

Comparison Analysis of CBR Value Enhancement of Soil Type in Swamp Area by Addition of Fly Ash

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Abstract

Roads built on swamp areas should consider the condition of the base soil, since the characteristics of the soil in swamp areas have always inundated and have a low soil carrying capacity. One of the efforts that could be done to improve the existing soil condition was using fly ash as a material for soil stabilization. This study was conducted to analyze the enhancement of CBR value on various soil types in swamp areas by the addition of fly ash. Testing on the values of index properties, compaction, and CBR values was done in a laboratory based on ASTM and AASHTO standards. The test results show that the type of soil at the location of the sampling is silty or clay gravel and sand, clay soil, and silty soil. The reduction of optimum water content after the addition of fly ash is the highest decrease of 20.92%. While the highest increase of dry content weight after the addition of fly ash was 0.904 g/cm³. An enhancement in the value of CBR by the addition of 20% fly ash in the study area, however, the increase magnitude depends on the existing soil types, i.e. 7.99% in the silty or clay gravel and sand, 6 - 8% in the clay soil and 0.22 - 5% on silty soil. This indicates that the addition of fly ash was the optimum used on the type of clay soil.

Keywords

CBR Value, Swamp Area, Fly Ash

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1. INTRODUCTION

At this time development in the swamp area is more massive, since considering the land in the productive areas is increasingly limited and the government continues to develop swamp areas both in the agricultural sector, plantations and fisheries (Alihamsyah et al., 2000). To support the development of the swamp area, certainly needed road infrastructure. Roads built on swamp areas must consider the existing soil condition, since the characteristic of swampy areas has always inundated and have low carrying capacity soil (Subagyo, 2006). One of the efforts that can be done to improve the existing soil condition by using fly ash as a material for soil stabilization (Indera et al., 2016; Mina et al., 2016; Devi and Sudam, 2016; Apriyanti and Hambali, 2014).

Considering the fly ash has a material containing pozzolan materials such as Silica (SiO₂), iron oxide (Fe₂O₃), Aluminum Oxide, Calcium oxide (CaO), Magnesium oxide (MgO), and Sulfate (SO₄) (Zunino et al., 2017; Hausmann and Manfred, 1990), then would be form a pozzolanic reaction between the calcium contained in fly ash with alumina and silicate contained in soil, resulting in a hard and rigid mass. The addition of fly

ash also to improve the soil gradation (Budi et al., 2003).

Defilement of environment can be caused by the availability of fly ash in large quantities, so that required good management. One of the handling environments that could be applied was to utilize fly ash waste for the purpose of soil stabilization materials, especially soils in swamp areas. To get the increase percentage of CBR value on soil of swamp area with the addition of fly ash, it was necessary to do research on some soil type that exist in swamp area to get comparison of increasing of CBR value at various type of soil in swamp area.

2. EXPERIMENTAL SECTION

2.1 Classification method

The study type is quantitative study by laboratory test. The equipment used in this study includes complete computer equipment for data processing and analysis, GPS to determine the location of soil sampling, laboratory equipment for field testing and laboratory tests including: a set of handbor tools, an atterberg limit testing tool, an index properties testing tool, a hydrometer testing tool, a compaction testing tool and a testing tool of CBR value. The soil samples were taken from several locations in swamp area and fly ash from coal burning residue



Figure 1. Sampling Location

of PT. Tanjung Enim.

Sampling of soil was done at several locations on the swamp area in Banyuasin District that is one of the biggest swamp areas in South Sumatera Province. Testing was done to obtain comparison CBR value between the original soil and the soil by the addition of fly ash. The location of the soil sampling can be seen in Figure 1.

2.2 Analysis Methods

Parameters to be tested include index properties (testing of specific gravity, moisture content, gradation, hydrometer, atterberg limit), soil compaction testing (the original soil and the soil by 20% fly ash addition), and CBR value testing by soaking of the original soil and the soil by 20% fly ash addition base on AASHTO and ASTM testing guidelines. Stages of study can be seen in Figure 2.

3. RESULTS AND DISCUSSION

3.1 Testing of the Properties Index

This test was conducted to obtain the index properties of soil from 10 location sampling on swamp area, consisting of specific gravity test, water content test, atterberg limit test, and gradation test. The results of soil index properties tests can be seen in Table 1.

Table 1 shows the avarage of soil type in swamp area base on AASHTO classification was silty or clayey gravel and sand at location 2.

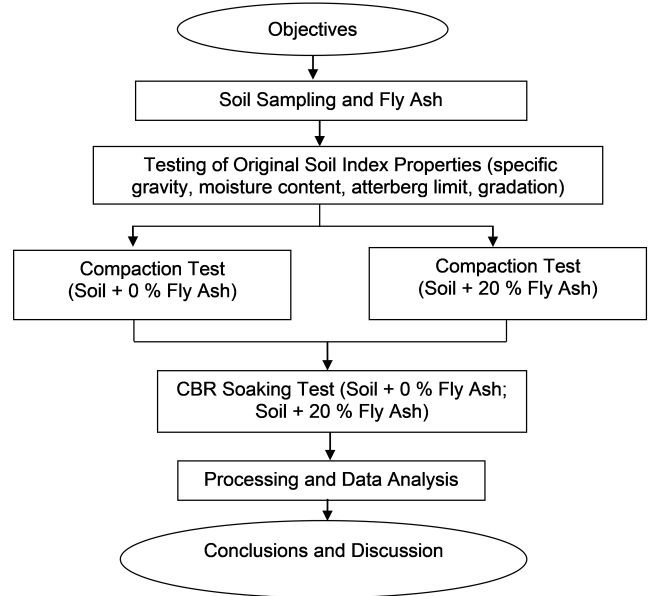


Figure 2. Flow Diagram of Research

3.2 Compaction Testing

The compaction test was conducted in 2 conditions, namely the original soil compaction and the soil compaction by the addition of fly ash 20%. The optimum water content percentage and the weight of the soil dry contents from the results of the compaction test can be seen on the Figure 3 and Figure 4.

The graph on Figure 3 shows there is a decrease in optimum water content after the addition of fly ash. The lowest optimum water content reduction was at location 6 namely to 0.26% and the highest at location 10 namely to 20.92%.

The graph on Figure 4 shows there is an increase of the dry weight contents of the soil after the addition of fly ash. The lowest increase is at location 1 i.e. to 0.006 g/cm³ and the highest at location 6 ie to 0.904 g/cm³.

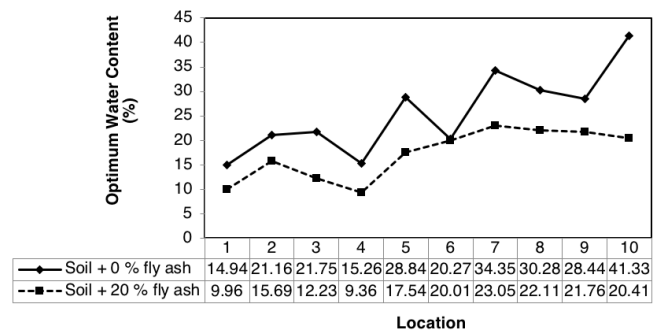


Figure 3. Comparison of optimum water content of the original soil and the soil by addition of fly ash

Table 1. Test results and analysis of Properties Index based on AASHTO classification

Location	Avarange Value						Soil Type
	Specific Gravity	Percent Passing 4.75 mm	Percent Passing 0.075 mm	Liquid Limit	Plasticity Index	Soil Classification	
1	2.66	100	63.45	17.97	1.82	A-4	Silty Soil
2	2.59	96.72	33.57	33.77	6.23	A2-4	Silty or clayey gravel and sand
3	2.68	99.71	57.69	27.86	5.94	A-4	Silty Soil
4	2.6	100	79.98	36.87	11.72	A-6	Clayey Soil
5	2.46	99.98	79.26	47.3	8.59	A-5	Silty Soil
6	2.46	100	54.62	54.62	19.97	A-7	Clayey Soil
7	2.42	100	62.13	62.13	9.15	A-5	Silty Soil
8	2.53	99.85	63.96	63.96	13.2	A-7	Clayey Soil
9	2.21	99.88	75.3	75.3	45.15	A-7	Clayey Soil
10	2.17	100	71.97	71.97	16.15	A-7	Clayey Soil

Table 2. Comparison of CBR value between the original soil and the soil by addition of fly ash

Location	Type of Soil	CBR + 0 % Fly Ash	CBR + 20 % Fly Ash	Increase of CBR Value (%)
1	Silty Soil	3.7	10.7	7
2	Silty or clayey gravel and sand	8.33	16.32	7.99
3	Silty Soil	3.94	10.08	6.14
4	Clayey Soil	2.13	4.54	2.41
5	Silty Soil	4.88	13.5	8.62
6	Clayey Soil	2.13	4.33	2.2
7	Silty Soil	6.45	13.41	6.96
8	Clayey Soil	6.64	10.42	3.78
9	Clayey Soil	4.88	5.1	0.22
10	Clayey Soil	4.62	9.5	4.88

3.3 Testing of CBR Value

Testing of CBR value was conducted under soaking conditions both for the original soil and the soil by 20% fly ash addition. The results of comparison of CBR value between the original soil and the soil by addition of fly ash can be seen on Table 2 and Figure 5.

From Table 2, it could be seen that on the swamp area in the study area has the highest CBR value at location 2 ie 8.33% at silty or clayey gravel and sand, whereas the lowest CBR value at location 4 and 6 with the type of clay soil ie 2.13%. And after additional fly ash 20% was obtained the highest CBR value at location 2 namely 16.32% and the lowest value at location 6 namely 4.33%.

Table 2 and Figure 5, show the CBR value will be increased by the addition of fly ash 20%, both on silty or clayey gravel and sand, silty soil, and clay soil. The highest increase in the type of silty soil was equal to 8.62% and the lowest increase in the type of clay soil was to 0.22%. The correlation between the original soil and the soil by the addition of fly ash can be seen

in Table 3.

Table 3 shows the correlation between the original soil and the soil by the addition of fly ash i.e. 0.72, this indicates a strong relationship between the soil by addition of fly ash and the original soil, whereupon the addition of fly ash would be caused the increase of CBR value of soil on the whole soil type at the swamp area on the study area.

The value of CBR test was obtained based on the AASHTO soil classification, namely: (i) silty or clayey gravel and sand > 7%; (ii) 3 - 7% of the silty soil; and (iii) the clay soil 0 - 7%. Previous studies have shown that the optimum ratio of fly ash addition for soil stabilization was 20%, so in this study the percentage used in the addition of fly ash was 20%. The test results show that there is an increase in CBR value by the addition of fly ash, however the amount of increase was not the same for each soil type. The increase of CBR value on soil type of silty or clayey gravel and sand is 7.99%, on the silty soil was 6 - 8%, while the increase on the clay soil is 0.22 - 5%. This indicates that the addition of fly ash is the optimum used in the

Table 3. Correlation of the original soil and the soil by the addition of fly ash

			CBR + 0 % Fly Ash	CBR+ 20 % Fly Ash
Spearman's rho	CBR + 0 % Fly Ash	R	1	0.720(*)
		Sig. (2-tailed)	.	0.019
		N	10	10
	CBR+ 20 % Fly Ash	R	0.720(*)	1
		Sig. (2-tailed)	0.019	.
		N	10	10

*Correlation is significant at the 0.05 level (2-tailed).

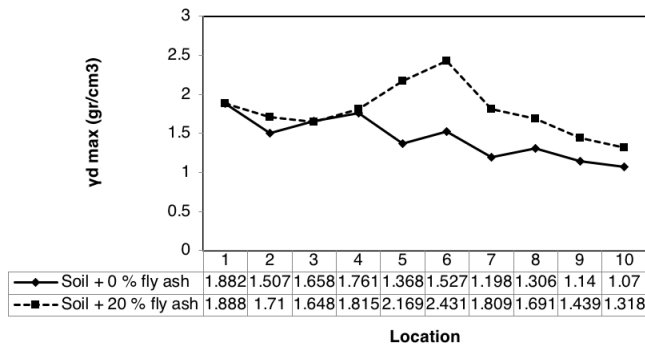


Figure 4. Comparison of dry weight content of the original soil and the soil by addition of fly ash

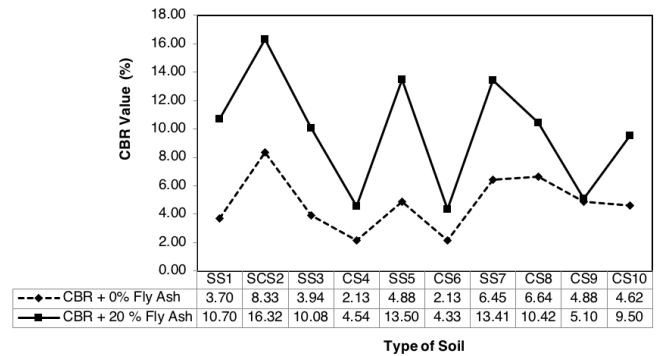


Figure 5. Comparison of CBR value between the original soil and the soil by addition of fly ash

type of silty soil. And there are a strong correlation between the original soil CBR value and soil by the addition of fly ash.

4. CONCLUSIONS

Type of soil base on AASHTO classification at the sampling location in Banyuasin Regency is silty or clayey gravel and sand at location 2; silty soil at locations 1, 3, 5, and 7; as well as clay soil at locations 4, 6, 8, 9, and 10. There is a decrease of optimum soil water content after addition of fly ash that the highest decrease of 20,92% and the dry content weight increased after the addition of fly ash that the highest increase of 0.904 gr / cm³. An increase in the CBR value by the addition of 20% fly ash in the entire swamp area in the study area, however the magnitude of the increase depends on the existing soil type, 7.99% on the silty or clayey gravel and sand, 6 - 8% on the silty soil, and 0.22 - 5% on clay soil.

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