Experimental Study of Silty Soil Using Gypsum and Cement on California Bearing Ratio (CBR)

Eko Budianto [1*], *Chitra* Utary[1], Hairulla[1] and *Dina Limbong* Pamuttu [1]

[1] Department of Civil Engineering, Faculty of Engineering, Universitas Musamus, Merauke 99600, Indonesia

Abstract. Merauke Regency is a lowland area, with soft soil conditions that dominate and urgently need to be stabilized. The purpose of this study was to determine the use of a mixture of cement and gypsum as a stabilizing agent. This research uses laboratory experimental methods. The tests carried out are physical and mechanical properties testing. Laboratory CBR is used to determine the value of the increase in CBR on the original soil and soil that has been mixed with cement and gypsum variations. Based on the results of testing the physical properties of the grain fraction for silt of 85.88%, in the calcification using the AASHTO method this soil is included in group A-5 with a description of silt soil with high plasticity. From the results of the tests carried out the CBR value on silt soil is 2.62% while the CBR value of stabilized soil with a percentage of 100% silt + 2% cement + 4% gypsum is 23.54%; 100% silt + 2% cement + 8% gypsum that is 24.41%; 100% silt + 2% cement + 12% gypsum ie 27.02%; 100% silt + 2% cement + 16% gypsum ie 30.51%; and 100% silt + 2% cement + 20% gypsum that is 31.38%. From the CBR value, it can be concluded that the variation increased with each addition of cement and the percentage of gypsum.

Keywords: Silty Soil, Gypsum, Stabilization, CBR Laboratory.

1 Introduction

1.1 Background

Construction on soft soil which is known to have low bearing capacity has been carried out in various ways to overcome the problem. With various developments of soft soil stabilization, namely using chemical stabilization to using stabilization using natural materials and waste that can still be used[1][2]. Merauke Regency is one of the areas with lowland conditions with soft soil types that need soil stabilization [3][4]. Another behavior of soft soils such as clays has the property of expanding and shrinking in several factors such as lithological variability at various scales, and cycles that vary repeatedly, in clay behavior [5][6].

Silty Soil is classified as fine-grained soil with a grain range between 0.05-0.002 mm which is known to have particles much smaller than sand and larger than clay [7]. In Merauke Regency, soft soil is often found, this soil has poor properties so it does not meet the desired technical requirements in a construction project [8], [9]. These properties are in the form of low bearing capacity, high compressibility, large volume changes, and difficulty in carrying out compaction work. One of the methods used to overcome these problems is to stabilize the soil by stabilizing the soil with cement [10]–[13].

This research examines how much influence cement with variations of Gypsum flour on changes in the physical properties of the soil and how much influence the increase in the CBR value and the bearing capacity of the original soil has[14][15]. The expected result of this research is how big the percentage of variation of gypsum flour is that can increase the CBR value from mixing with silt with high plasticity. and reduce the percentage of cement needed to obtain a large soil bearing capacity value, on Blorep Street.

1.2 Motivation and Objective

Merauke Regency is generally flat, surface soil conditions are dominated by soft soil, and problems occur when construction occurs on the soft soil. Soft land is often a problem in the construction of roads, bridges, buildings, and irrigation buildings. This study aims to conduct an experimental study to stabilize soft soil in Merauke Regency, especially in the Blorep street area which is a lot of housing and inter-districts, using a mixture of cement and variations in adding gypsum.

1.3 Problem Statement

What are the physical properties of the original soil in the Blorep street area and what is the California Bearing Ratio (CBR) value of the original soil in the Blorep street before adding and after adding cement with a

* Corresponding author : budiyanto_ft@unmus.ac.id

constant that is 2% and gypsum flour variations with percentage levels?

2 Research Methods

2.1 Types of Research

This study used an experimental study by testing a mixture of 100% native soil, cement with a percentage of 2% and gypsum which was varied with a percentage of 4%, 8%, 12%, 16%, 20%.

2.2 Sampling and Research Location

The location of this research was conducted at the Laboratory of the Department of Civil Engineering, Faculty of Engineering, Musamus University. The original soil sample was taken from the Blorep street area, Kamundu sub-district, Merauke District.

2.3 Method of Implementation

In this method the physical properties of the soil are tested first, namely, soil density test, moisture content, Atterberg and sieve analysis tested using the SNI standard method with several tools, namely pycnometer, hot plate, dryer, spatula, casagrande, measuring cup, water hose, filter. and scales. As well as mechanical testing of soil density using tools in accordance with SNI standards, namely using dryers, proctor standards, scales, jacks and hammers.

California Bearing Ratio (CBR) Test In this test, 5 kg of soil samples were prepared for each variation of the mixture. Then the soil is mixed with cement, gypsum flour, and water, and left for 3 days. The soil variations to be tested are BU1100% silt, BU2 variation 100% silt + 2% Portland cement + 4% Gypsum, BU3 variation 100% silt + 2% Portland cement + 8% Gypsum, BU4 variation 100% silt soil + 2% Portland cement + 12% Gypsum, variation of BU5 100% silt + 2% Portland cement + 16% Gypsum and variation of BU6 100% silt + 2% Portland cement + 20% Gypsum.

3 Result And Discussion

3.1 Soil Properties

Based on the results of testing the physical properties of soft soil taken from the Blorep road area, the water content obtained from the calculation results for the sample obtained results of 45.63%, 47.35%, and 42.01%, respectively, so that the average soil water content is average is 45.00%. The soil density was 2.64, with a bulk density of 1.95 g/cm3. Atterberg limit value From the graph of the relationship between the number of knocks and the water content, the liquid limit value (LL) = 63.57%, and the plastic limit value (PL) = 45.57%. For the value of the plasticity index (PI) obtained by the formula PI = LL - PL, the value of the Plasticity Index (PI) = 18.00%. In the standard proctor compaction test, the optimum moisture content value is Wopt = 17.085% and the maximum dry weight is d max = 1.45 gram/cm3.

3.2 Soil Classification

In the soft soil test taken from the Blorep street area, the soil classification in this test uses the AASHTO classification system. From the test results, the analysis of the grain size sieve that passed sieve no. 200 is 88.38%. From the test results, according to the AASHTO classification, this soil belongs to group A-5 with a description of silt with high plasticity.

3.3 Laboratory Testing Result

Based on the results of testing the California Bearing Ratio (CBR) laboratory for native soil and soil that has been stabilized in the area of Blorep Street has a value that can be seen in Table 1 below.

Table 1. Recapitulation of the results of CBR values of the soil before stabilization and after stabilization with variations of gypsum mixture

No	Test Object Code	Mixed Variations	Curing Time (Day)	CBR Value (%)
1	BU1	100% Silty Soil	3	2,62
2	BU2	100% Silty Soil + 2% Portland Cement + 4% Gypsum	3	23,54
3	BU3	100% Silty Soil + 2% Portland Cement + 8% Gypsum	3	24,41
4	BU4	100% Silty Soil + 2% Portland Cement + 12% Gypsum	3	27,02
5	BU5	100% Silty Soil + 2% Portland Cement + 16% Gypsum	3	30,51
6	BU6	100% Silty Soil + 2% Portland Cement + 20% Gypsum	3	31,38

From the results of table 1, the value of the California Bearing Ratio Unsoaked test on each test sample at curing for 3 days was obtained the California Bearing Ratio (CBR) value on the BU1 100% silty soil test was 2.62%. in the BU2 100% silty soil + 2% portland cement + 4% gypsum test sample obtained a CBR value of 23.54%. in the BU3 100% silty soil + 2% portland cement + 8% gypsum test sample obtained a CBR value of 23.54%. the BU4 100% silty soil + 2% portland cement + 12% gypsum test sample obtained a CBR value of 24.41%. the BU5 100% silty soil + 2% portland cement + 16% gypsum test sample obtained a value of 30.51%. the BU6 100% silty soil + 2% portland cement + 20% gypsum test sample obtained a CBR value of 31.38%.

In the graph of the test results, the values obtained from the results of the Laboratory CBR (California Bearing Ratio) test for curing before being tested for 3

days. From the CBR value of the original soil before stabilization, it got value of 2.62%. This is a CBR value that is not recommended for construction. After being stabilized using cement with a fixed percentage of 2% and gypsum material which was varied with a percentage of 4%, 8%, 12%, and 16% with the result that the CBR value increased which can be seen in the graph (see **Fig.1.** In the increase seen from the trend line in the mixed variety of the addition of gypsum with a percentage of 20%, it can be seen that there is a downward trend from the graph (see **Fig.1.**).

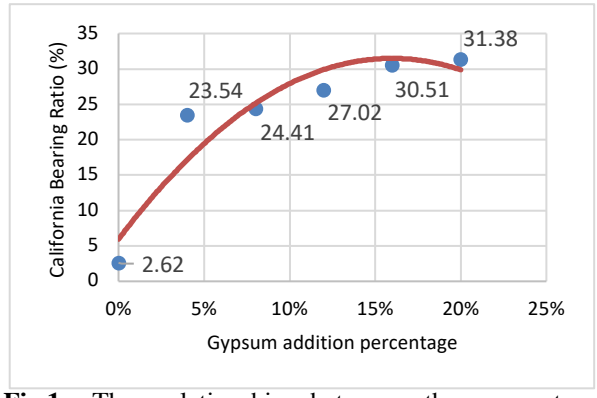

Fig.1. The relationship between the percentage additions of gypsum with the value of the California Bearing Ratio (CBR) laboratory.

3.4 Discussion

Based on the test results of the mixture of silt, cement, and gypsum variations, the highest increase in CBR value occurred in the addition of 4% gypsum with a CBR value of 23.54%, an increase of 11% from before mixing variations of cement and gypsum. In the variation in the percentage of gypsum addition with percentages of 8%, 12% and 16%, the percentage increase in CBR value is not too significant and the percentage of gypsum addition at the 20% trend line in graph 1 shows the direction of decline even though it has higher soil.

4 Conclusion

Based on the results of testing the physical properties of the soil in the Blorep street area, it has a water content of 45%, and a specific gravity value of 2.64. The classification was carried out using the AASHTO method. This soil was included in group A-5 with the dominant material being silt with high plasticity.

The results of the California Bearing Ratio (CBR) laboratory value of high plasticity silt in the Blorep street area before and after being stabilized using cement and variations of gypsum obtained a value for the BU1 sample of 2.62% while for the BU2 sample of 23.54%, then for the sample BU1 BU3 obtained by 24.41%, for sample BU4 obtained by 27.02%, then for sample BU5 obtained by 30.51%, and for sample BU6 obtained by 31.38%. From the CBR value that has been obtained, it has increased with each addition of cement and the percentage of gypsum variants. From the CBR value obtained, the soil that has been stabilized using cement and Gypsum Variations has good results to be used as a sub-base layer with a note that the percentage of gypsum is not too excessive.

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