary data used in this research are undisturbed samples (UDS) from drilling and cone penetration test (CPT) field tests. The secondary data used are correlation data from the CPT tests.

RESULTS AND DISCUSSION

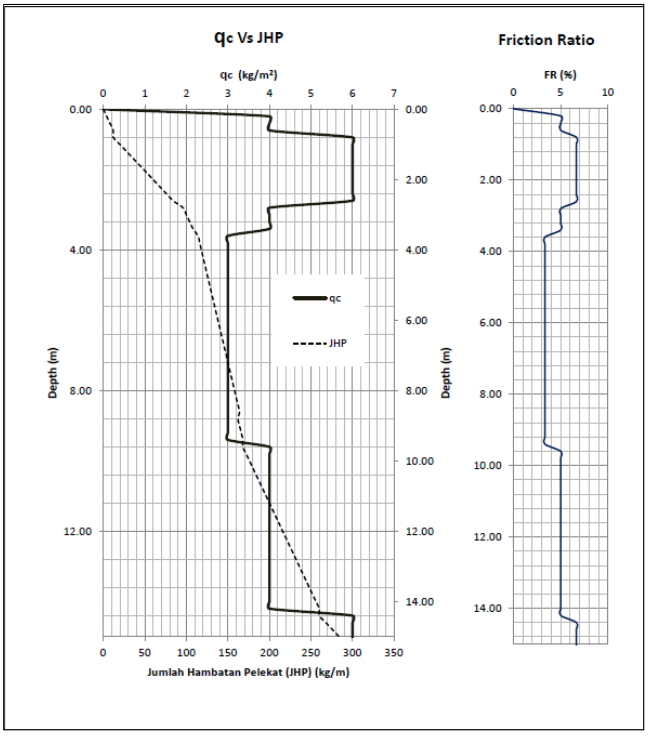
The geotechnical investigation conducted includes a cone penetration test (CPT) using a bicone tip, obtaining data for manometers 1 (one) and 2 (two), as well as collecting undisturbed samples (UDS) at a depth of 4 meters using a Shelby tube, as shown in the following picture:

Picture 1. Cone Penetration Test (CPT) Execution at Point 1, Land View

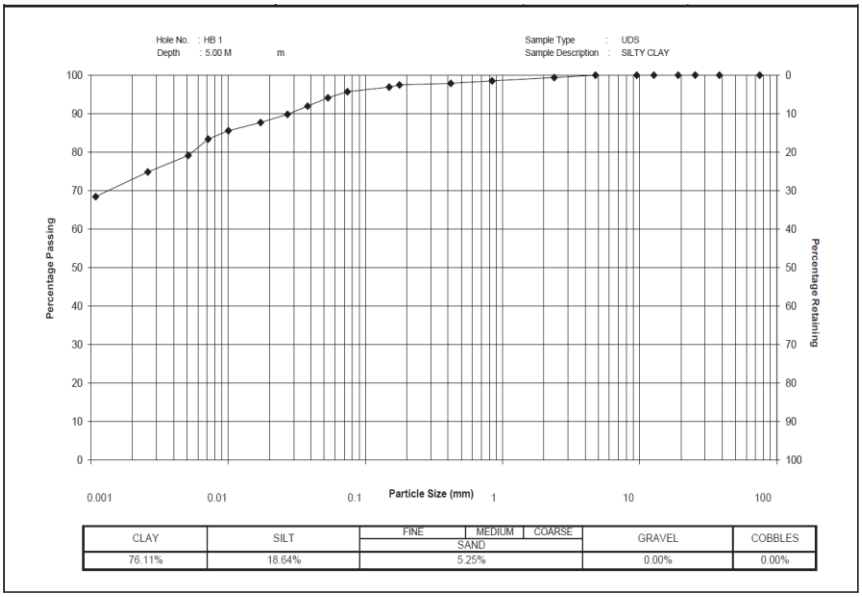
Picture 2. Cone Penetration Test (CPT) Execution at Point 1, River View

Picture 3. Undisturbed Sample (UDS) at a Depth of 5 Meters

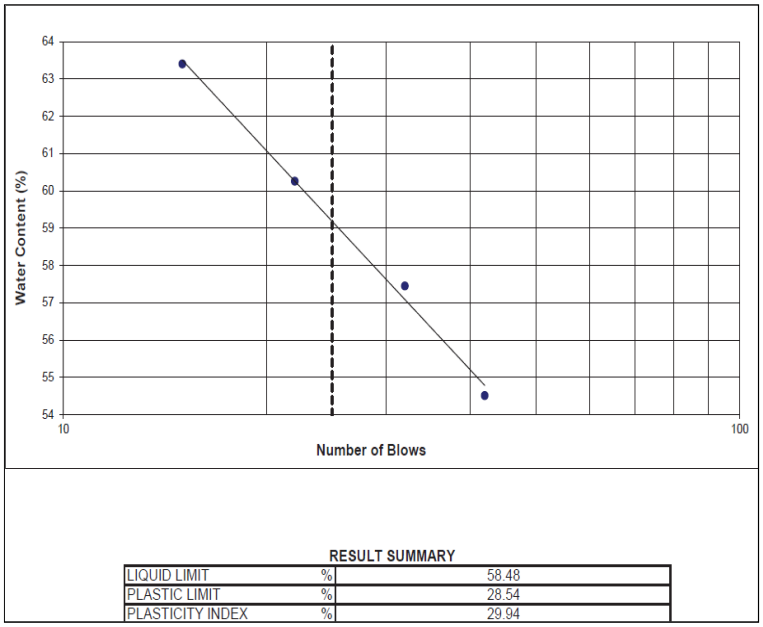
From the field investigation conducted, the data of manometer readings on the cone penetration test are collected up to a depth of 15 meters. The laboratory testing results are also conducted in accordance with the Indonesian National Standard (SNI) for the Undisturbed Sample (UDS) at a depth of 5 meters. These initial steps are taken to obtain the necessary soil parameters for this faculty development research. The graphs representing the test data are provided in the appendix.



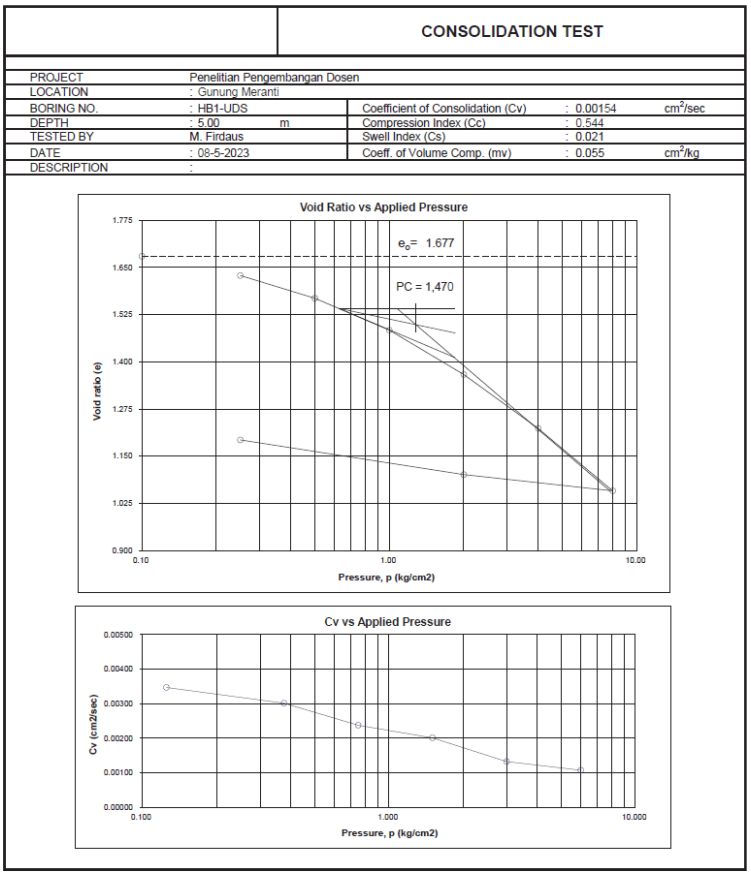
Picture 4. Graph of Cone Penetration Test (CPT) Field Test Results



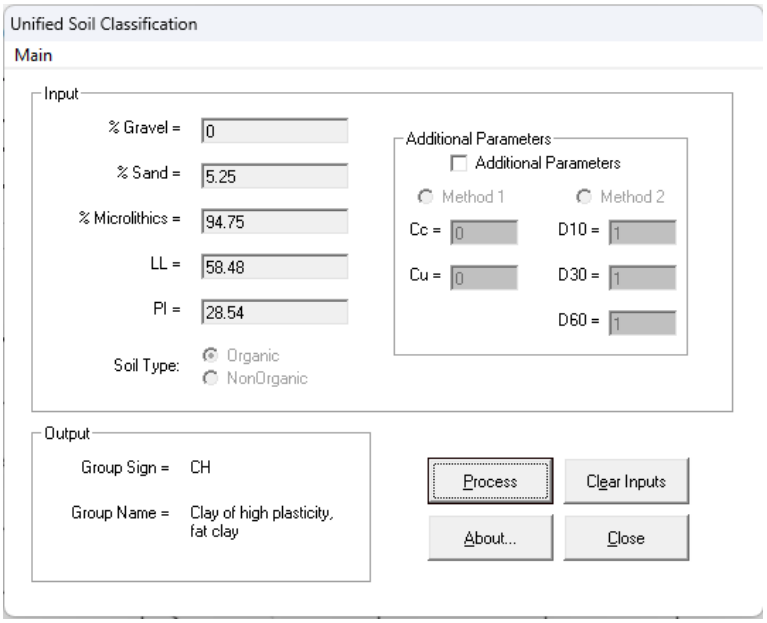
Picture 5. Output of Gradation and Hydrometer Testing in Accordance with the Indonesian National Standard (SNI)



Picture 6. Output of Soil Consistency Limit Testing in Accordance with the Indonesian National Standard (SNI)

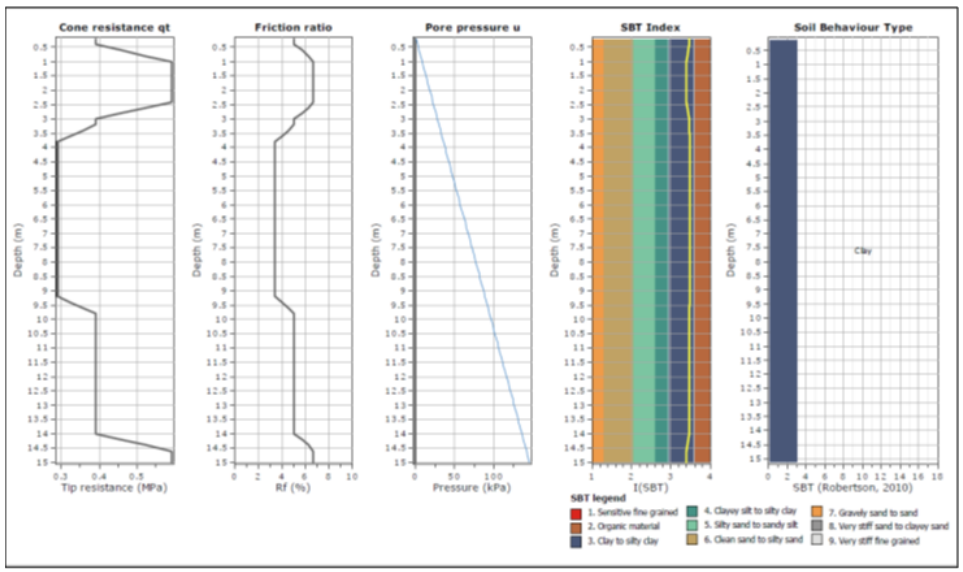


Picture 7. Output of One-Dimensional Consolidation Testing in Accordance with the Indonesian National Standard (SNI)



Picture 8. Output of Soil Properties Testing to Determine Soil Type Using the Unified Soil Classification System (USCS) at a Depth of 5 Meters

The Robertson Method (2010) output in determining soil types in the soil classification system based on manometer data readings from the cone penetration test up to a depth of 15 meters indicates that the identified soil type is clay. The laboratory testing results, conducted in accordance with the Indonesian National Standard (SNI) for the Undisturbed Sample (UDS) at a depth of 5 meters, in correlation with the Robertson Method's cone penetration test results, yield the necessary soil parameters for this faculty development research. The correlated test result data is presented in the attached table.



Picture 9. Soil Type Identification Result from Cone Penetration Test Data Based on Robertson Method, 2010

Table 1. Correlation Results between Robertson Method, 2010 Cone Penetration Test Manometer Data and CV Values from Consolidation Testing

	In situ data				Estimations			
No	**Depth (m)**	**qc (MPa)**	**fs (kPa)**	**SBTn**	**Ksbt (m/s)**	**Cv (m2/s)**	**Cv (cm2/s)**	**Average**
1	0.2	0.39	19.6	9	2.51E-07	1.39E-04	1.39000	
2	0.4	0.39	19.6	4	1.48E-07	8.11E-05	0.81100	
3	0.6	0.39	19.6	4	1.01E-07	6.45E-05	0.64500	
4	0.8	0.59	39.2	3	7.57E-08	5.51E-05	0.55100	
5	1	0.59	39.2	3	6.09E-08	4.99E-05	0.49900	
6	1.2	0.59	39.2	3	4.66E-08	3.79E-05	0.37900	
7	1.4	0.59	39.2	3	3.72E-08	3.01E-05	0.30100	
8	1.6	0.59	39.2	3	3.02E-08	2.43E-05	0.24300	
9	1.8	0.59	39.2	3	2.49E-08	1.99E-05	0.19900	
10	2	0.59	39.2	3	2.08E-08	1.65E-05	0.16500	
11	2.2	0.59	39.2	3	1.76E-08	1.39E-05	0.13900	
12	2.4	0.59	39.2	3	1.51E-08	1.18E-05	0.11800	
13	2.6	0.59	39.2	3	1.13E-08	7.71E-06	0.07710	
14	2.8	0.39	19.6	3	8.32E-09	4.86E-06	0.04860	
15	3	0.39	19.6	3	6.07E-09	2.94E-06	0.02940	
16	3.2	0.39	19.6	3	5.12E-09	2.46E-06	0.02460	
17	3.4	0.39	19.6	3	3.98E-09	1.51E-06	0.01510	
18	3.6	0.29	9.8	3	3.13E-09	8.80E-07	0.00880	
19	3.8	0.29	9.8	3	2.55E-09	5.12E-07	0.00512	
20	4	0.29	9.8	3	2.19E-09	4.10E-07	0.00410	
21	4.2	0.29	9.8	3	1.88E-09	3.30E-07	0.00330	
22	4.4	0.29	9.8	3	1.62E-09	2.67E-07	0.00267	
23	4.6	0.29	9.8	3	1.40E-09	2.16E-07	0.00216	
24	4.8	0.29	9.8	3	1.21E-09	1.76E-07	0.00176	0.00160
25	5	0.29	9.8	3	1.05E-09	1.43E-07	0.00143	

CONCLUSION

The discussion and results lead to the conclusion that the Unified Soil Classification System (USCS) classification for the Undisturbed Sample (UDS) at a depth of 5 meters at the BH-1 point shows high plasticity clay. This classification is based on laboratory testing of the sample's properties. The correlation calculation of soil type at the reviewed depth using the Robertson Method 2010 Soil Behavior Type (SBT) identifies it as either clay or silty clay. The correlation calculation of data from the cone penetration test manometer, which gives soil mechanical parameters using the Robertson 2010 method, gives an average Cv value of 0.00160 cm2/sec from a depth of 4.8 meters to 5 meters. This value is very close to the result of the laboratory consolidation test, which was 0.00154 cm2/sec. A literature study is required as a follow-up for clarification or identification of the calculation results with other correlations in terms of foundation-bearing capacity.

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