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Clay stabilization by using gypsum and paddy husk ash with reference to UCT and CBR value

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Abstract. Clays that have low shear strength need to be stabilized in order to meet the technical requirements to serve as a subgrade material. One of the usual soil stabilization methods is by adding chemicals such as Portland cement, lime, and bitumen. The clay stabilization research was done by adding gypsum and paddy husk ash. The research goals were to find out the value of engineering properties of clay due to the addition of 2% gypsum and 2% - 15% paddy husk ash. The soil was classified as Clay – Low Plasticity (CL) based on USCS and was classified as A-7-6 (10) based on AASHTO classification system. The UCT value of original soil was 1.41 kg/cm^2. While the CBR soaked and unsoaked values of original soil were 4.41% and 6.23% respectively. The research results showed the addition of paddy husk ash decreased the value of unconfined compressive strength as well as CBR. The stabilized soil by 2% gypsum and 0% paddy husk ash gave maximum UCT value of 1.67 kg/cm^2, while the maximum value of CBR were found 6.71% for CBR soaked and 8.00% for CBR unsoaked. The addition of paddy husk ash did not alter the soil classification according to AASHTO or USCS, even degrade the engineering properties of original soil.

1. Introduction

Soil stabilization is a mixture of soil with chemical materials, in order to upgrade the engineering properties of soil[1]. The usual soil stabilization is by adding chemical materials to the soil. The most common additives are Portland cement, lime, bitumen and tar [2, 3]. The clay stabilization research was done by adding powder gypsum and paddy husk ash. Gypsum is a soft white mineral consisting of hydrated calcium sulfate. The chemical formula is calcium sulfate dehydrate (CaSO4. 2(H2O)). Gypsum has better properties than organic additives because it does not cause air pollution, relatively cheap, fire resistant, and resistant to deterioration by biological factors and chemicals [4]. Paddy husk ash (PHA) used in this research was originated from Secanggang, Langkat, North Sumatera. Paddy husk ash is a by-product of agricultural products, which is considered only waste. However, burned paddy husk has pozzolan properties that have high silicate element, SiO_2 [5]. Percentage of SiO_2 is 86.90 % – 97.30 % and CaO 0.20 % – 1.50 %. This Pozzolan contains cementation properties when mixed with water [6].

2. Research Methods

The research was carried out using experimental method at Soil Mechanics Laboratory, Department of Civil Engineering, University of Sumatera Utara. The research samples were original clay and clay samples which had been mixed with 2% gypsum and paddy husk ash.

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2.1. Preparatory work

Preparations conducted in this research were as follows:

1. First stage was collecting and studying the literature related to this research.
2. Determining the location of clay soil sampling. The clay soil was taken from PTPN II, Patumbak, Deli Serdang.
3. Providing the additives materials (gypsum and paddy husk ash).

2.2. Manufacture of test specimens and testing implementation

The preparation of the specimens was divided into several sorts according to each test with gypsum content and paddy husk ash for all tests.

Testing performed:

1. Test of indigenous soil properties index, ie: water content, soil type, specific gravity, Atterberg limits, and grain size distribution.
2. Test of gypsum properties and raw paddy husk ash index, ie: water content, specific gravity test, Atterberg limits, and grain size distribution.
3. Proctor Standard test to obtain the optimum moisture content and the maximum dry density of indigenous clay.
4. Proctor Standard test for UCT test and soaked and unsoaked CBR laboratory test.
5. Curing time for stabilized clay was 7 days.

After all data were gathered, they were analyzed. All results would be presented in the form of tables, graphs, and explanation.

3. Results and Discussion

3.1 Original Soil Testing

Engineering properties of original soil was shown in Table 1.

Table 1. Soil Physical Properties Test Data

No.	TEST	RESULT
1	Water Content	12.55%
2	Specific Gravity	2.66
3	Liquid Limit	45.76%
4	Plastic Limit	17.72%
5	Plasticity Index	28.05%
6	Sieve Analysis	50.34%
7	Optimum Moisture Content	20.50%
8	Maximum Dry Density	1.31 gr/cm^3
9	CBR soaked	4.41 %
10	CBR unsoaked	6.23%

3.2. Stabilization Material Testing

Index properties of paddy husk ash and gypsum were presented in Table 2 below:

Table 2. Index properties of paddy husk ash and gypsum

No	TEST	Paddy Husk Ash	Gypsum
1	Specific Gravity	2.55	2.74
2	Liquid Limit		
3	Plastic Limit	Non Plastic	Non Plastic
4	Plasticity Index		
5	Sieve Analysis	8.56%	51.62%

3.3. Engineering properties of the stabilized soil

The engineering properties of stabilized soil with gypsum and paddy husk ash were presented in the following Figures.

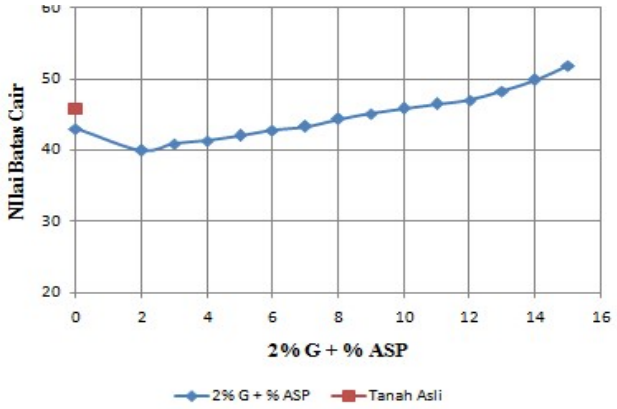

Figure 1. Correlation of Liquid Limit (LL) value with variation of 2% gypsum in the addition 0% - 15% paddy husk ash

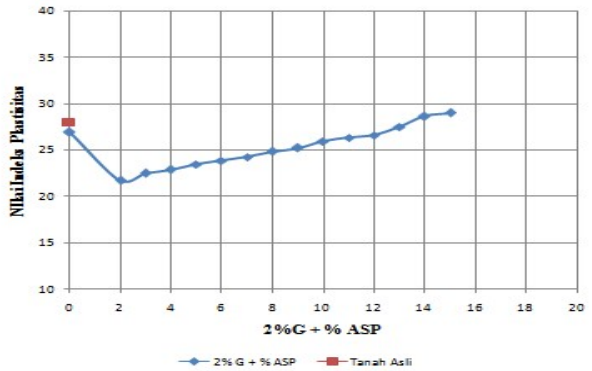

Figure 2. Correlation of Plasticity Index (PI) value with variation of 2% gypsum in the addition 0% - 15% paddy husk ash

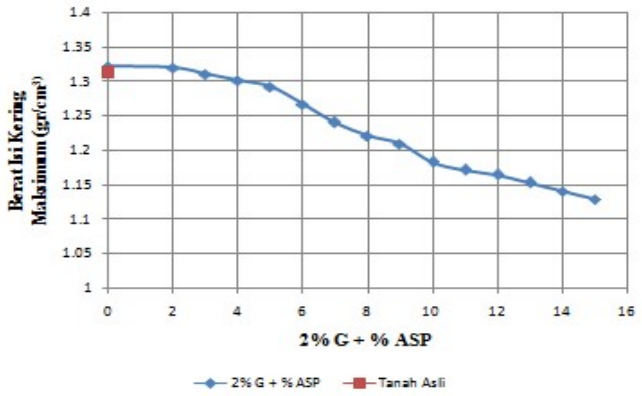

Figure 3. Correlation γd_{max} of soil with the variation of 2% gypsum in the addition 0% - 15% of paddy husk ash

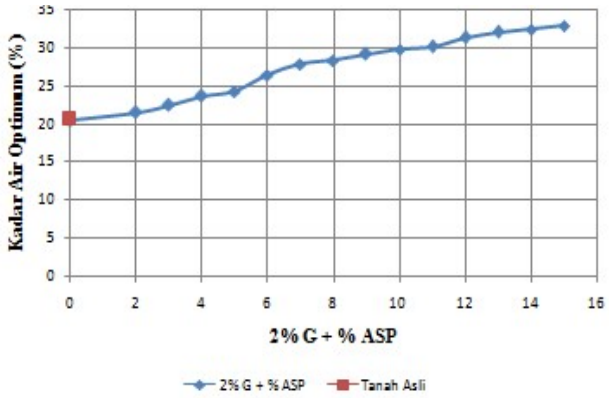

Figure 4. Correlation of w_{opt} with the variation of 2% gypsum in the addition 0% - 15% paddy husk ash

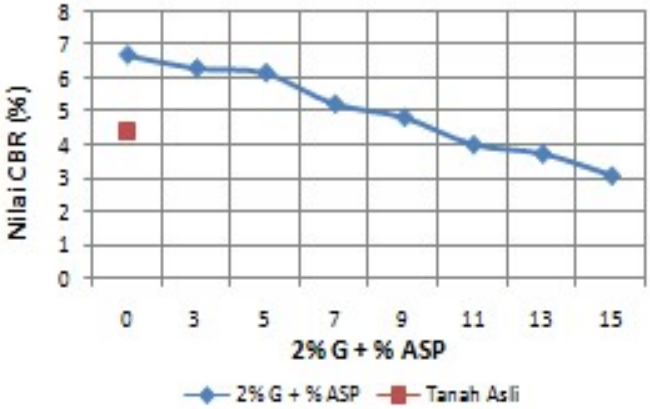

Figure 5. Correlation of soaked CBR value with the variation of 2% gypsum in the addition 0% - 15% paddy husk ash

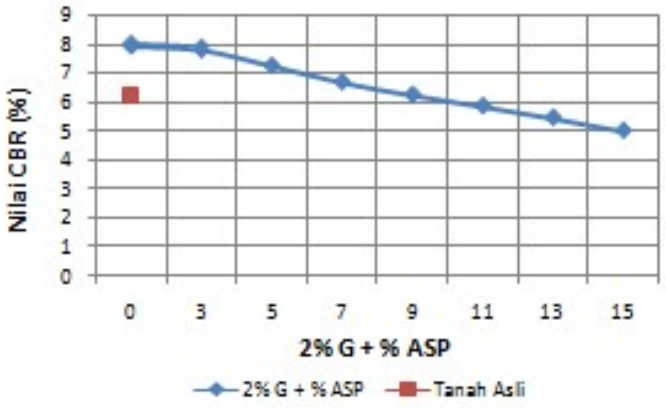

Figure 6. Correlation of unsoaked CBR value with the variation of 2% gypsum in the addition 0% - 15% paddy husk ash

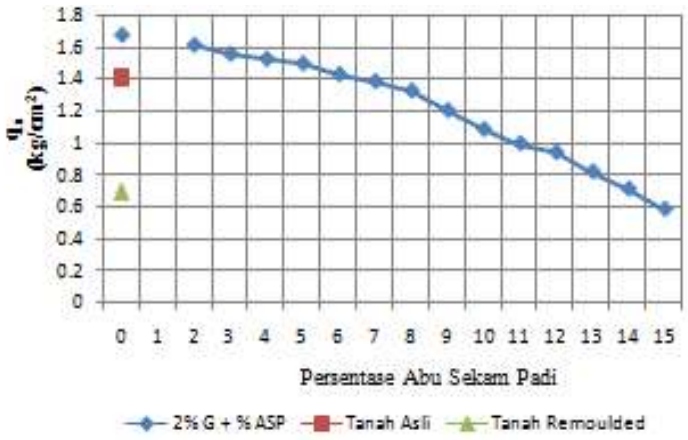

Figure 7. Correlation of UCT value with the variation of 2% gypsum in the addition 0% - 15% paddy husk ash

Figure 7 showed that the stabilized clay with variation of 2% G + 0% PHA produced highest UCT value of 1.67 gr/cm^2.

4. Conclusions

From the research results, it could be concluded that:

1. Based on USCS classification, the soil samples are included in CL (Clay - Low Plasticity).
2. Based on the AASHTO (American Association of State Highway Transportation Official) classification, the original soil samples was A-7-6 (10).
3. From the Proctor standard test, the optimum moisture content of original soil was 20.50% and the maximum dry density was 1.31 gr/cm^3. While the maximum dry density of all mixture was in the variation of 2% gypsum + 0% paddy husk ash which is 1.32 gr / cm^3 and its optimum water content is 20.32%.
4. The specific gravity of original soil was 2.66. The specific gravity of the gypsum was 2.74 and the specific gravity of paddy husk ash was 2.55.

5. The original soil had Liquid Limit (LL) of 45.76% and plasticity index of 28.05% and liquidity index (LI) of -0.18% (LI <0). The mixture of 2% G + 2% PHA had the lowest plasticity index of 22.46%. With a liquid limit value of 40.69%.
6. The CBR value of original soil was 4.41% for soaked CBR and 6.23% for unsoaked CBR respectively. The mixture of 2% G + 0% paddy husk ash produced highest value of CBR of 6.71% for soaked CBR and 8.00% for unsoaked CBR respectively.
7. The value of UCT original soil was 1.41 kg/cm^2. While the stabilized soil mixture with 2% G + 0% PHA had resulted the highest UCT value of 1.67 kg/cm^2.
8. Stabilized clay with 2% gypsum + 0% paddy husk ash, based on USCS classification was classified as CL (Clay - Plasticity) and based on AASHTO was classified as A-7-6 (9). While stabilized clay with 2% gypsum + 2% paddy husk ash was classified as A-7-6 (8). In addition, stabilized clay with 2% gypsum + 3% - 15% paddy husk ash were classified as A-7-6 (11).
9. The stabilized clay with a fixed percentage of gypsum and addition of paddy husk ash caused a decrease in shear strength of soil as shown in reduction of UCT and CBR value.

References

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