

Correlation of Soil Plasticity Index (PI) Value with California Bearing Ratio (CBR) for Soil in Banjarmasin

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Abstract

During this time to get the price of California Bearing Ratio (CBR) planners will conduct field tests and / or laboratory tests. This takes time and is relatively large. For this reason, it is needed a practical matter or formulation about the relationship between soil parameters so that planners do not need to test the overall soil parameters. To get this formula, it is necessary to do repeated experiments in the laboratory, which will produce graphical relationships or correlations between soil parameters. From this correlation, if there is a value of soil parameters, the other soil parameters can be known as well.

This study aims to obtain a graph or correlation of Plasticity Index (PI) with California Bearing Ratio (CBR) for the Banjarmasin region. The practical benefit that can be obtained from this research is by knowing the PI price for land in Banjarmasin, then the CBR price can also be obtained.

Tests conducted in this study are the Atterberg Limit test, and the CBR test. The test will be conducted at the Soil Mechanics Laboratory of the Islamic University of Kalimantan MAB Banjarmasin. Soil samples will be taken at 2 (two) locations in the city of Banjarmasin. The conclusion in this test is that the correlation between CBR and PI is $CBR = -0.2421 PI + 7.842$

Introduction

Accurate soil properties data is required to make a good and safe construction. These data were obtained from experiments in the laboratory. However, sometimes it is not necessary to thoroughly test the soil in a practical plan. Thus, an approach towards various soil properties is needed. To obtain these approaches, it needs to carry out experiments in the laboratory so that a form of relationship between soil properties is graphically described and equations are obtained. From the graphics and equations, if one of the factors or soil properties is known, the other properties will also be known.

In building construction, the bearing capacity value (CBR= California Bearing Ratio) influences planning. To find out the CBR value, experiments must be carried out in the laboratory and the field. Every CBR test plan will certainly take a lot of time and money. Therefore, there is a need to simplify the parameters concerning the CBR. One of the soil parameters used to get the CBR price is the soil plasticity index (PI). If the PI value can be obtained, the CBR value can also be obtained by using accurate laboratory test data and the help of PI and CBR correlation. Marwan and Sundry (2012) show the relationship between PI and CBR as follows:

1. CBR not submerged = $- 0.990 \text{ PI} + 28.79$; $R^2 = 0.868$ in disturbed soil samples.
2. CBR not submerged = $- 0.464 \text{ PI} + 10.60$; $R^2 = 0.728$ in the undisturbed soil sample.
3. Submerged CBR = $- 0.673 \text{ PI} + 15.88$; $R^2 = 0.706$ in disturbed soil samples.
4. Submerged CBR = $- 0.132 \text{ PI} + 3.625$; $R^2 = 0.887$ in the undisturbed soil sample.

Meanwhile, Mego Purnomo (2011), in his research, obtained the following results:

1. Correlation of CBR and PI was $\text{PI} = 137.86 - 6.792 \text{ CBR}$ and $\text{PI} = 90.796 - 4.574 \text{ CBR}$.
2. Correlation of CBR with soil shear angle (Φ), namely: $\Phi = 18.379 + 1.155 \text{ CBR}$ and $\Phi = 10.496 + 1.71 \text{ CBR}$.
3. Correlation of CBR and cohesion (C), namely: $C = 0.165 \text{ CBR} - 0.279$ and $C = 0.174 \text{ CBR} - 0.5996$.
4. Correlation of PI with soil shear angle $\Phi = 49.916 - 0.4\text{PI}$

However, this correlation did not come from Banjarmasin, which certainly had different soil structures and properties. In comparison, the correlation between PI and CBR for the Banjarmasin has not existed. This condition became a research background, namely, investigating the correlation of PI values with CBR for soil conditions in Banjarmasin.

Based on the explanation above, this research tried to correlate the PI and CBR values for Banjarmasin soil. The research results hopefully can find PI value so that the CBR value can be known without further testing in the laboratory.

The problem that will be discussed in this research was the correlation between the PI and the CBR values in North and South Banjarmasin soil. The research objective was to determine the properties of the original soil on the distribution of grain size, specific gravity, plasticity index (PI), standard compaction, and CBR, and the correlation of PI with CBR values Banjarmasin soil.

Method

Location and Time of Research

The location of the soil sampling was explained later in this chapter. At the same time, the laboratory used for this research was the Geotechnical Laboratory, Faculty of Engineering, Kalimantan Islamic University MAB of Banjarmasin.

Research Procedures

The research was carried out through the following stages:

Soil sampling. Soil samples were taken at two points in South Banjarmasin City. Three samples were taken from each location. Each sample had an average distance of 50 m and was taken using a hoe as much as 60 kilograms per sample.

Testing the soil samples that had been taken. Furthermore, the clay samples that had been taken underwent a series of tests. These tests were the grain size distribution, specific gravity, liquid limit and plastic limit, standard compaction, CBR, swelling, and UCS. The number of original soil samples required for each test is as shown in Table 1 below.

Table 1. Number of Original Soil Samples

Tests	Number of samples/locations	Total samples
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Grain Size Distribution	3	6
Specific Gravity	3	6
Liquid Limit	3	6
Plastic Limit	3	6
Compaction	3	6
CBR	3	6
UCS	3	6

Research Flowchart

The research process above was described as the research flowchart in Figure 1 below

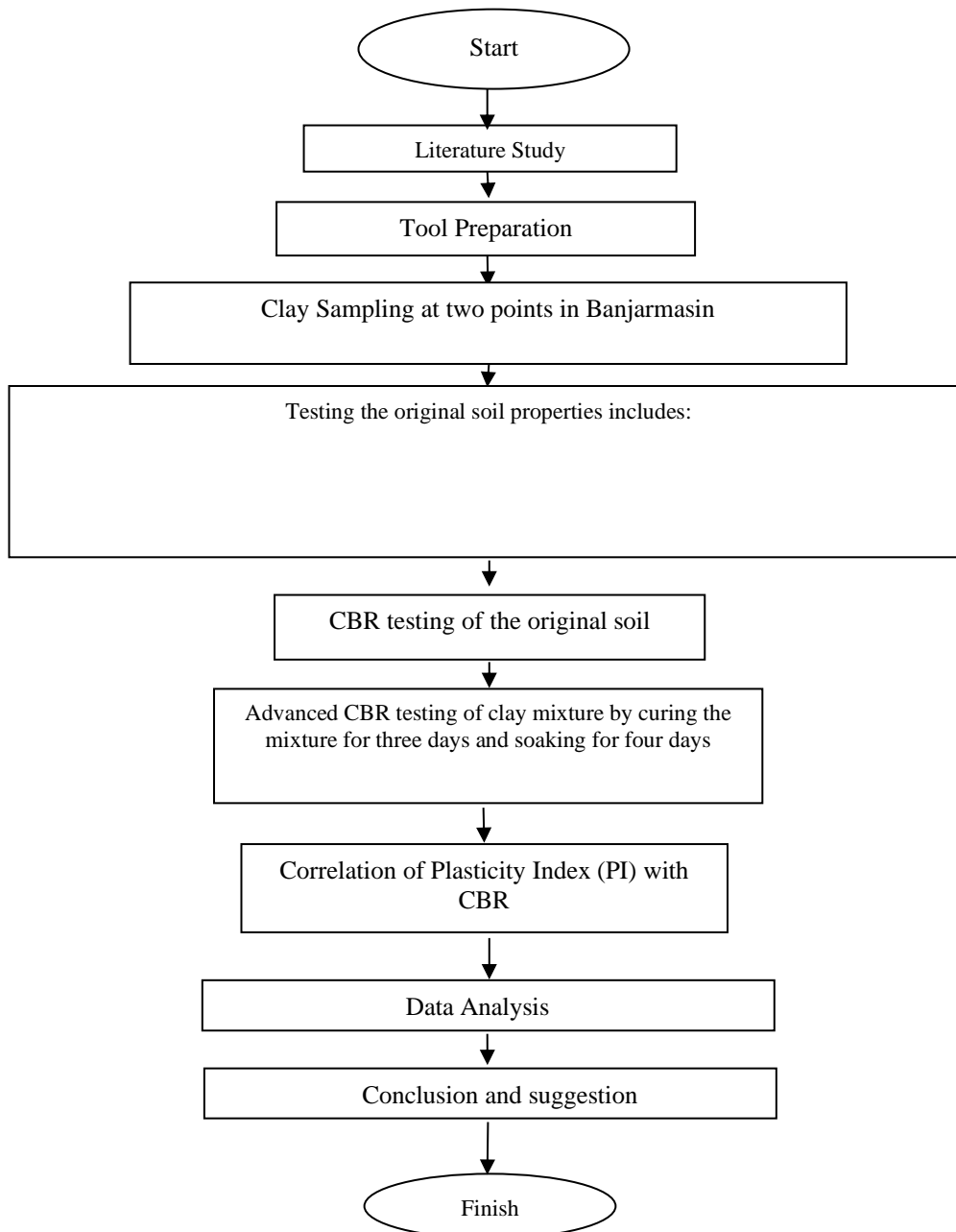


Figure 1. Research Flowchart

Results and Discussion

Research Results

After researching at the Geotechnical Laboratory, Faculty of Engineering, Kalimantan Islamic University MAB of Banjarmasin, the characteristics of the clay soils of South Banjarmasin city based on each sampling were found and can be seen in Table 2.

Table 2. Characteristics of South Banjarmasin Clay

Test Type	Unit	Point 1	Point 2
Starting Water Level	%	2.17	2.19
Specific Gravity	-	2.57	2.63
Liquid Limit (LL)	%	32.20	38.17
Plastic Limit (PL)	%	22.34	28.63
Plasticity Index (PI)	%	10.86	9.54
Pass Filter No.200	%	66.43	61.72
Maximum Dry Fill Weight	gr/cm ³	1.63	1.65
Optimum Moisture Content	%	19.23	18.77
SOIL CLASSIFICATION			
According to USCS		ML	CL
According to AASHTO		A-4	A-6

Correlation Between *Plasticity Index (PI)* and *California Bearing Ratio (CBR)*

Based on the results of the tests carried out, CBR and PI values could be grouped based on the sampling location in the field. In comparing the two values, the CBR value used was the Design CBR value or 90% CBR. The test results are outlined in Table 3 below:

Table 3. Comparison of PI and CBR Values

No	Soil Type	PI (%)	CBR (%)
1.	Point 1	8.17	6.12
2.	Point 2	9.65	5.37
3.	Point 3	19.37	3.97

The results of the comparison table of PI and CBR values above can be stated in Figure 2 below.

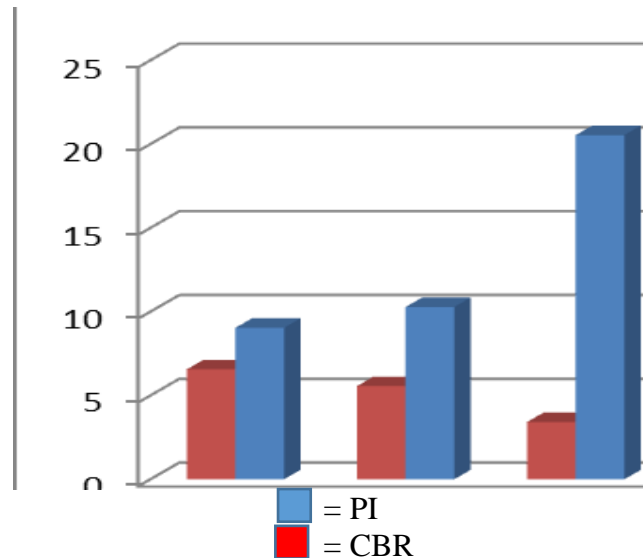


Figure 2. Diagram of PI and CBR Test Results Values

The test results in Figure 2 showed that an increase in the CBR value was inversely proportional to the PI value. In general, each of the compiled samples experienced an increase. Meanwhile, the PI value of each compiled sample has decreased. As before, the correlation between the Plasticity Index (PI) and CBR values could be made in a relationship in the equation $Y = a + bX$. In practice, this correlation could be done using linear graph methods and linear equation analysis. In the picture below, the correlation between the PI and the CBR values was done graphically.

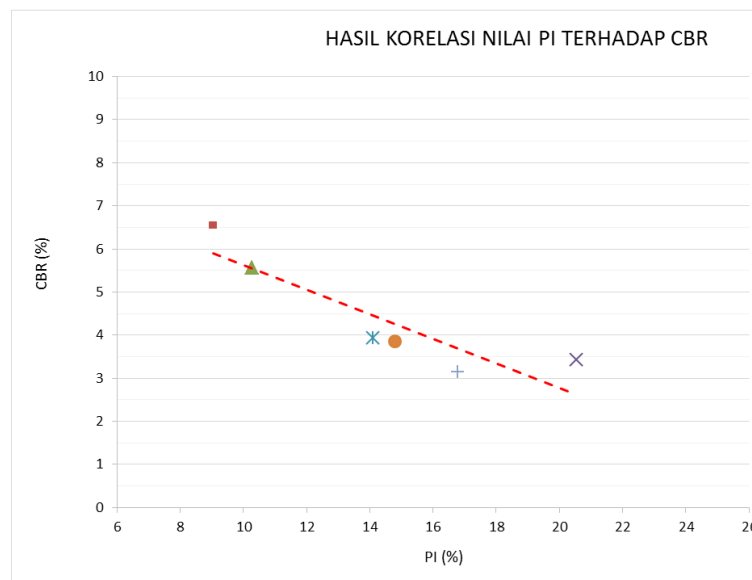


Figure 3. Correlation Graph of PI and CBR Values

As seen in Figure 3, the graph of the correlation between the PI (*Plasticity Index*) to the CBR (*California Bearing Ratio*) values of six clay samples correlated using linear regression. These results made a linear equation where the CBR value was Y , and the PI value was represented by X . Then, the linear equation $y = -0.2854x + 8.4816$ was obtained. It meant that it formed the equation $CBR = -0.2854 PI + 8.4816$. Based on the test results, the correlation value of PI and CBR showed that if the PI value of the soil was high, the CBR value of the soil decreased.

Conclusion

The conclusion in this test stated that the correlation between CBR and PI values was:

$$\text{CBR} = -0.2854 \text{ PI} + 8.4816$$

This correlation had a value of $R = 0.801$. This correlation had a strong relationship, according to the benchmark correlation calculation results $R = 0.80 - 1.00$. The greater the PI value of the soil, the smaller the CBR value of the soil.

Recommendations

The next test that can be done is testing the water content, namely the percentage of water content in the soil sample taken by disturbed (disturbed soil condition). As well as testing soil samples in the areas of West Banjarmasin, East Banjarmasin and North Banjarmasin.

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