Analysis of Clay Stabilization Bearing Capacity with Matos and Cement for Subgrade in Kalimantan Pavement (Case Study of Beringin Village Soils)

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Abstract. Beringin Village clay has low soil bearing capacity due to this reason, soil stabilization will be carried out using the Matos Stabilizer. It is expected can improve CBR and UCS values. The stabilization by mixing it with Matos and Cement. The proportion of the mixture is 1%, 3%, 5% Matos, and 12% cement in each percent of Matos. Research showed that the CBR value of the original soil was 4.61% and UCS was 2.00 kg / cm2. Then, after stabilization with Matos 1%, 3% and 5% the CBR value respectively 34.55%, 49.07% and 40.55%. While UCS values respectively are 3.98 kg / cm2, 4.70 kg / cm2 and 3.57 kg / cm2. The result showed Matos 3% gave CBR value increased significantly 112.15% and UCS decreased by 3.45 kg / cm2. Generally, the addition of Matos and cement results increase the CBR value and decrease of UCS values.

Keywords: stabilization, matos, CBR, UCS.

1 Introduction

Soil is the foundation for a building or road construction [1]. Therefore, when the planning stage, one must consider is the original soil conditions in the field. Testing is needed to determine the bearing capacity of the sub-grade soil as a requirement for building roads. If the soil has a carrying capacity that satisfies the requirements, stabilization is not necessary. The requirements for the value of the carrying capacity of the soils to be categorized as good is if the CBR value based on field testing is ≥3%, and the laboratory testing the value is ≥ 6%. If soils do not meet these requirements can be categorized as having low bearing capacity. Soft soil can be categorized as soil with low bearing capacity because the CBR value is low, due to stabilization is necessary. Stabilization is the mixing of soil with certain materials to improve the technical properties of the soils. Or in other terms, soil stability is an attempt to change or improve the technical properties of the soils so that it meets certain technical requirements [2]. Generally, soil stabilization is carried out by two methods, namely mechanical or mechanical methods, and chemical stabilization or with added materials from factories.

In the study [3] using Matos 0%, 4%, 8%, and 12% with the addition of 10% cement, the highest CBR value was obtained at the addition of 4% Matos, while for the UCS value the highest was the addition of 8% Matos. At Palangka Raya, one of the areas with soil conditions with low carrying capacity is Beringin village. Beringin Village is a strategic area through the

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northern route of the province of Central Kalimantan. Referring to these conditions, we have a desire to see the condition of the soils in the village of Beringin as an object of research. The research we did was how to stabilize the soils Beringin village with additives in the form of Matos combined with cement with a certain ratio.

2 Literature review

2.1 Matos

Matos is an additive that functions for freezing and stabilization of soil by physical and chemical processes. Matos is a fine powder material consisting of odorless inorganic mineral composition, has a pH of 8.37, a specific gravity of 2.35043 g / cm3, and 1: 3 water solubility [3]. If we look at soil particles microscopically, then on the surface of the soils there is a thin layer of water, about 0.05 mm thick. This layer has tremendous strength, approximately 200,000 kg for every 1 mm2, to move this water layer, it takes a lot of energy. The main functions of the Matos Stabilizer are as follows:

a) Increasing the soil bearing capacity parameter to replace the base and subbase, as well as stabilization of the subgrade.
b) Reducing soil permeability, keeping soil water content to remain stable.
c) Maximizing the function of other stability materials such as cement and lime.

Apart from containing an inorganic mineral composition, Matos also contains a polymer which functions as follows:

a) Prevent liquefaction (flow) of soil in the sand and minimize the potential for liquefaction due to cyclic loads due to earthquakes,
b) Functioning in coastal and estuary reclamation works, because the soil is exposed to seawater and sulfates. And applications on cliffs where the soil is unstable and prone to landslides.

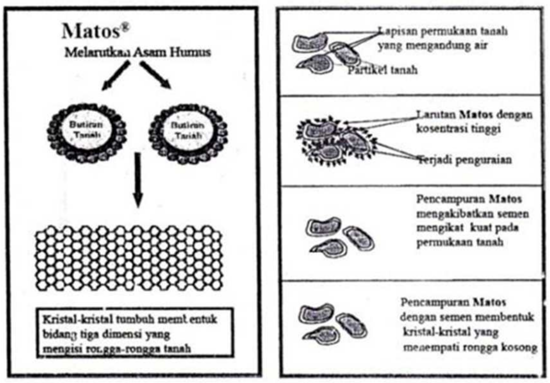

Fig. 1. Soil, Cement and Matos Reaction Process

2.2 Portland cement

Portland cement is an adhesive medium when it reacts with water. This adhesive medium then condensed and formed a hard mass. In the hydration process, the results of hydration will settle on the outside being divided into hydration gradually so that the volume decreases. This type of cement is ordinary Portland cement (Ordinary Portland Cement) used for buildings in general, where there are no special requirements [2]. Portland cement type I has advantages over other types of cement, in addition to being a fine powdered hydraulic material that can harden when mixed with water. The use of type I cement is widely used for general construction, such as construction of buildings that do not require special requirements, including residential buildings, multi-storey buildings, bridges, runways and highways [4].

3 Methodology

Soils samples in this study were taken from Beringin Village, Pahandut Seberang Subdistrict km.4 disturbing conditions. The soil samples were taken at a depth of approximately 20 cm as much as 150 kg. The stages of the research carried out were started from taking soil samples in the field then continued with testing the physical and mechanical properties of the soil. Soil investigations were carried out to determine the classification of clay soils to be studied [5]. After the soil parameters are obtained, then a comparison of the CBR value of clay soil before and after mixing Matos and cement is carried out. The amount of cement used was 12% by weight of the mixture. For the test sample in this study, it is listed in the table below:

Table 1. Soil Sample Requirements

No.	Testing	Number of Sample Requirements
1.	Water content	3
2.	Specific gravity	
	a. Original Soil	3
	b. Soil, Cement 12% and Matos 0%	3
	c. Soil, Cement 12% and Matos 1%	3
	d. Soil, Cement 12% and Matos 3%	3
	e. Soil, Cement 12% and Matos 5%	3
3.	Grain Distribution	3
4.	Plastic Limits	3
5.	Liquid Limit	3
6.	Proctor Compaction	3
	a. Original Soil	5
	b. Soil, Cement 12% and Matos 0%	5
	c. Soil, Cement 12% and Matos 1%	5
	d. Soil, Cement 12% and Matos 3%	5
	e. Soil, Cement 12% and Matos 5%	5
7.	CBR	
	a. Original Soil	3
	b. Soil, Cement 12% and Matos 0%	3
	c. Soil, Cement 12% and Matos 1%	3
	d. Soil, Cement 12% and Matos 3%	3
	e. Soil, Cement 12% and Matos 5%	3
8.	UCS	
	a. Original Soil	1
	b. Soil, Cement 12% and Matos 0%	1
	c. Soil, Cement 12% and Matos 1%	1
	d. Soil, Cement 12% and Matos 3%	1
	e. Soil, Cement 12% and Matos 5%	1

4 Results and Discussion

After conducting research at the Geotechnical Laboratory of the Faculty of Engineering, UM Palangkaraya, the characteristics of the clay soil in Beringin village, Palangka Raya city based on each sampling can be seen in the table below.

Table 2. Characteristics of Clay Village of Beringin Village

Type of Testing	Unit	Result
Passed Filter No.200	%	81.08
Liquid Limit (LL)	%	36.20
Plastic Limit (PL)	%	24.33
Plasticity Index (PI)	%	11.87
Specific gravity	-	2.70
Maximum dry fill weight	gr / cm3	1.56
Optimum water content	%	24.60
Development	%	6.40
CBR	%	4.61
UCS	kg / cm2	2.00

Source: Research Results, (2019)

The identification result of the original soil is a description of the properties of the soil. These characteristics will be compared to several theories, existing regulations / research that has been conducted. This can be seen in Table 3 below.

Table 3. Results of Original Soil Identification

Theory/ regulations	Requirements	Test result	Conclusion
AASHTO	PI> 11% LL> 41% Sieve Analysts> 35% pass no.200	PI average = 11.87% LL Average = 36.20% Passed Filter no.200 = 80.08%	Classification A-6 CL / inorganic clay with moderate plasticity
USCS	LL <50% Filter analysis> 50% passed no. 200	LL = 36% Passing Filter no.200 = 80.08%	CL / Inorganic clay with low to medium plasticity
Hardiyatmo (2006)	2.68 <Gs <2.75	Gs average = 2.70	Contains Inorganic Clays

Source: Research Results (2019)

4.1 Relationship of Specific gravity, CBR and UCS of Soil on Mixed Soil Matos and Cement

Based on the results of the tests that have been carried out, it can be done grouping the specific gravity and CBR values of the original soil and the mixed soil and cement mix that have been varied. The test results are set out in the table below:

Table 4. Comparison of Specific gravity, CBR and UCS values

No.	Soil Conditions	Specific gravity	CBR (%)	UCS (kg / cm^2)
1.	Original Soil	2.69	4.61	2.00
2.	Soil, Cement 12% and Matos 0%	2.68	41.78	4.00
3.	Soil, Cement 12% and Matos 1%	2.64	34.55	3.98
4.	Soil, Cement 12% and Matos 3%	2.58	49.07	4.70

No.	Soil Conditions	Specific gravity	CBR (%)	UCS (kg / cm^2)
5.	Soil, Cement 12% and Matos 5%	2.69	112.15	3.45

Source: Research Results, (2019)

Based on the value in the comparison table for the specific gravity and CBR values above, it can be stated in the curve image below.

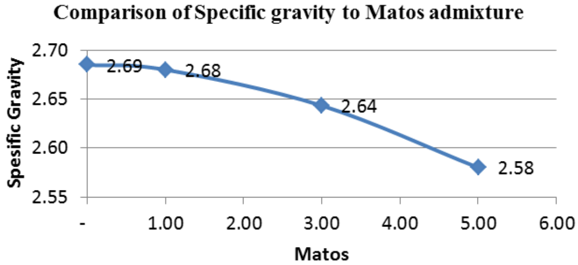

Fig. 2. Graph of Specific gravity Against Matos Increase
(Research Results, 2019)

From the test results in Figure From the image above, it can be seen that the value of specific gravity (Gs) decreases with increasing mixture of cement and matos. The value of specific gravity (Gs) is at the lowest point in the cement mixture of 12% and 5% Matos. Meanwhile, the comparison of CBR and UCS values can be stated in Figures 4 and 5 below.

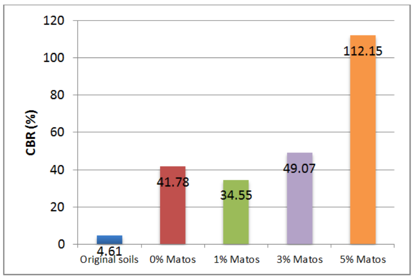

Fig. 3. CBR value comparison curve
(Research Results, 2019)

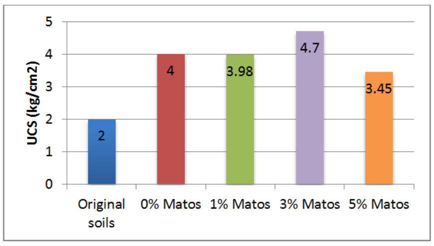

Fig. 4. Curve value comparison of UCS values
(Research Results, 2019)

In Figure 4, it can be seen that the CBR value increases with increasing matos mixture. It can be seen that the non-matos mixture obtained CBR of 41.78%. then the addition of 1%

matos was able to provide CBR values up to 34.55% and decreased from the non-matos mixture. Then the addition of 3% matos the CBR value increased to 49.07% and at the addition of 5% matos the CBR value increased to 112.15%. The increase in CBR value at a percentage of 1%, 3%, 5% was due to the addition of certain cement and matos that could reduce the development and reduce the moisture content so that the bonded particles would stick together and harden. While in Figure 5 it can be seen that the UCS value obtained is irregular where the lowest value is obtained in the original soil conditions and the highest value is obtained at the addition of 3% matos. From the test results recorded on the curves in Figures 4 and 5 it can be concluded that. CBR and UCS values on stabilization testing do not have a significant correlation [6]. It is proven in the stabilization test using cement and matos. The maximum CBR value of 112.15% is obtained in a mixture of 5%. While the maximum UCS value of 470 kg/cm^2 was obtained in a 3% matos mixture [7].

5 Conclusions and Suggestions

5.1 Conclusions

The conclusions that can be drawn from the research that has been done are as follows:

a) The specific gravity and CBR values of the original soil were obtained at 2.69 and 4.61%, respectively.
b) The density of soil mixed with 12% cement will decrease along with the increase in the number of matos.
c) In the original soil mixing composition, 12% cement and 0% matos obtained CBR values of 41.78% and UCS 4.00 kg/cm^2. In the mixture composition of 12% cement and 1% matos, the CBR value was 34.55% and UCS 3.98 kg/cm^2, then in the original soil mixing composition, 12% cement and 3% matos increased with a CBR value of 49.07% and UCS 4.70 kg/cm^2, then in the composition of mixing the original soil, 12% cement and 5% matos increased with a CBR value of 112.15% and decreased with a UCS value of 3.54 kg/cm^2.
d) It can be concluded that with the addition of 12% cement and variation of Matos, it is known that the CBR value is inversely proportional to the specific gravity value obtained. Where the CBR value will increase with the addition of Matos while the specific gravity value will decrease with the addition of Matos.
e) In addition, it can also be concluded that the CBR and UCS values in this study do not have a significant correlation.

5.2 Suggestion

Suggestions that can be given from the results of the research that have been done are as follows: Increase the number of soil samples and different soil types; For further research, it can be considered to correlate the PI value to the CBR value stabilized with Matos.

Acknowledgements

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Reference

[1] Sukirman,S. 2015. Dasar-dasar Perencanaan Geometrik Jalan, , Jakarta : Karya Manunggal Lithomas.

[2] Hardiyatmo, H.C. 2010. Stabilisasi Tanah Untuk Perkerasan Jalan, Yogyakarta : Gajah Mada University Press,

[3] Janah, R. N., Respati, R., & Saputra, N. A. (2017). Pengaruh Matos Terhadap Stabilisasi Tanah Lempung Desa Mintin Dengan Semen Untuk Perkerasan Jalan Raya. *Media Ilmiah Teknik Sipil*, *6*(1), 01-07. https://doi.org/10.33084/mits.v6i1.1455

[4] Hatmoko, J. T., & Lulie, Y. (2007). UCS Tanah Lempung Ekspansif Yang Distabilisasi Dengan Abu Ampas Tebu Dan Kapur. *Jurnal Teknik Sipil Universitas Atma Jaya Yogyakarta*, *8*(1), 64-77. http://jurnalmesin.petra.ac.id/index.php/uaj/article/view/17523

[5] Das, B.M. 1995. Mekanika Tanah (Prinsip-prinsip Rekayasa Geoteknis). Jakarta : Erlangga

[6] Bowles,J.E, 1993. Sifat-sifat fisik dan Geoteknis Tanah, Jakarta : Erlangga

[7] Predikson, 2015. Korelasi Nilai CBR dan UCS Tanah Lempung Palangka Raya Distabilisasi Pasir dan Semen, Penelitian Skripsi, Program Studi Teknik Sipil, Universitas Muhammadiyah Palangkaraya.