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Ir. Aniek Prihatiningsih, M.M.

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Effectiveness of Additional Organic Waste on Expansive Soil Using Handheld Penetrometer and Free Sweel Test

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Effectiveness of adding organic waste on expansive soil using handheld penetrometer and free swell test

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Abstract. Soil is the most important component in construction field, because soil supports construction buildings. The problem is, almost 65% soil in Indonesia is expansive soil that has large swelling and shrinking potential. This problem made worse by the tropical climate. Expansive soils easily shrink in dry season and swell in rainy season. Not only those problems, waste is also major problem in Indonesia. In order to prevent these two problems, a research was conducted by using organic waste as expansive soil stabilization material. Organic wastes that use in this research includes sugarcane bagasse, used tea leaves, rice husk ash, eggshell, and palm fiber. These five organic wastes will be combined with South Jakarta, Cikupa, Bekasi 1, Cikarang, and Bekasi 2 soil sample. All of these samples will be tested with penetrometer and free swell test. Based on the results, organic waste that most affected the increase of q_u up to 69.56% and decrease of FSI up to 80.00% of South Jakarta, Bekasi 1, and Bekasi 2 samples is rice husk ash. Whereas organic waste that most affected the increase of q_u up to 98.67% and decrease of FSI up to 53.41% of Cikupa and Cikarang samples is Sugarcane bagasse.

1. Introduction

Soil is generally defined as a material consisting of aggregates (granules) of solid minerals that are not cemented (chemically bound) to each other and of decayed organic matter (which has a solid particle) accompanied by liquid and gas filling empty spaces between these solid particles [1]. Some types of clay which have the potential for large shrinkage are soils that can experience significant volume changes along with changes in water content. This type of soil is clay which contains many minerals with high development potential. Land with this condition is often referred to as expansive clay. Expansive clay soil is soil that has large shrinkage characteristics due to capillary events or changes in water content. Expansive soils contain minerals such as smectite, bentonite, montmorillonite, beidellite, vermiculite, oroulgite, nontronite, illite, chlorite, and some sulfate salts, resulting in development. Shrinkage is a problem that often occurs in the type of expansive clay. The phenomenon of high shrinkage in expansive soils can cause damage to light buildings and highways [2].

A simple understanding of waste is anything that is no longer used and discarded. Waste can come from daily activities or come from industry, commercial places, markets, parks, gardens, and so on [3]. According to the Office of the Environment [4], organic waste can be classified into two, namely wet organic waste and dry organic waste. Wet organic waste, which is organic waste that contains a lot of water. Examples are food scraps, tea or coffee pulp, animal carcasses, animal or human waste, and so on. Wet organic waste usually creates an unpleasant odor because it has a high water content, causing this type of waste to rot quickly. Dry organic waste, which is organic waste that contains little water. Examples are wood, tree branches, and dry leaves. Usually this type of waste is difficult to be reprocessed so that it is often burned to destroy it.

2. Method and materials

2.1. Sample preparation

The tested soil samples are expansive soil samples taken from five different locations, namely South Jakarta with a depth of 29-30 meters, Cikupa with a depth of 4-5 meters, Bekasi 1 with a depth of 8-9 meters, Cikarang with a depth of 4-5 meters, and Bekasi 2 with a depth of 2-3 meters.

2.2. Method

Due to force majeure, unconfined compression test based on ASTM D2166 [5] cannot be carried out at the Tarumanagara University Soil Mechanics Laboratory so that a penetrometer test is used at home using a handheld penetrometer. The first step is to weigh a 100 gram soil sample, then add 1/4 of the part to the mold and compact it. Height falls ± 10 cm and the number of collisions as much as 20 times. Continue until all soil samples are printed in the mold. After that puncture the ground using a handheld penetrometer to the specified limit. Read the results shown by the handheld penetrometer (unit in kg / cm^2).

Due to force majeure, free swell tests based on IS: 2720 [6] cannot be carried out at the Tarumanagara University Soil Mechanics Laboratory so free swell tests are used with other methods. Penetrometer test soil samples were re-compacted, then measure the diameter and initial height of the soil (for more accurate data, a minimum measurement of height is three times). After that, spray water on the surface of the soil (most of the sprays in this study were 100 times) as if the ground was exposed to rain. Leave the soil for a few minutes until all the water is absorbed into the ground. Then measure the diameter and height of the soil after being sprayed with water.

3. Results and discussion

3.1. Result of penetrometer test

After conducting research on five different soil locations, namely South Jakarta, Cikupa, Bekasi 1, Cikarang, and Bekasi 2, the results of the free compressive strength (q_u) value of the land have not been mixed with organic waste and soil that has been mixed with five kinds of organic waste. . Then from the q_u results can be analyzed which organic waste most influences the increase in q_u and the consistency of the soil. Table 1 shows the results of soil consistency analysis.

Table 1. Result of penetrometer test

Sample		T	T + 10% ABT	T + 10% ADT	T + 10% ASP	T + 10% CT	T + 10% SIA
Jakarta Selatan	q_u (kN/m^2)	56.39	90.71	68.65	95.61	85.81	88.26
	Consistency	Average	Average	Average	Average	Average	Average
	Increase (%)	0	60.87	21.74	69.57	52.17	56.52
Cikupa	q_u (kN/m^2)	183.87	365.30	208.39	269.68	196.13	245.17
	Consistency	Hard	Very Hard	Very Hard	Very Hard	Hard	Very Hard
	Increase (%)	0	98.67	13.33	46.67	6.67	33.33
Bekasi 1	q_u (kN/m^2)	139.74	178.97	144.65	208.39	154.45	159.36
	Consistency	Hard	Hard	Hard	Very Hard	Hard	Hard
	Increase (%)	0	28.07	3.51	49.12	10.53	14.04

Table 2. Result of penetrometer test

Sample		T	T + 10% ABT	T + 10% ADT	T + 10% ASP	T + 10% CT	T + 10% SIA
Cikarang	q_u (kN/m^2)	171.62	323.62	181.42	252.52	176.52	191.23
	Consistency	Hard	Very Hard	Hard	Very Hard	Hard	Hard
	Increase (%)	0	88.57	5.71	47.14	2.86	11.43
Bekasi 2	q_u (kN/m^2)	142.20	193.68	176.52	220.65	178.97	183.87
	Consistency	Hard	Hard	Hard	Very Hard	Hard	Hard
	Increase (%)	0	36.21	24.14	55.17	25.86	29.31

With T = soil with no organic waste, ABT = sugarcane bagasse, ADT = used tea leaves, ASP = rice husk ash, CT = eggshell, and SIA = palm fiber.

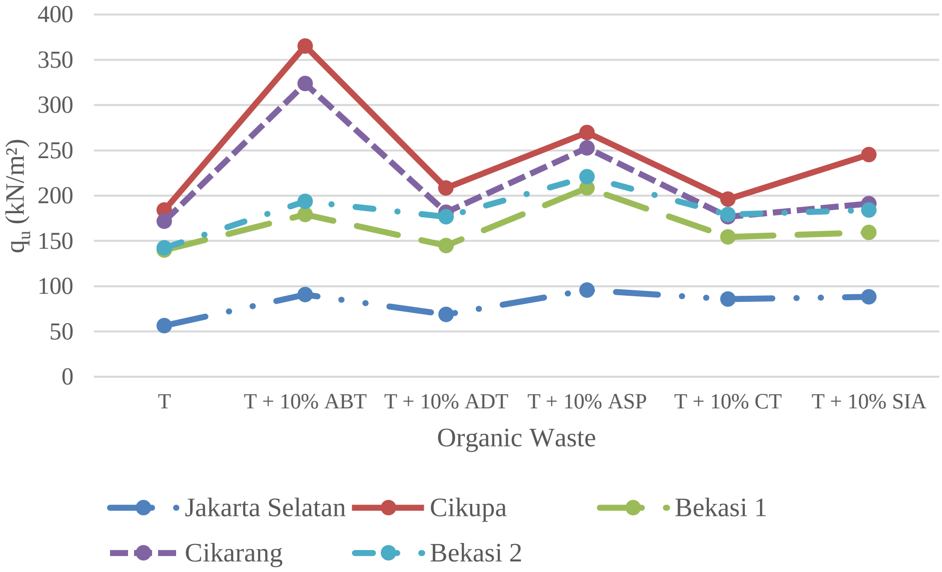

Figure 1. Result of penetrometer test

3.2. Result of free swell test

After conducting research on five different soil locations, namely South Jakarta, Cikupa, Bekasi 1, Cikarang, and Bekasi 2, the results of the FSI value of the land have not been mixed with organic waste and the soil has been mixed with five kinds of organic waste. Then from the results of the FSI can be analyzed which organic waste most influences the reduction in FSI and swell potential of the soil. Table 3 shows the results of soil consistency analysis.

Table 3. Result of penetrometer test

Sample		T	T + 10% ABT	T + 10% ADT	T + 10% ASP	T + 10% CT	T + 10% SIA
Jakarta Selatan	FSI (%)	8.33	2.51	7.84	1.67	7.03	3.38
	Swell Potential	Low	Low	Low	Low	Low	Low
	Decrease (%)	0	69.86	5.96	80.00	15.60	59.46

Table 4. Result of penetrometer test

Sample		T	T + 10% ABT	T + 10% ADT	T + 10% ASP	T + 10% CT	T + 10% SIA
Cikupa	FSI (%)	28.52	15.00	22.13	21.00	26.24	15.26
	Swell Potential	Low	Low	Low	Low	Low	Low
	Decrease (%)	0	47.40	22.41	26.36	7.99	46.50
Bekasi 1	FSI (%)	19.30	16.00	17.78	12.92	16.23	14.38
	Swell Potential	Low	Low	Low	Low	Low	Low
	Decrease (%)	0	17.09	7.88	33.07	15.91	25.49
Cikarang	FSI (%)	47.70	22.22	30.95	27.14	31.11	25.36
	Swell Potential	Low	Low	Low	Low	Low	Low
	Decrease (%)	0	53.41	35.11	43.10	34.78	46.83
Bekasi 2	FSI (%)	19.63	15.28	16.34	12.67	14.13	15.59
	Swell Potential	Low	Low	Low	Low	Low	Low
	Decrease (%)	0	22.17	16.77	35.47	28.01	20.57

With T = soil with no organic waste, ABT = sugarcane bagasse, ADT = used tea leaves, ASP = rice husk ash, CT = eggshell, and SIA = palm fiber.

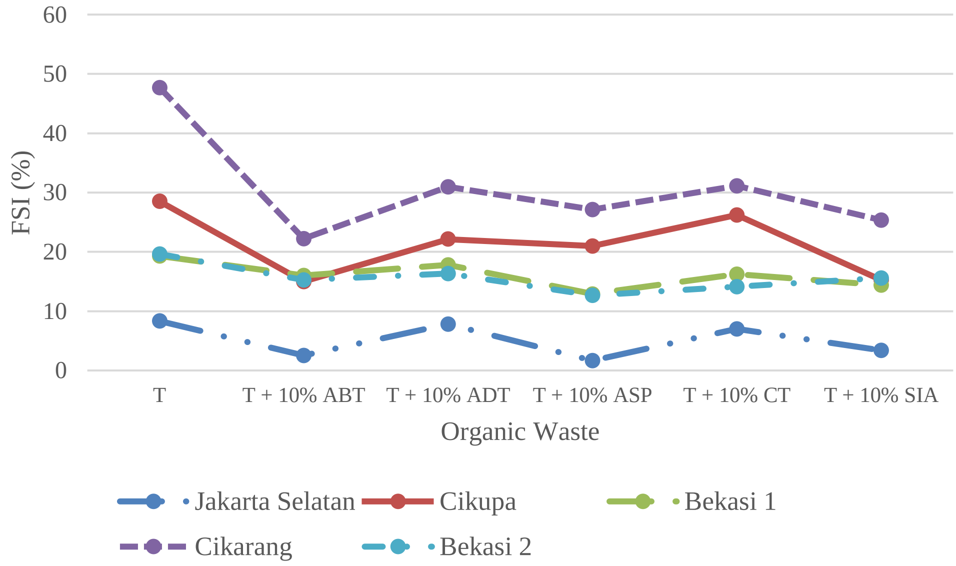

Figure 2. Result of penetrometer test

4. Conclusion

Organic waste that most influences soil samples in South Jakarta, Bekasi 1 and Bekasi 2 is ash husk ash powder. In South Jakarta soil samples, I experienced an increase of up to 69.56% and FSI decreased up to 80.00%. In the Bekasi 1 q_u soil sample, it increased to 49.12% and FSI decreased to 33.07%. In Bekasi 2 q_u soil samples increased up to 55.17% and FSI decreased up to 35.47%. The organic waste that most affected the Cikupa and Cikarang soil samples was sugarcane bagasse powder. In the Cikupa q_u soil sample, it increased to 98.67% and FSI decreased to 49.91%. In the Cikarang q_u soil sample increased to 88.57% and FSI decreased to 53.41%. Addition of organic waste to expansive soils in South Jakarta, Cikupa, Bekasi 1, Cikarang, and Bekasi 2 gives varying results, but overall q_u value increases and FSI value decreases so that all organic waste used in research can improve expansive soils.

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