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Comparative analysis of increasing CBR value of soil with adding bamboo leaf ash

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ABSTRACT

Consider the importance of the subgrade strength in road building since its strength impacts the soil's performance in absorbing the load on it. One of the efforts to improve the subgrade, which has a low bearing capacity, is by stabilizing the soil using bamboo leaf ash. This study aims to analyze the increase in CBR value with the addition of bamboo leaf ash. The analysis results showed that bamboo leaf ash from the furnace combustion process with a temperature range of 800^{O}-1000^{O}C produced a higher CBR strength value than bamboo leaf ash from ordinary combustion without a furnace. The result is the higher silica content in the bamboo leaf ash from the furnace combustion process. This silica has pozzolanic and self-cementing properties, namely the ability to harden and increase strength when reacted with water. The addition of bamboo leaf ash with ordinary burning resulted in the optimum CBR value at seven days of curing of 13.1 % at 10 % bamboo leaf ash variation. At the same time, bamboo leaf ash with Furnace combustion resulted in optimum CBR values of 34.99 % and 38.21 % at 6% variation of bamboo leaf ash.

ABSTRAK

Dalam konstruksi jalan mempertimbangkan nilai kekuatan tanah dasar, karena nilai kekuatan tanah dasar mempengaruhi performa tanah dalam menerima beban di atasnya. Salah satu upaya yang dapat dilakukan untuk memperbaiki tanah dasar yang memiliki daya dukung rendah yaitu dengan cara stabilisasi tanah menggunakan abu daun bambu. Penelitian ini bertujuan untuk melakukan analisa peningkatan nilai CBR dengan penambahan abu daun bambu. Hasil analisa menunjukkan bahwa abu daun bambu dari proses pembakaran furnace dengan range suhu 800^{O}-1000^{O} C menghasilkan nilai kekuatan CBR lebih besar dibandingkan dengan abu daun bambu dari pembakaran biasa tanpa furnace. Hal ini disebabkan karena adanya kandungan silika yang lebih tinggi yang ada pada abu daun bambu dari proses pembakaran furnace. Silika ini memiliki sifat pozzolanic dan self cementing yaitu kemampuan untuk mengeras dan meningkatkan kekuatan jika bereaksi dengan air. Penambahan abu daun bambu dengan pembakaran biasa menghasilkan nilai CBR optimum pada pemeraman 7 hari sebesar 13,1 % pada variasi abu daun bambu 10 %. sedangkan abu daun bambu dengan pembakaran Furnace menghasilkan nilai CBR optimum sebesar 34,99 % dan 38,21 % pada variasi abu daun bambu 6 %.

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1. Introduction

Road infrastructure development is growing rapidly with the times, so that in its construction, it is necessary to consider the condition of the subgrade. One of the efforts that can be done to improve the condition of the subgrade, which has a low bearing capacity, is stabilization with ash materials such as fly ash, husk ash, and bamboo leaf ash [1-11]. Ash material contains silica, iron oxide, aluminum oxide, calcium oxide, magnesium oxide, and sulfate [12-13].

Bamboo leaf ash from furnaces produces high silica content and can be used as a soil stabilizer [14]. Bamboo leaf ash has a 75.90-82.86% [14]. The increase in unsoaked CBR value with bamboo leaf ash is significant [14-15]. The purpose of this study was to assess the influence of bamboo leaf ash, which may be employed as a soil stabilizer in both natural and forced combustion processes.

2. Research Methodology

2.1. Classification Method

The research conducted is research with laboratory tests and field tests. The test carried out is a test of the physical and mechanical properties of the soil. Field testing was carried out, namely the dynamic cone penetrometer (DCP) test, to determine the bearing capacity of the soil at the research site. Laboratory testing consists of testing soil properties, compaction, and CBR. The soil sample was taken from Munjul Highway, Kampung Ciherang, Pasir Tenjo Village, Pandeglang Regency. The soil sample is disturbed soil. The mixed material was in bamboo leaf ash obtained from the apus bamboo (Gingantocchloa apus) type of bamboo tree.

2.2. Analysis Method

Parameters to be tested include the index of soil properties (test specific gravity, moisture content, grain sieve analysis, atterberg limit), compaction test, and unsoaked CBR test. The variations of bamboo leaf ash used were 0%, 5%, 10%, and 15%. Klasifikasi tanah menggunakan metode USCS. The soil sample used to test the physical properties of the soil is the original soil sample without a mixture of bamboo leaf ash. Atterberg test and unsoaked CBR used native soil samples and mixed bamboo leaf ash + each variation to determine the PI and CBR values before and after stabilization.

2.3. Comparative Analysis Method

This study conducted a comparative analysis of the CBR value with the addition of bamboo leaf ash variations of 0%, 5%, 10%, and 15% with a study belonging to [15], which carried out soil stabilization research using bamboo leaf ash variations of 0%, 2 %, 4%, 6%, 8%, and 10%.

3. Result and Discussion

The results of the original soil physical test are shown in Table 1: Based on Table 1, it shows that the original soil has a plasticity index with a high category of 20.11%. The following are the results of this study and previous studies to compare the increase in CBR values that occurred with the addition of bamboo leaf ash.

Table 1. The results of the original soil physical test.

No	Test	Unit	Result
1	Natural moisture content	(%)	11.59
2	Liquid Limit (LL)	(%)	51.00
3	Plastic Limit (PL)	(%)	30.89
4	Plasticity Index (PI)	(%)	20.11
5	Specific gravity (Gs)	-	2.64

Table 2. Comparison of the results of testing the physical properties of the original soil.

Sample	Natural moisture content (%)	Specific gravity	Liquid limit (%)	Plastic limit (%)	Plastic index (PI)	Soil classification	Soil Type
[5]	11.59	2.64	51.00	30.89	20.11	USCS (OH)	Clay
Sample A [9]	22.22	1.80	62.10	32.89	29.21	AASHTO (A-2-7(1))	Silty
Sample B [9]	12.01	1.89	49.80	28.80	21.00	AASHTO (A-2-4(1))	Silty

Based on Table 2, the results of the physical properties of the original soil. The research sample of [5], also samples A and B, from research by [9], had a plasticity index > 17%, including the PI in the high category, So that the original soil needs to be stabilized because it has a low bearing capacity value and a fairly high PI. Research [5] and [9] used bamboo leaf ash as a subgrade stabilizer. The unsoaked CBR test is shown in Table 3. The table shows the CBR value of the original soil and CBR for each variation. In [5], the CBR value at the optimum percentage was 13.1%, while in the Olugbenga and Adetuberu study, the CBR value at the optimum percentage was 38.21% (sample). A) and 34.99% (sample B) show an increase in the CBR value after stabilization.

Figure 1 shows an increase in the CBR value from the original soil CBR value, meaning that the addition of bamboo leaf ash increases the unsoaked CBR value for clay and silt soil types. Bamboo leaf ash used in this research results from ordinary combustion without a furnace, while the bamboo leaf ash used in samples A and B (research by Olugbenga and Adetuberu, 2010) is bamboo leaf ash from furnace combustion with temperatures between 800^{o}C-1000^{o}C. So it can be concluded from both the ordinary combustion process and the furnace that it affects the increase in the CBR value, even though the furnace combustion produces a more significant increase in CBR value and is greater than the addition of bamboo leaf ash from ordinary combustion because

the combustion furnace produces a fairly large silica content. Silica has pozzolanic and self-cementing properties [14]. The more silica content, the more it will increase strength and harden when reacted with water.

Table 3. Comparison of unsoaked CBR test results.

Sample	Bamboo leaf ash percentage (%)	CBR unsoaked (%)	Plasticity Index (%)
[5]	0	4.1	20.11
	5	12	19.06
	10	13.1	16.94
	15	10.5	15.96
Sample A [9]	0	5.44	29.21
	2	12.84	27.32
	4	17.62	29.19
	6	38.21	39.30
	8	23.22	21.52
Sample B [9]	0	11.42	21.00
	2	13.10	14.24
	4	18.22	8.16
	6	34.99	17.77
	8	21.37	21.57

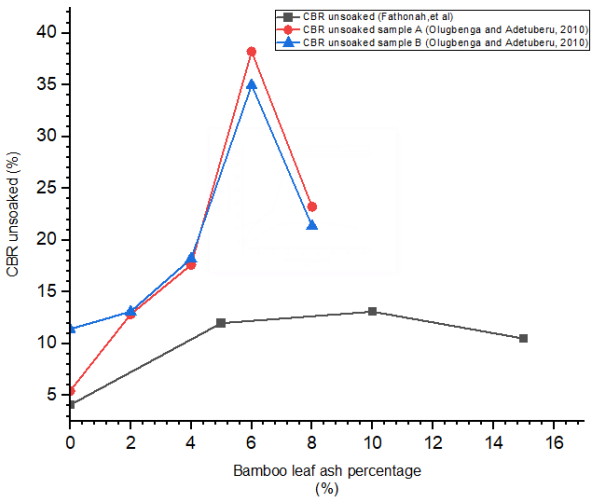

Figure 1. Relationship of bamboo leaf ash percentage (%) and CBR unsoaked (%).

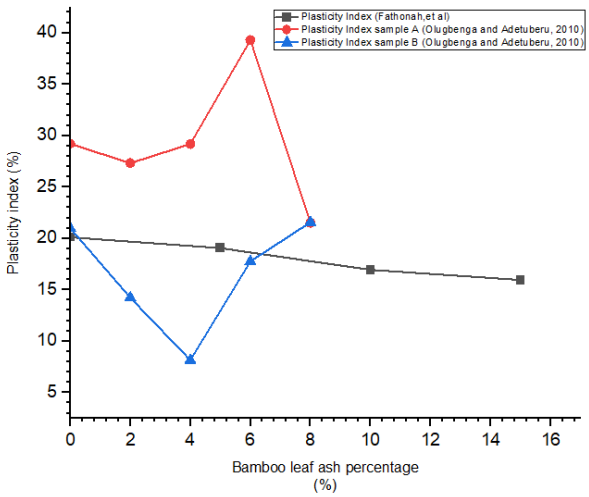

Figure 2. Relationship of bamboo leaf ash percentage (%) and plasticity index (%).

Figure 2 shows that the value of the soil plasticity index reduced, although not dramatically, with the addition of bamboo leaf ash. Research [5] calculated a PI value of 16.94% for the optimal CBR values, including the moderate plasticity group. In comparison, at the optimal proportion of CBR values corresponding to the category of high plasticity, samples A and B from [9] generated a PI value of 39.30 percent and 17.77 percent, respectively. The sample's PI value A increased when 6% bamboo leaf ash was added and decreased when 8% bamboo leaf ash was added. In sample B, the PI value climbed

by 6% and 8% as the proportion of bamboo leaf ash increased. It indicates that bamboo leaf ash stabilization must be paired with other additional elements that can compensate for its weaknesses. It cannot greatly lower the plasticity index value.

4. Conclusion

According to the findings of the study, the subgrade stabilization material in the form of bamboo leaf ash from the ordinary burning process could not be applied to Jalan Raya Munjul, Kampung Ciherang, Pasir Tenjo Village, Pandeglang Regency because the soil plasticity index value did not meet the minimum criteria for the PI value for subgrade. The inclusion of bamboo leaf ash may raise the unsoaked CBR value of both furnace and regular combustion processes, but bamboo leaf ash from the furnace combustion process provides a greater CBR strength value than bamboo leaf ash from ordinary combustion without furnaces. Because of the high silica concentration, this is the case. Adding bamboo leaf ash to regular burning resulted in a CBR value of 10.1 percent without curing at a 10% bamboo leaf ash variation. In comparison, bamboo leaf ash with Furnace combustion resulted in optimal CBR values of 34.99% and 38.21% at a 6 percent variation in bamboo leaf ash. The impact of bamboo leaf ash on reducing plasticity index was not statistically significant.

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