Analysis of Unconfined Compressive Strength in Clay Mixed with Sand

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Abstract. Clay soils are soils that have high shrinkage potential and have good carrying capacity in water unsaturated conditions but poor in water-saturated conditions. Clay soil has a low carrying capacity, so to increase the carrying capacity of the soil it needs to be stabilized by using an added material which is sand. Land used for 100% disturbed soil, 95% disturbed soil + 5% sand, 90% disturbed soil + 10% sand, 85% disturbed soil + 15% sand, with curing time 3,7,14, and 28 days. The mixture was tested using unconfined compressive strength test instrument with SNI 03-6887-2002 method. The results of the unconfined compressive strength test showed that the increase in maximum soil strength occurred in the addition of 90% disturbed soil + 10% sand at the age of 28 days curing, which reached 1,194 kg/cm². But the results of unconfined compressive strength increased when the mixture of 85% disturbed soil + 15% of sand reaching 1,348 kg / cm². Based on testing that the more amount of sand is added, the higher the value of unconfined compressive strength obtained.

Keywords: Clay; Sand; Stabilization; Unconfined compressive strength; Analysis.

1 Introduction

Asmat Regency is located in Papua with an area of 31,983.69 km² or 31.98% of the total area of Papua Province and is a division of Merauke Regency, the type of soil found in Asmat Regency consists of clay soil which is usually found in swampy areas and in lowland. In general, development in Asmat Regency is carried out on swamps and lowlands so that clay soil is a problem that must be overcome.

Clay soils have the property of expanding and developing several factors such as lithological variability at various scales, and cycles that vary repeatedly, on the behavior of clay [1] and have low bearing capacity. The compressive strength test of clay needs to be carried out to determine the compressive strength capacity of clay to be carried out with sand. Therefore, scientific and systematic research is needed to determine the character and proportion of each ingredient. In this study, the clay and sand materials used are local materials from several areas in Asmat Regency.

2 Methods

2.1 Location of Sampling

Obtaining the physical properties and mechanical properties of the soil that are limited in the UCS test was

carried out at the Civil Engineering Laboratory, Musamus University, Merauke.

2.2 Research Materials

- Soil samples taken and used in this study were sourced from Akantapak Village, Aswi District, Asmat Regency.
- Sand samples taken and used in this study were sourced from Bawos Village, Aswi District, Asmat Regency.

2.3 Method of testing

- Testing of soil density is adjusted to SNI. [2] The tools used are hot plates, pycnometers, ovens, electric scales, spatulas.
- Testing of water content is adjusted to SNI. [3] The tools used are ovens, cups, electric scales.
- Testing of grain analysis is adjusted to SNI. [4] The tools used are sieve filters, brushes, electric scales, water hoses, cups.
- Atterberg boundary testing devices are adjusted to SNI. [4, 5] est equipment used is casagrande, cup, glass with dimensions of 0.9 cm x 45 cm x 45 cm, spatula, oven.
- Compaction test equipment adjusted to SNI. [6] The tools used are ovens, standard hammer proctors, standard proctors, electric scales, jacks.

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- Tests to get an overview of the results of this study using the unconfined compressive strength (UCS).

3 Results and Discussions

3.1 Soil Properties

Based on the results of testing the physical characteristics of the soil in the laboratory, the following data were obtained:

Table 1. Recapitulation of the results of testing the physical properties of the soil

No	Test type	Symbol	Test Result	Unit
1	Water content	wc	57.71	%
2	Specific gravity	gs	2.62	
3	Weight	γ	1.43	grams/cm ³
4	Atterberg's boundaries			
	a. Liquid Limit	LL	71.15	%
	b. Plastic Limit	PL	52.45	%
	c. Index Plastic	PI	18.40	%
5	Screening analysis			
	a. Clay		30	%
	b. Silt		20	%
	c. Sand		30	%
	d. Gravel		0	%

3.2 Sand Properties

Based on the results of testing the physical characteristics of sand carried out in the laboratory, the following data were obtained:

Table 2. Recapitulation of the results of testing the physical properties of sand

No	Test	Score	Unit
1	Moisture content of fine aggregate (Sand)	3.59	%
2	Saturated surface dry density (SSD)	2.67	%
3	Oven dry weight (Bulk)	2.61	%
4	Apparent dry density (Apprent)	2.76	%
5	Absorption	2.04	%
6	Pass filter 200	99.65	%

3.3 Unconfined Compressive Strength Test (UCS)

In this study, the curing time used was 3 days, 7 days, 14 days and 28 days. In this test using a mixed variation of 100% disturbed soil, 95% disturbed soil + 5% sand, 90% disturbed soil + 10% sand, 85% disturbed soil + 15% sand. The results of the compressive strength test for

undisturbed soil without a mixture of sand can be seen in table 3.

Table 3. Testing of the compressive strength of undisturbed soil without a mixture of sand

No.	Curring	Value of q_u (kg/cm ²)	Percentage increase	Stress (kg/m ²)
1	3	0.894	0.12	0.447
2	7	1.094	0.12	0.547
3	14	1.433	0.12	0.716
4	28	1,848	0.13	0.924

Fig.1. Graph of the relationship between ripening age and the value of q_u in the 100% soil test

Based on the results of the test data obtained and the graphic image shows the compressive strength of the disturbed soil without a mixture of sand at the age of 3 days is 0.416 kg/cm², while at the age of 28 days there is an increase of 0.924 kg/cm². The results of the undisturbed compressive strength test with a mixture of 95% soil and 5% sand can be seen in Table 4.

Table 4. Test of soil unconfined compressive strength with a mixture of 95% soil and 5% sand

No.	Curring	Value of q_u (kg/cm ²)	Percentage increase	Stress (kg/m ²)
1	3	1.063	0.12	0.531
2	7	1.309	0.13	0.655
3	14	1,725	0.13	0.863
4	28	2,311	0.13	1.078

Based on the results of the test data obtained and the graphic image shows the value of the compressive strength of undisturbed soil with a mixture of 95% soil and 5% sand at the age of 3 days is 0.531 kg/cm², while at the age of 28 days there is an increase of 1,078 kg/cm². The results of the undisturbed compressive strength test with a mixture of 90% soil and 10% sand can be seen in table 5.

Fig.2. Graph of the relationship between curing and the value of q_u in the 95% soil + 5% sand test

Table 5. Value of undisturbed compressive strength of soil with a mixture of 90% soil and 10% sand

No.	Currin g	Value of q_u (kg/cm2)	Percentage increase	Stress (kg/m2)
1	3	1.217	0.13	0.608
2	7	1.556	0.12	0.778
3	14	1969	0.12	0.985
4	28	2,388	0.12	1.194

Fig.3. Graph of the relationship between curing and the value of q_u in the test of 90% soil and 10% sand

Based on the results of the test data obtained and the graphic image shows the compressive strength of disturbed soil with a mixture of 90% soil and 10% sand at the age of 3 days is 0.608 kg/cm², while at the age of 28 days there is an increase of 1.194 kg/cm². The results of the undisturbed compressive strength test with a mixture of 85% soil and 15% sand can be seen in Table 6.

Table 6. Value of undisturbed compressive strength of soil with a mixture of 85% soil and 15% sand

No.	Curring	Value of q_u (kg/cm2)	Percentage increase	Stress (kg/m2)
1	3	1.417	0.12	0.709
2	7	1,742	0.12	0.871
3	14	2.138	0.12	1.069
4	28	2,696	0.12	1.348

Fig.4. Graph of the relationship between curing and the value of q_u in the test of 85% soil and 15% sand

Based on the results of the test data obtained and the graphic image shows the compressive strength of disturbed soil with a mixture of 85% soil and 15% sand at the age of 3 days is 0.709 kg/cm², while at the age of 28 days there is an increase of 1.348 kg/cm².

Fig.5. Graph of the effect of curing on the value of stress (q_u) with mixed variations variasi

Based on the results of calculations on the UCS test for a mixture of soil and sandit can be concluded that the more addition of sand and the longer the curing age the higher the value of q_u is shown in Figure 5.

Table 7. The results of the recap of the average independent compressive strength value

Variations	Curring Time	q_u (kg/cm ²)
100% Land Disturbed	3	0.447
	7	0.547
	14	0.716
	28	0.924
95% Land Disturbed+ 5% Sand	3	0.531
	7	0.655
	14	0.863
	28	1.078
90% Land Disturbed + 10% Sand	3	0.608
	7	0.778
	14	0.985
	28	1.194
85% Land Disturbed + 15% Sand	3	0.709
	7	0.871
	14	1.069
	28	1.348

4 Conclusion

Based on the results of the research and discussion above, it can be concluded that the maximum unconfined compressive strength test results occurred at 28 days of curing as follows:

- a. Score The unconfined compressive strength of the clay subgrade in Akantapak village is 0.924 kg/cm².
- b. Influence clay soil with mixer local sand against unconfined compressive strength.
 - 95% land disturbed + 5% sand obtained the value of $q_u = 1.078 \text{ kg/cm}^2$.
 - 90% land disturbed + 10% sand obtained the value of $q_u = 1.194 \text{ kg/cm}^2$.
 - 85% Disturbed soil + 15% sand obtained the value of $q_u = 1.348 \text{ kg/cm}^2$.

Judging from the test results above, it can be seen that the optimum q_u occurs in the variation of the mixture of 90% disturbed soil + 10% sand of 1,194 kg/cm², and the effect of the addition of a mixture of sand can increase the strength of the soil, it can be seen in the test results above, where at the time of testing the sample of 85% disturbed soil + 15% sand obtained a q_u value of 1.348 kg/cm.

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