Soil Stabilization on Cibingbin Village Roads Using Rice Husk Ash and Cement

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ABSTRACT

Soil is a support for the foundations of civil buildings, which supports and holds structural loads. Unstable soil conditions will cause problems in the future with construction, such as the soil condition on Jalan Cibingbin Village, Cibaliung Banten, which has high plasticity with poor bearing capacity. To increase the bearing capacity value of the soil, a unique method is needed for the soil using soil stabilization materials such as rice husk ash (RHA) and type 1 cement; both materials are elementary to obtain. Soil stabilisation uses 20% cement, RHA (0%, 5%, 10%, 15%), soil and water. Compacted using standard compaction methods and unconfined compressive strength (UCT) testing was conducted. Soil samples were taken on Cibingbin Village Road, with 0, 7, 14, and 28 days of curing times. From the results of soil stabilization tests in Cibingbin village, it can be classified as high plasticity inorganic clay (CH) based on the USCS classification table. The UCT results show that the most optimum RHA content is found at a variation of 5%. The highest unconfined compressive strength value was found at a curing time of 28 days with an RHA content of 5% and 20% cement with an unconfined compressive value of 20.9 kg/cm2. However, adding rice husk ash and cement increases the plasticity index value. This indicates that rice husk ash and cement cannot reduce the plasticity index value of the soil on the Cibingbin Cibaliung Banten road.

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1. INTRODUCTION

Soil is the foundation of civil buildings, and its function is to support and withstand structural loads on the structure [1]. Soil consists of three parts: soil particles, water, and air. Soil has different characteristics from one place to another, so if soil conditions do not comply with the requirements that have been determined, then an oil stabilization process is needed to increase the carrying capacity and improve the soil properties, changes in volume, and weight—type by adding in—tTypecals, waste materials or other materials [2]. The soil condition of the Cibingbin village road has a CBR value of less than 3% after DCP testing [3]. This results in the soil condition being unsuitable for use as a subgrade for road construction. Therefore, to improve the soil or stabilize the soil. One of the materials for soil stabilization is cement, which binds soil grains and hardens and is easy to obtain on the market. Indonesia is an agricultural country that produces rice in 2021 of 55,269,619 tons [4]. To become rice, rice must be ground first. In this process, there is waste from rice in the form of rice husks. When rice husks are burned, they produce rice husk ash (RHA), which has cement-like properties and can be used as a soil stabilization material [5]. The use of RHA aims to utilize waste from rice as a valuable material and has potential in the future as a soil stabilization material. This research uses two materials, including type 1 cement and RHA, used as a filler to stabilize the soil. The function of the filler is to fill the voids between the coarse aggregate, which is expected to increase the density and reduce the permeability of the mixture. The research sample that will be used is a 20% cement mixture, RHA(0%, 5%, 10%, 15%), soil, and water-based on the optimum water content of the original soil. Sample testing uses the unconfined compressive strength test (UCT).

2. METHODS

I started this research by collecting data in the form of references for soil stabilization materials from cement and RHA from previous research. Cement is a material that provides strength and durability to bare soil. The cement material used in this research is because this material is easy to obtain and the price is affordable [6]. Apart from cement, RHA is another material that will be added to this research. RHA is waste from burnt rice husks. RHA has a material component of SiO2 [7], where this material has pozzolan characteristics like the properties contained in cement [8]. The vast potential of RHA waste in Indonesia provides a reason to reuse RHA originating from waste into materials. This activity is expected to reduce waste generated from rice production.

Conduct a survey to look for land that will be used as research, namely on Jalan Cibingbin Cibaliung Banten village, where the road condition is damaged, see Figure 1. Disturbed soil samples were taken using a hoe and sent to the Untirta Civil Engineering Soil Mechanics laboratory for research.

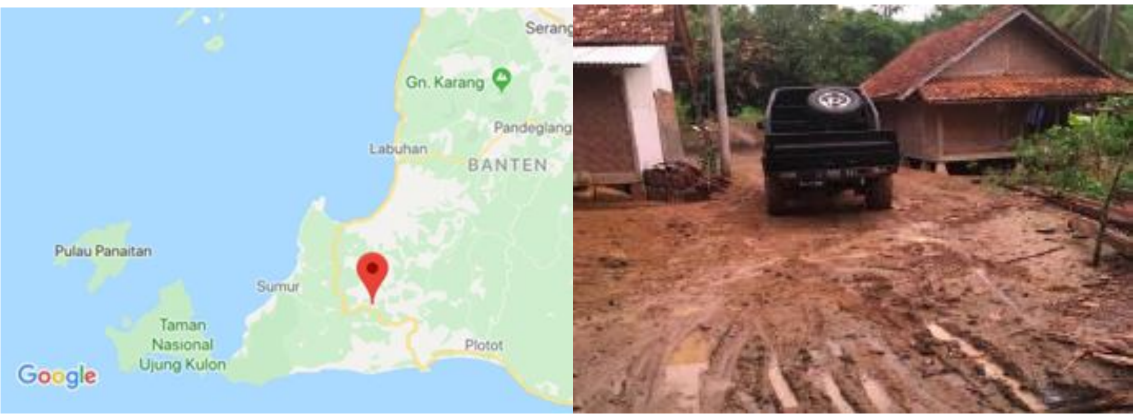

Figure 1 Cibingbin village location and village road condition 3

RHA samples were obtained from a rice mill in Cilegon, picture 2, and type 1 cement, which is sold freely in building stores. We were carrying out tests on soil samples that had been brought in the form of water content tests, specific gravity tests, Atterberg tests, sieve tests and standard compaction tests to determine the type of soil classification. RHA was filtered using filter No. 200, and the RHA used was RHA that passed filter No. 200 [9].

Figure 3 Rice Husk Ash (RHA) in a rice milling factory in Cilegon

Soil stabilization samples are made by mixing water, soil, cement and RHA. Water is obtained from the results of standard compaction tests in the form of the optimum water content of the original soil based on the dry weight of the original soil. The cement used for type 1 is 20% constant of the dry weight of the original soil. As well as RHA with variations (0%, 5%, 10%, 15%) to the dry weight of the original soil. Research samples were made according to the specified variations, then compacted using standard compaction methods and moulded for free compressive strength (UCT) testing. Research samples were made with UCT test sizes according to the variations that had been determined and then tested for 0 days, 7 days, 14 days and 28 days [10]. Curing is carried out to determine changes in strength and provide time for chemical reactions in the sample to increase the soil's bearing capacity.

UCT testing is carried out according to the sample variations and curing time that have been determined; from these results, the strength value of the soil stabilized by cement and RHA will be seen. This data will be analysed and discussed to determine which mixture variation is the best so that conclusions and suggestions can be drawn for this research. We can see the flow chart in Figure 4

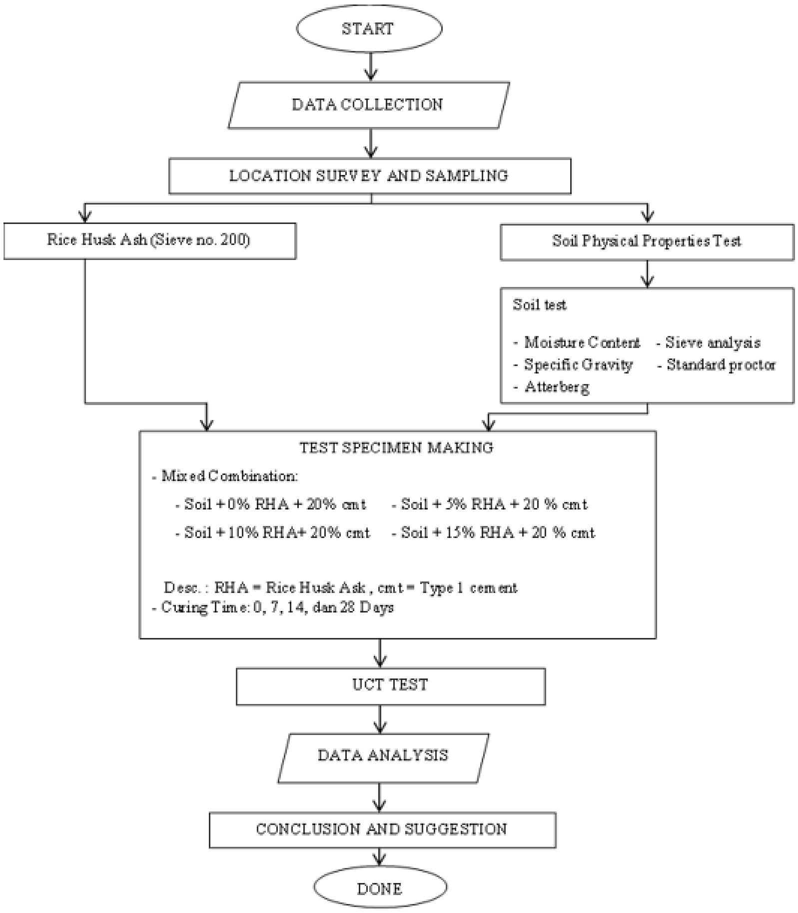

Figure 4. Research Flowchart

3. RESULTS AND DISCUSSION

3.1 Soil Classification

We can see the test results for the original soil samples in Table 1

Table 1. Soil Classification

No.	Test Type		Unit	Test Result
1	Moisture Content		%	27,86
2	Liquid Limit		%	65
3	Plastic Limit		%	30,92
4	Plasticity Index		%	34,08
5	Specific Gravity			2,691
6	Sieve Analysis (Passing Sieve no. 200)		%	52
7	Weight Content		g/cm^3	1,418
8	Compaction	MDD[a]	g/cm^3	1,310
		OMC[b]	%	28

[a]: *Maximum Dry*

[b]: *Optimum Moisture Content*

This study's determination of soil classification is based on the USCS (United States Classification System). The test results found in **Table 1** are described as follows:

a) Grain Size Analysis
   The soil that passes the No.200 sieve is 52%, which means it is included in the fine-grained soil (clay).
b) Liquid Limit (LL)
   The original liquid limit value is more than 50%, which is 65%.
c) Plastic Limit (PL)
   The value of the soil plastic limit is 30.92%.
d) Plasticity Index (IP)
   The value of the soil plasticity index is 34.08%.
   All test results were compared with the USCS soil classification [11]. Soil from Cibingbin village can be classified as high plasticity inorganic clay (CH).

3.2 Soil Characteristic

3.2.1 Liquid limit (LL)

Table 2. Effect of (RHA +Cement+ Soil + Water) on Liquid Limit of Soil

RHA (%)	**Cement** (%)	**Liquid limit** (%)	**Sample Name**
0	20	54	RHA0%+C20%
5	20	56	RHA5%+C20%
10	20	59	RHA10%+C20%
15	20	62	RHA15%+C20%

Based on **Table 2**, the liquid limit value will increase as the RHA content increases. So, adding RHA can affect the soil's liquid limit (LL) matter. **Figure 5** shows the graph of the liquid limit.

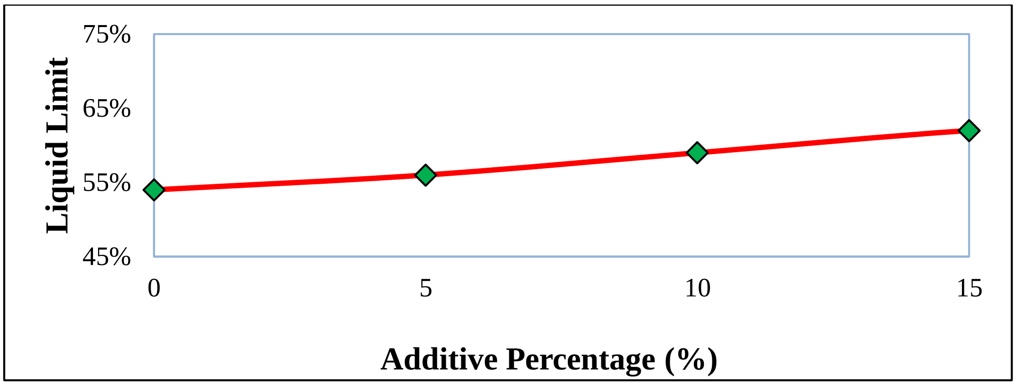

Figure 5. Liquid Limit to RHA content and 20% Cement at 0-Day Aging

3.2.2 Plastic limit

Table 3. Plastic limit

RHA (%)	**Cement** (%)	**Plastic Limit** (%)	**Sample Name**
0	20	42,20%	RHA0%+C20%
5	20	43,06%	RHA5%+C20%
10	20	45,38%	RHA10%+C20%
15	20	46,78%	RHA15%+C20%

Table 3 shows that adding RHA can increase the percentage of plastic limit as the ash content of the mixed soil increases. **Figure 6**6 shows the graph of the plastic limit (PL).

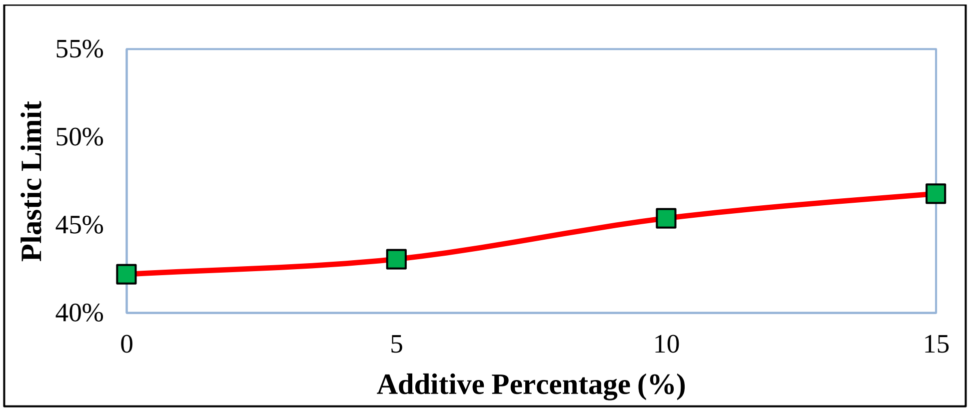

Figure 6. Plastic Limit to RHA Content and 20% Cement at 0-Day Aging

3.2.3 Plasticity index

Table 4. Plasticity Index

RHA (%)	Cement (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
0	20	54	42,20	11,80
5	20	56	43,06	12,94
10	20	59	45,38	13,62
15	20	62	46,78	15,22
20	20	64	47,81	16,19

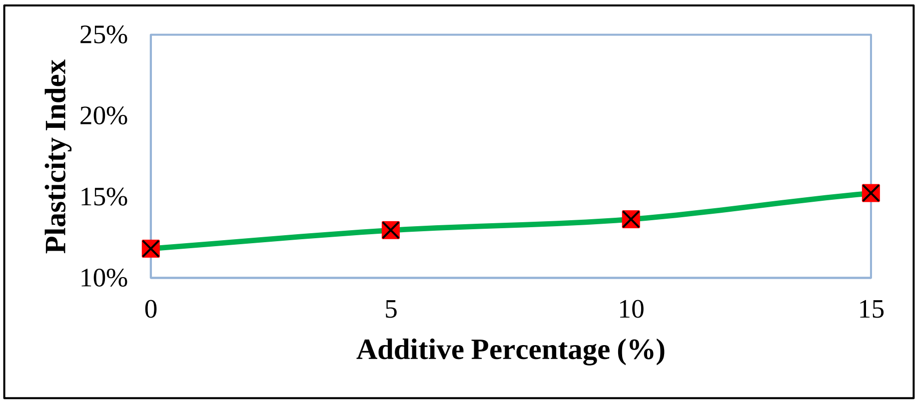

Figure 7. Plasticity Index to RHA Ash Content and 20% Cement at 0-Day Aging

Based on **Table 4** and **Figure 7**, the addition of RHA causes the liquid limit (LL) and plastic limit (PL) values to increase, affecting the soil plasticity index. This has happened in previous research where there was an increase in the surface area and specific activity of the soil [12][13]. So, the soil stabilization materials for RHA and cement have not been able to reduce the soil plasticity index value originating from Cibingbin Cibaliung Banten. In the range of soil plasticity index values between 7% - 17% [14], it is included in the type of silty clay soil with cohesive properties with medium plasticity.

3.3 UCT Result

The UCT test results for each RHA variation and curing time can be seen in **Table 5**.

Table 5. UCT Result

Curing Time	RHA	Cement	*qu*
Days	**%**	**%**	**kg/cm^2**
0	0	20	1,737
	5	20	3,401
	10	20	2,986
	15	20	0
7	0	20	4,297
	5	20	11,197
	10	20	9,478
	15	20	0
14	0	20	8,794
	5	20	16,829
	10	20	12,083
	15	20	0
28	0	20	16,503
	5	20	20,9
	10	20	13,275
	15	20	0

Based on the UCT results in **Table 5**, soil samples with variations in RHA 15% + cement 20% cannot be tested because the formation of UCT samples cannot be carried out because the soil samples immediately disintegrate when formed, this is due to the lack of water in creating the models. The lack of water is caused by water taken based on the optimum water content of the original soil, and the available water is directly absorbed by cement and RHA [15], so it cannot lubricate all the soil grains in the samples made.

To make it easier to graph the relationship between the addition of RHA to the qu value and curing time, **Table 6** was created.

Table 6 Recapitulation of RHA addition, the effect of curing on UCT (qu) value

Sample Name	qu (kg/cm^2), Curing Time (days)			
	0	7	14	28
RHA0%+C20%	1,737	4,297	8,794	16,503
RHA5%+C20%	3,401	11,197	16,829	20,9
RHA10%+C20%	2,986	9,478	12,083	13,275
RHA15%+C20%	0	0	0	0

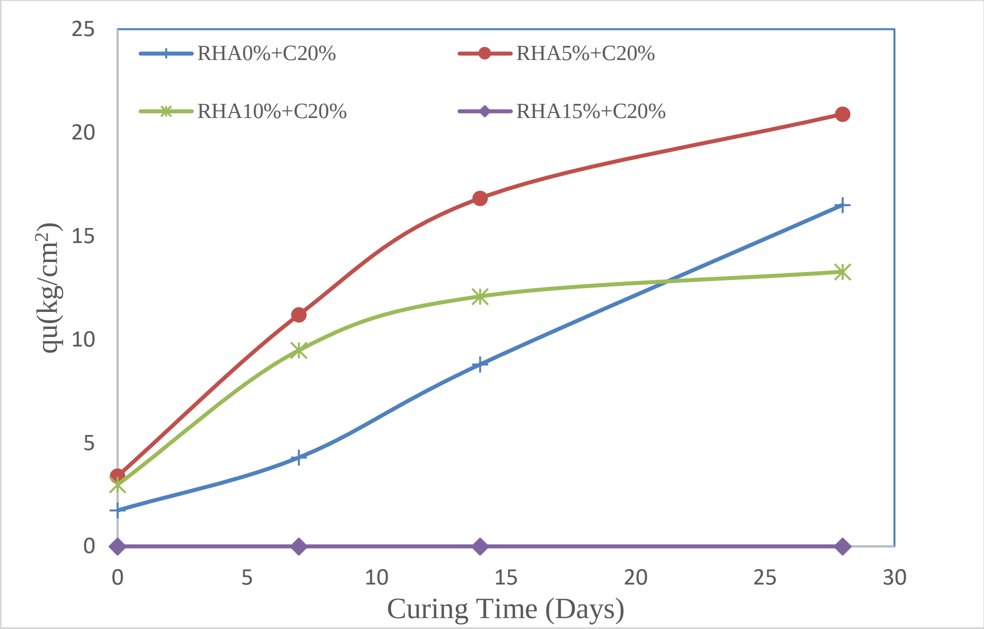

Figure 1. qu value to curing time

Figure 6 shows that the addition of RHA 5% + 20% cement has the highest qu value compared to other sample variations. The qu value continues to increase from 0 to 28 days, indicating that the RHA and cement harden following the concrete pavement pattern. Likewise, variations in other samples increased with increasing curing time, which suggests that the stabilized material using RHA underwent a hardening process [16].

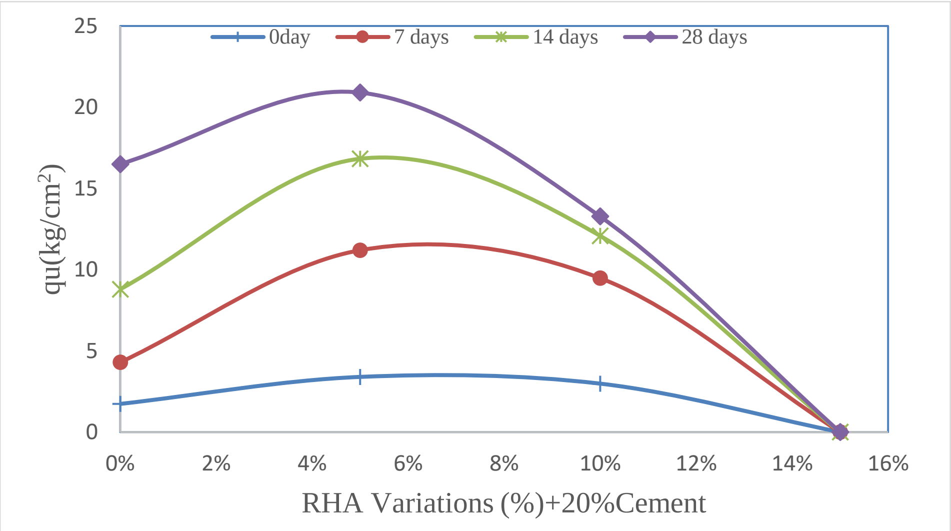

Figure 2. qu value to RHA content and 20% cement

In **Figure 7,** we can see a graph between the addition of RHA to the qu value. From this graph, the optimum qu value is obtained in a mixture of 5% RHA + 20% cement with a qu value = 20.9 kg/cm2 with a curing time of 28 days. The addition of RHA after 5% causes the qu value to decrease. Meanwhile, the RHA15%+ 20% cement mixture cannot be tested for strength because the sample cannot be moulded. The model immediately disintegrates when removed from the mould.

4. CONCLUSION

In testing the physical properties of the original soil, the soil at the Cibingbin location, according to the USCS classification system, is included in the CH group with a Plasticity Index value of 34.08%, namely high plasticity inorganic clay. Because the soil is included in the clay category and has high plasticity, improving the soil, including chemical stabilization is necessary. In the unconfined compressive strength (UCT) test, RHA and cement can influence the unconfined compressive strength value. The longer the curing time, the higher the qu value. The optimum value obtained from variations of 5% RHA and 20% qu cement was 20.9 kg/cm2 with a curing time of 28 days. From the research results, soil stabilization with RHA and cement additives can increase the unconfined compressive strength value with increasing c. For further research, it is recommended to add water so that the soil samples can be printed perfectly for adding RHA above 15%.uring time, but it has not been able to reduce the LL and PL values of Cibingbin Village road soil.

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