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The Influence of Adding Matos Soil Stabilizer to the Foundation Layer of a Road Body Stabilized Using Lime on it's Physical Properties.

Andro Ricardus [1*], Priadi E [1], and Rustamaji R M [1]

[1] *Department of Civil Engineering, Faculty of Engineering, Universitas Tanjungpura, Jl. Prof.Dr. Hadari Nawawi, Pontianak 78124, Indonesia*

*Corresponding Author: ricardusandro@gmail.com

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Abstract
From the perspective of Civil Engineering, soil is a collection of minerals, organic matter, and relatively loose deposits, which are located on bedrock. The relatively weak bonds between grains can be caused by carbonates, organic matter, or oxides precipitating between the particles. The space between the particles can contain water, air, or both. The process of physical soil formation that changes rock into smaller particles, occurs due to the effects of erosion, wind, water, humans, or the destruction of soil particles due to changes in temperature or weather. Soil stabilization with lime and matos soil stabilizer is an alternative soil improvement by adding additives. Soil stabilization with lime and matos soil stabilizer as a mixture of crushed soil, lime, matos soil stabilizer, and water which is then compacted to produce a new material, where strength, deformation characteristics, resistance to water, weather, and so on can be adjusted with the need for road pavement, building and road foundations, streams, retaining walls and so on.
The physical properties test used is water content (w), γ = soil volume weight (gr/cm3), specific gravity (Gs), atterberg limits, permeability, hydrometer and gradation analysis

Keyword: Soil Stabilization, Matos, *Soil Stabilizer*, Physical Properties,

1. Introduction

Soil has an important role, as a supporting foundation in every construction work both as a supporting foundation for the construction of buildings, roads (subgrade), embankments and dams, while soil that is not good enough must be stabilized first before being used as a supporting foundation.

Construction activities carried out are usually inseparable from earthworks which form the basis for the establishment of infrastructure in almost all places. This means that construction activities related to the geotechnical field continue to develop. For example, the initial activities of soil investigation, construction of foundations (both shallow foundations and deep foundations (drill pile, driving pile), excavation, backfilling, repair and strengthening of soil, as well as other activities as the initial activities of the construction process are carried out. The development of these geotechnical construction activities has led to creativity and innovation in terms of implementation methods, tool instrumentation, and other new inventions.

The soil stabilization work using a mixture of lime and matos soil stabilizer. There are several things to do such as soil stabilization work. One way to stabilize the soil is by mixing additive materials with a certain percentage so as to produce maximum soil bearing strength.

Soil stabilization with lime and matos soil stabilizer is an alternative soil improvement by adding additives. Soil stabilization with lime and matos soil stabilizer as a mixture of crushed soil, lime, matos soil stabilizer, and water which is then compacted to produce a new material, where strength, deformation characteristics, resistance to water, weather, and so on can be adjusted with the need for road pavement, building and road foundations, streams, retaining walls and so on.

2. Materials and Methods

Physical property test which includes a test) Moisture content test (ASTM-D 2216-29) Volume weight test (ASTM D 7263) Specific gravity test (ASTM 854-02) Atterberg limit test (ASTM D 4138-00) Hydrometer analysis test (ASTM D 422-63) Sieving analysis test (ASTM D 422-63) Permeability test (ASTM D2434). In this study, tests were carried out to evaluate the physical properties of the soil with a mixture of lime and Matos soil stabilizer. Variations in the mix include natural soil mixed with 4% lime, and different percentages of Matos soil stabilizers, namely 1%, 2%, 4%, and 8%. The curing time for each mixture variation was 0 days, 7 days and 14 days. After completing the test, data analysis will be carried out.

Table 1. Composition of Soil Mix, Lime, Matos

Code	Persentase *Additive*		Soil mixture
	Lime (%)	Matos (%)	
S	0	0	Soil disturbed
SL	4	0	Soil + Lime 4%
SLM 01	4	1	Soil + Lime4% + matos 1 %
SLM 02	4	2	Soil + Lime 4% + matos 2 %
SLM 04	4	4	Soil + Lime 4% + matos 4 %
SLM 08	4	8	Soil + Lime 4% + matos 8 %

2. 1 Testing of Soil Mixture

Table 1. Water Content test

code	Water Content		
	(Curing 0 days)	(Curing 7 days)	(Curing 14 days)
S	24.255	24.109	23.954
SL	22.222	21.622	20.821
SLM-01	22.784	22.726	22.71
SLM-02	22.519	22.477	22.447
SLM-04	22.101	22.059	22.015
SLM-08	21.261	21.117	21.071

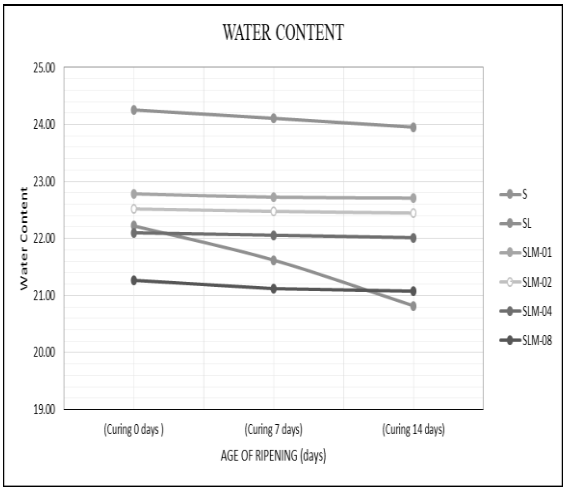

Figure 1. Water content test on palnting time

In the graph above it can be concluded that the higher and longer the curing of the lime and matos variations, the lower the crude water value obtained. The lowest water content value obtained at 4% lime variation (20.821).

Table 2 volume weight test

Curing Time	code	Volume Weight (ɣwet) gr/cm3	
		laboratory test	empirical formula
0 days	S	1.811	1.816
	SL	1.794	1.849
	SLM-01	1.801	1.877
	SLM-02	1.820	1.862
	SLM-04	1.838	1.855
	SLM-08	1.876	1.833
7 days	S	1.811	1.816
	SL	1.783	1.840
	SLM-01	1.792	1.876
	SLM-02	1.811	1.862
	SLM-04	1.829	1.854
	SLM-08	1.866	1.831
14 days	S	1.811	1.813
	SL	1.773	1.828
	SLM-01	1.783	1.876
	SLM-02	1.801	1.861
	SLM-04	1.820	1.853
	SLM-08	1.857	1.831

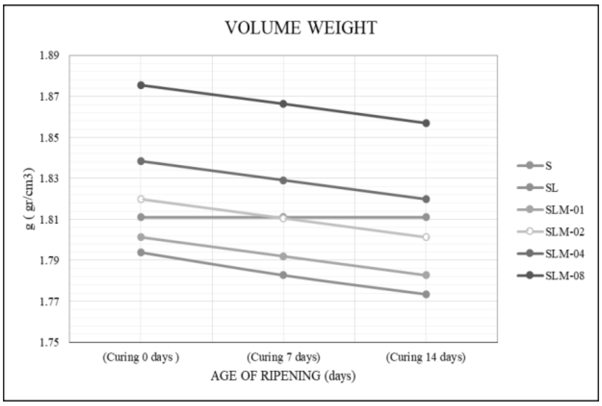

Figure 2. Volume weight test on planting time

From the test results it was found that there was a decrease in the volume weight of wet soil for each variation of matos added with 4% lime both non-curing and curing 7.14 days. This is in line with the reduction in water content that occurs. If the water content decreases, the unit weight of wet soil also decreases. the difference in volume weight using laboratory tests (soil samples are weighed) and with the empirical formula is due to the accuracy of the large scales making the results less precise.

Table 3 specific gravity test

code	Spesivic Gravity		
	(Curing 0 days)	(Curing 7 days)	(Curing 14 days)
S	2.612	2.613	2.614
SL	2.665	2.607	2.543
SLM-01	2.580	2.540	2.496
SLM-02	2.473	2.427	2.390
SLM-04	2.384	2.360	2.335
SLM-08	2.289	2.243	2.187

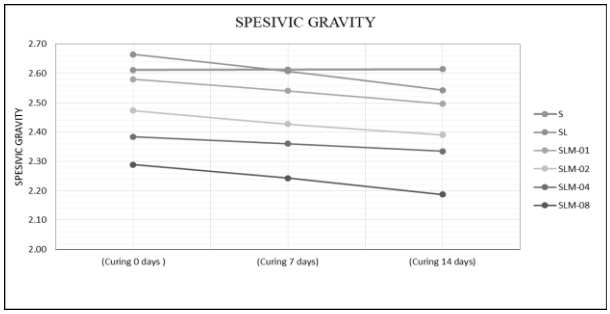

Figure 3 spesific gravity test on planning time

that there was a decrease in specific gravity for each variation of Matos added with 4% lime and 1,2,4,8% Matos both non-curing and curing 7.14 days. It can be concluded that the greater the matos variation, the smaller the specific gravity value obtained where the lowest specific gravity results are in the lime 4% + matos 8% variation (GS = 2.187).

Table 4 Atterberg Limits Test

Indeks Plastisitas		
(Curing 0 days)	(Curing 7 days)	(Curing 14 days)
14.252	14.132	14.062
10.578	9.529	8.189
9.103	8.806	7.961
8.759	7.932	7.129
8.329	7.534	6.697
7.729	6.702	6.035

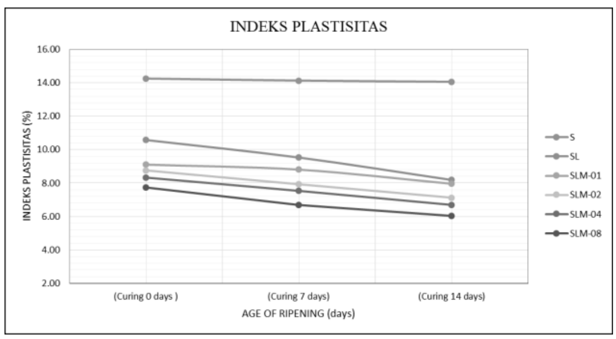

Figure 4 indeks plastisitas test on planning time

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Based on the graph shown in the graph, it shows the effect of adding the percentage of lime and matos to the value of the soil plasticity index. The lowest soil plasticity index value at curing 0.7.14 days was shown in the percentage of lime 4% + matos 8% (14 days), that is 6.035%. While the highest soil plasticity index value at 0 days ripening is shown in the percentage of lime 4% + matos 1% which is equal to 9.103%. it can be concluded that the greater the percentage of lime + matos added to the soil, the greater the value of the soil plasticity index. However, in testing the Atterberg limits on lime + matos stabilized soil at 0.7.14 days of curing there was a human error so that such results were obtained.

Table 5 Permeability Test

Permability		
(Curing 0 days)	(Curing 7 days)	(Curing 14 days)
3.4851E-06	3.4751E-06	3.4651E-06
3.3218E-06	0.00000328	3.24074E-06
2.27861E-06	0.000002260	2.12668E-06
2.20247E-06	2.18349E-06	0.000002089
0.0000021	0.00000193870	1.82692E-06
1.8455E-06	0.00000171589	0.0000016239

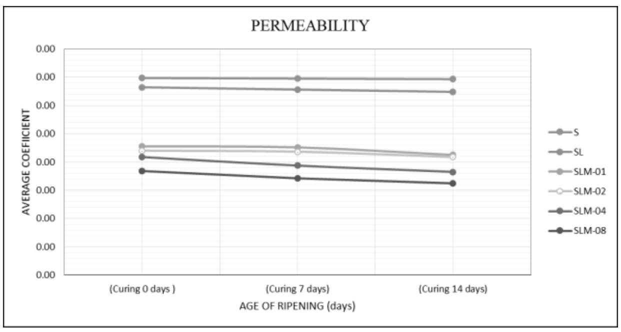

Figure 5 Permeability test on planning time

The value of the permeability coefficient for variations in the mixture of lime and mattos during different curing periods decreased, where the highest decrease was in ST-06 curing 14 days, namely 0.0000016239 cm/second.

Table 6 USDA Method Claficitaion

Curing	code	Soil Claficitation
0 days	S	silted clay
	SL	sandy clay
	SLM-01	sandy clay
	SLM-02	sandy clay
	SLM-04	sandy clay
	SLM-08	sandy clay
7 days	S	silted clay
	SL	sandy clay
	SLM-01	sandy clay
	SLM-02	sandy clay
	SLM-04	sandy clay
	SLM-08	sandy clay
14 days	S	silted clay
	SL	sandy clay
	SLM-01	sandy clay
	SLM-02	sandy clay
	SLM-04	sandy clay
	SLM-08	sandy clay

Based on the USDA classification where Undisturbed TA was obtained with the classification of silt clay, 4% Limestone TA and 1,2,4,8% matos variation obtained sandy clay. The graph can be seen that for Undisturbed TA the percentage of silt is greater than the percentage of sand and clay, while TA Limestone 4% and matos variation 1,2,4,8% the percentage of sand is greater than silt and clay. With this method it can be concluded that the higher the variation of matos and lime, the higher the percentage of sand in the soil.

Table 7 USCS Method Claficitation

curing	code	soil claficitation	soil type
0 days	S	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand
	SL	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand
	SLM-1 SLM-2 SLM-4 SLM-8	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand
7 days	S	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand
	SL	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand
	SLM-1 SLM-2 SLM-4 SLM-8	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand
14 days	S	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand
	SL	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand
	SLM-1 SLM-2 SLM-4 SLM-8	ml	inorganic silt, very fine sand, rock powder, silted or loamy fine sand

It can be seen from the results of the USCS soil classification method that as the addition of matos and lime variations into the soil for different curing variations, the soil type changes due to an increase in the type of sand grains and a decrease in the type of clay grains. , very fine sand, rock powder, fine silt or loamy sand) because it has silt and clay the search limit is 50% or less different from lime with ml classification (inorganic silt, very fine sand, rock powder, fine silt or loamy sand) because silts and clays have a liquid limit of more than 50%.

Table 8 AASHTO Method Clasification

curing	code	Soil Claficitation AASHTO	F (The material passes through the sieve No.200 (%))	GI (Grou Indeks)
0 days	S	A-7-6	83.280	13.352
	SL	A-7	45.700	2.340
	SLM-01	A-5	55.216	3.948
	SLM-02	A-5	49.364	3.804
	SLM-04	A-5	46.864	3.610
	SLM-08	A-5	49.390	3.327
7 days	S	A-7-6	82.138	13.352
	SL	A-4	36.136	1.985
	SLM-01	A-5	64.308	3.814
	SLM-02	A-5	50.446	3.420
	SLM-04	A-5	55.026	3.249
	SLM-08	A-5	55.330	2.865
14 days	S	A-7-6	80.514	13.352
	SL	A-4	47.082	1.545
	SLM-01	A-5	35.840	3.420
	SLM-02	A-5	40.874	3.051
	SLM-04	A-5	38.934	2.862
	SLM-08	A-5	46.182	2.568

In the soil classification based on AASHTO by reviewing the number of passes in filter no.200, it is 35% smaller or larger. The liquid limit values and plasticity index values obtained for disturbed soils are categorized in group A-7-6, namely loamy soils. Soils with a mixture of 4% lime with a curing time of 0-14 days are categorized in groups A-7 and A-4. Whereas soil with a mixture of lime and matos variations is categorized in group A-5, that is silt.

3. Conclusion

The activity value of clay stabilized with lime and matos ranges from 0.17-0.368, so the clay sample stabilized with lime and matos contains the mineral Kaolinite and is classified as inactive clay. With low development potential.

Based on the results of the permeability test stabilized with 4% lime and matos variations of 1%, 2%, 4% and 8% it is concluded that the permeability coefficient value the greater the matos variation the smaller the permeability coefficient value.

Based on the results of the specific gravity test on lime-stabilized soil with 4% lime variation and 1,2,4,8% matos variation, it can be concluded that the higher the percentage of lime and matt in clay soil, the higher the value of specific gravity (sg).

Based on the results of the Atterberg test stabilized with 4% lime variation and 1,2,4,8% matos variation, it can be concluded that the more matos variations, the lower the plasticity index (PI) value.

Before carrying out soil sampling at the specified location, it should be prepared with critical measures so that energy, time, funds and so on become efficient. The need for accuracy in sample processing during soil mashing to match the planned data.

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