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IMPROVEMENT OF SOIL BEARING CAPACITY BASED ON MODERATE VOLUME USING RICE HUSK ASH

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Abstract

Good soil is soil that has good stability and load-bearing capacity for any construction built on it. However, the existing soil conditions may not possess sufficient load-bearing capacity, necessitating a method to improve it. For instance, in North Sumatra, the soil is relatively soft and predominantly used for agriculture. Rice husk ash is a byproduct of rice farming and exhibits pozzolanic properties, making it a potential alternative for enhancing soil load-bearing capacity. Typically, soft soil is fine-grained, has high moisture content, high saturation, high porosity, high initial pore pressure, low shear strength, and significant potential for settlement under increasing effective stress. This research aims to improve soil load-bearing capacity by using rice husk ash with varying mixtures of 0%, 4%, 8%, 12%, 16%, and 20%. Soil samples were collected in the Lubuk Pakam area of North Sumatra. Testing included soil physical properties, such as soil index properties, and soil mechanics tests conducted in the soil mechanics laboratory at the University of Santo Thomas, Medan.Based on the tests, the soil was categorized as organic soil, highly cohesive, and had high plasticity. According to the USCS classification, it falls into the fine-grained or organic soil category with the symbol PT. The CBR values after 7 days of curing with various lime additions of 0%, 4%, 8%, 12%, 16%, and 20% were found to be 0.98, 1.18, 2.00, 4.80, 13.00, and 18.80, respectively. Therefore, it can be concluded that the higher the proportion of rice husk ash in the mixture, the higher the CBR value. This can potentially enhance farmers' income through rice husk sales.

Keywords **: Soil Bearing Capacity, Rice Husk Ash, Income Enhancement**

1. INTRODUCTION

Good soil is characterized by its stability and strong load-bearing capacity for any construction erected upon it. However, the existing soil conditions often lack the necessary load-bearing capacity, necessitating the implementation of a method to enhance the soil's index properties. In regions such as North Sumatra, the soil remains relatively soft. Soft soil, in general, is composed of fine-grained particles, high moisture content, elevated saturation, considerable porosity, and a high initial pore pressure, but it exhibits low shear strength and has the potential for significant settlement under increased effective stress. One specific type of soft soil is clay, which does not meet the physical and technical requirements for construction work due to its high water content, high compaction, and low load-bearing capacity. The map below illustrates the distribution of soft soil in North Sumatra. Rice husk ash is a byproduct derived from the burning of rice husk agricultural waste and contains silica content ranging from 87% to 97% of its dry weight. Rice husk ash is classified as a pozzolanic material, which can significantly improve the properties of concrete. This material is abundant in Indonesia, a country known for its substantial rice production, totaling approximately 54 million tons. The utilization of rice husk can help reduce the waste generated from rice milling processes.

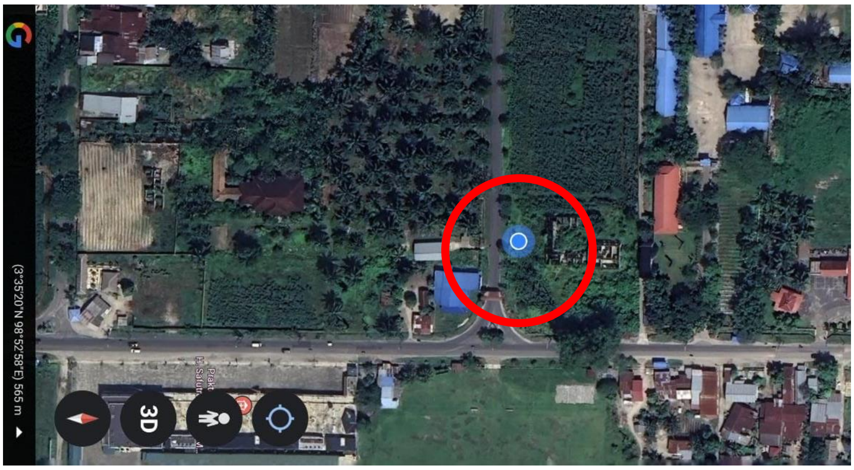
Picture 1 Process Of Producing Rice Husk Ash

In the planning of construction on soft soil, improvements are necessary to maintain soil stability and simultaneously reduce the risk of infrastructure damage. This requires a comprehensive survey and study of soil characteristics to enable construction on such soil. Soil stabilization, commonly known as geotechnical and civil engineering soil stabilization, is the process of enhancing the structural integrity of soil with very low load-bearing capacity, prone to rapid settlement compared to soils with higher load-bearing capacity. In this research, a mixture of rice husk ash, previously screened with a No. 10 sieve to ensure the complete mixing of rice husk ash particles, is employed. The objective of this study is to assess the natural soil properties without altering the surrounding soil in the Lubuk Pakam area and to investigate the impact of incorporating rice husk ash as a stabilization material to enhance the soil's CBR value, with various proportions of rice husk ash.

2. IMPLEMENTATION METHOD

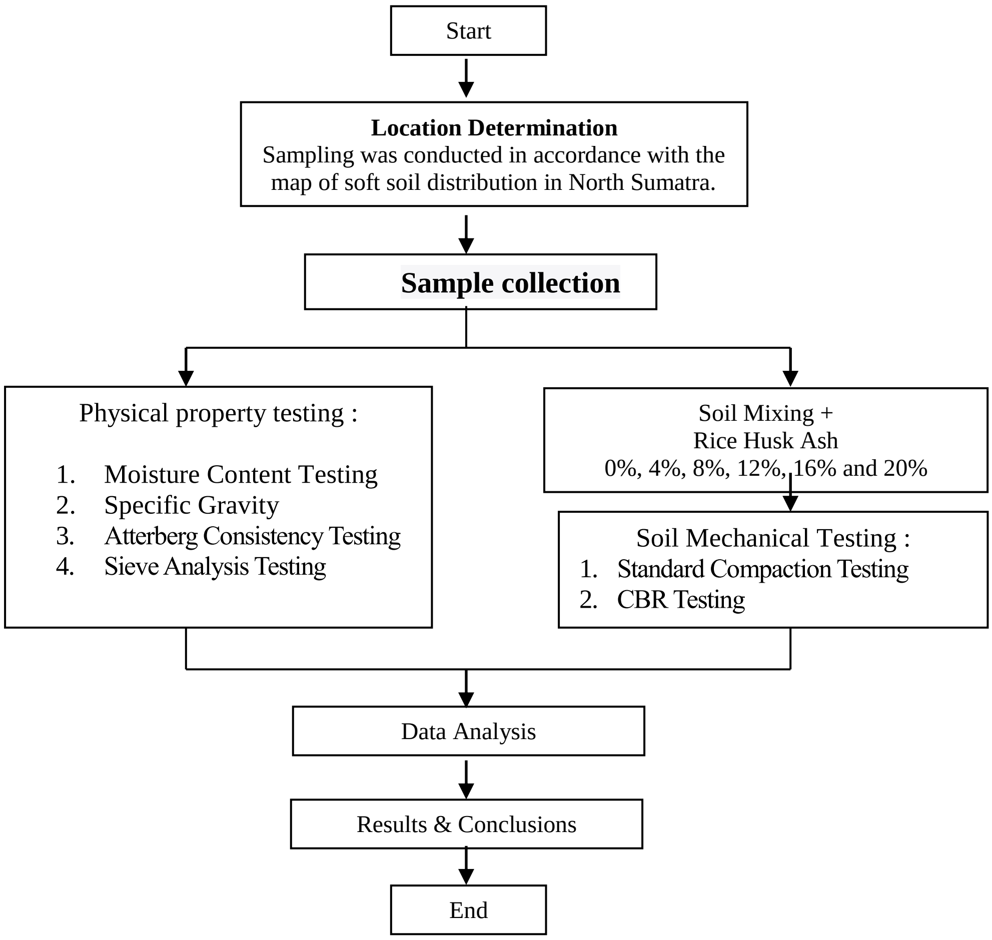
The research was conducted at the laboratory of St. Thomas Catholic University in Medan, and the soil samples were collected in the Lubuk Pakam area, North Sumatra. The testing conducted included physical soil property tests and soil mechanical tests. The soil property tests encompassed soil moisture content testing, soil density testing, Atterberg limit testing, and sieve analysis. The soil mechanical tests included standard proctor tests for soil compaction and California Bearing Ratio (CBR) testing. After soil classification was determined, mechanical testing of the soil mixture would proceed with variations of rice husk ash mixtures at 0%, 4%, 8%, 12%, 16%, and 20%. The sample collection location is in Lubuk Pakam.

Picture 3 Soil’s Sample



Picture 3 The sample collection location

The test results will be presented in the form of tables, graphs, and diagrams, allowing for a comparison of each percentage of rice husk ash mixture with varying proportions. Before a series of tests can be conducted, a number of sample containers need to be prepared, depending on the requirements and mixture proportion variations. The conceptual framework can be seen in Figure 4 below:



Picture 4 Framework of thinking

3. RESULTS AND DISCUSSION

3.1 Testing of Moisture Content and Soil Density of Native Soil

The results of the moisture content test are expressed as a percentage, and the moisture content in this test is obtained from two organic clay soil samples to determine the average moisture content of the soil. For the soil density test, two samples were taken, each weighing less than 15 grams, to obtain the average value of the tested soil density. The results of the moisture content and soil density tests for soft soil can be seen in Table 1.

Table 1 Original Soil Moisture Content Testing Results

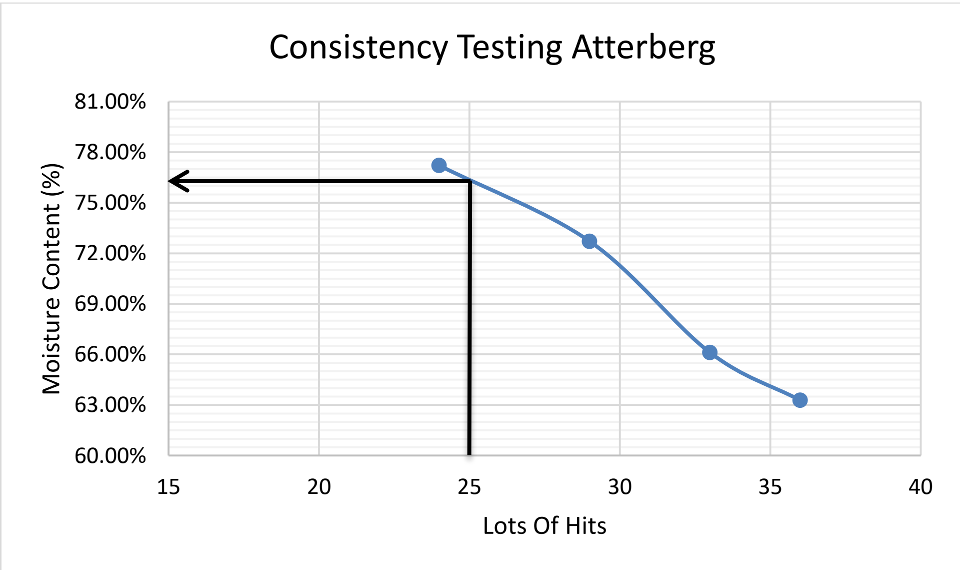
Testing	Sampel 1	Sampel 2	Average
Moisture Content	29,39%	29,05%	29,22%
Specific Gravity	2,59	2,63	2,61

3.2 Atterberg Consistency Testing of Native Soil

Atterberg consistency testing, or Atterberg limits testing, consists of liquid limit testing and plastic limit testing, from which the plasticity index values can be determined. For this test, air-dried soil is ground and sieved through a No. 40 sieve. The results of the Atterberg consistency test are shown in the table below.

Tabel 2 Atterberg Consistency Testing Results

Consistency Testing Atterberg						
Liquid Limit (SNI 1967 - 2008)					Plasticity Limit	
Lots Of Hits	24	29	33	36	(SNI 1966 - 2008)	
Moisture Content (%)	77,21%	72,71%	66,11%	63,28%	40,11	48,73
					44,42	



Picture 5 Water Limit Testing Chart

Based on the liquid limit test graph, the liquid limit (LL) was measured at the 25th blow and obtained a value of 76.50%. According to Casagrande (1948), in the USCS (Unified Soil Classification System), soil with a liquid limit >50% is categorized as organic clay soil and highly cohesive. The plastic limit (PL) is determined from the average moisture content in the plastic limit test, which is 44.42%.

Meanwhile, the plasticity index can be calculated as follows:

Plasticity Index = Liquid Limit (LL) - Plastic Limit (PL)
= 76,50% - 44,42%
= 32,08%

According to Bowles (1997), a plasticity index value above 30% indicates that the soil is highly plastic and highly cohesive.

3.3 Sieve Analysis Testing

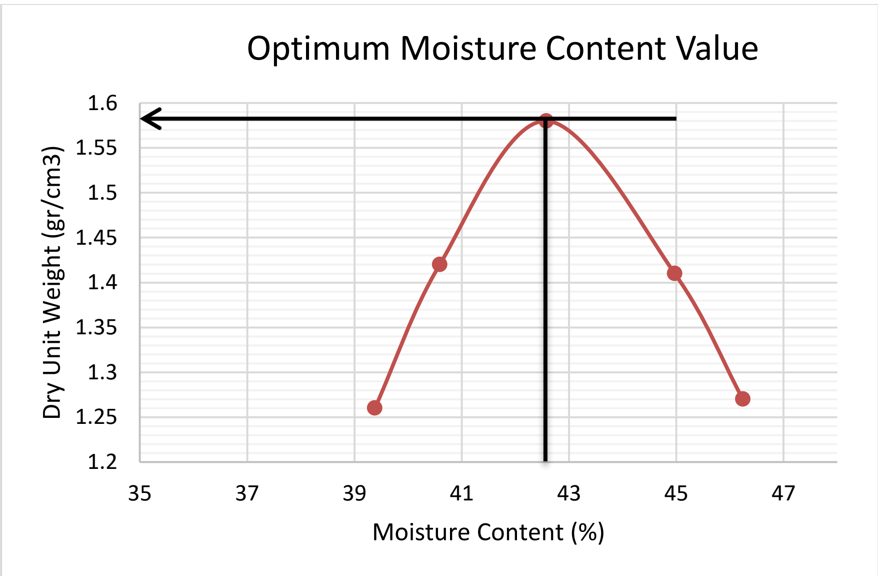
In the sieve analysis test, which was conducted with a 500g sample, a value of 12.57% was obtained for the portion retained on the No. 200 sieve, and 87.43% passed through the No. 200 sieve. According to the USCS classification, soil with more than 50% passing through the No. 200 sieve is classified as the fine-grained fraction or organic soil with the symbol PT.

3.4 Standard Compaction Testing

Standard compaction testing aims to determine the optimum moisture content, which is used as an additional moisture content in the CBR test. This testing is divided into two stages: standard compaction testing for the native soil and standard compaction testing for the soil mixed with rice husk ash. The results of these tests can be seen in the tables and figures below.

Table 3 Original Soil Standard Compaction Test Results

Information	Sampel				
Adding Water (cc)	350	400	450	500	550
Moisture Content (%)	38,38	40,59	42,58	44,97	47,24
Dry Unit Weight (gr/cm^3)	1,36	1,42	1,58	1,32	1,27



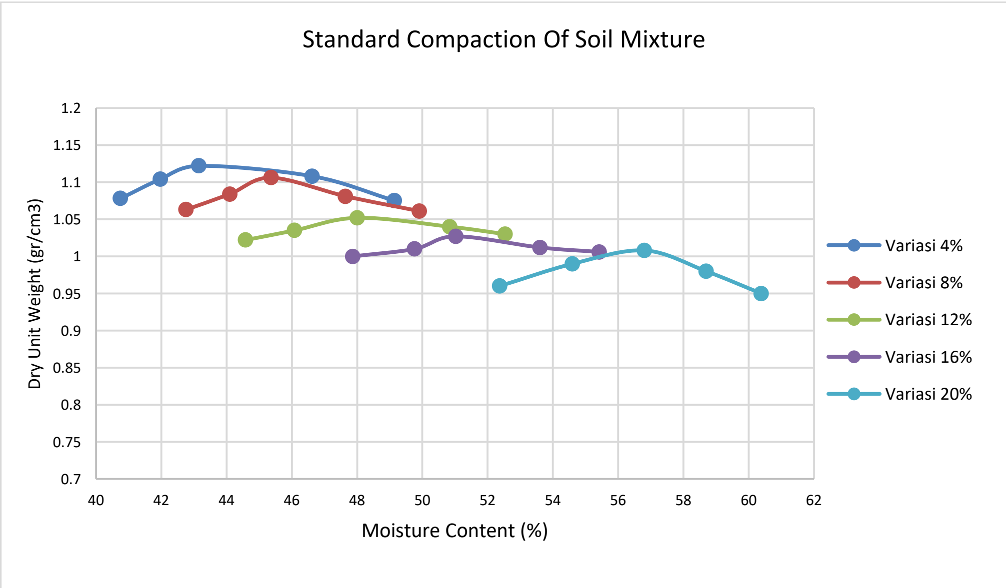
Picture 6 Original Soil Standard Compaction

From the table and the figure, it can be observed that the standard compaction test for the native soil yielded an optimum moisture content value of 42.58%. Meanwhile, the results of the standard tests for the mixtures with rice husk ash at 4%, 8%, 12%, 16%, and 20% are presented in the table below:

Table 4 Standard Compaction Test Results Of Mixed Soil Samples 1

No	Variation Of Rice Husk Ash Mixture	Dry Unit Weight	Optimum Moisture Content
1	4%	1,122	43,15%
2	8%	1,106	45,37%
3	12%	1,052	48,01%
4	16%	1,027	51,03%
5	20%	1,008	56,81%

The respective optimum moisture contents are 43.15%, 45.37%, 48.01%, 51.03%, and 56.81%. This testing indicates that as the percentage of rice husk ash mixture added increases, the dry unit weight of the soil decreases. These results also show that the ratio of optimum moisture content tends to increase. From this, it can be concluded that the higher the level of rice husk ash mixture addition, the higher the soil moisture content tends to be.



Picture 7 Standard Compaction Of Soil Mixture

The optimum moisture content values used in the addition of each type of rice husk ash were effective in this testing because they were used to determine the optimum amount of water to be mixed with the soil during the compaction test. After determining the initial and optimum moisture content for each sample, calculations were made to determine the moisture content to be used in the CBR test. The variations of rice husk ash mixture used were 0% (native soil), 4%, 8%, 12%, 16%, and 20% of the total dry soil weight for the CBR test. Subsequently, the mixed soil was placed back into plastic bags and allowed to stand for 7 days before testing can be senn in Picture 8. The test results can be seen in Table 5.

Picture 8 CBR Test

Tabel 5 CBR Test Result

Curing Time	Variation Of Rice Husk Ash Mixture					
	0%	4%	8%	12%	16%	20%
7 Days	0,98	1,18	2,00	4,80	13,00	18,80

Based on the table above, the CBR (California Bearing Ratio) testing for both native soil and the rice husk ash mixture soil indicates an increase in the CBR value.

4. CONCLUSION

Based on the results of the native soil's physical property testing, the soil at the research site is classified as organic soil, characterized by high cohesion and significant plasticity. According to the USCS classification, it falls within the fine-grained fraction or organic soil category, denoted by the PT symbol. The CBR values, obtained after 7 days of curing with lime mixtures ranging from 0% to 20%, demonstrate that an increased lime proportion in the mixture leads to higher CBR values. This can potentially enhance farmers' income through rice husk sales.

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