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Peat Soil Stabilization by Adding Solution of Endogenous Aerobic Decomposer Bacteria Consortium

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Abstract: *Peat soil is soil with an organic content more than 75%. This soil formed by accumulation of decomposed plant with slow decomposition velocity. One of the reasons causing decomposition is decomposer microorganism activities which live inside peat soil. The changes of peat fiber size during decomposition process causes peat soil compressed continuously and the shear strength decreasing. Therefore, it would be better if the decomposition process ended before construction begin. So, the compressibility and the shear strength decreasing would not occur when construction have been used. Therefore, this research tries to accelerate decomposition process by adding solution of endogenous aerobic decomposer bacteria consortium with bacteria solution variation 0%, 10%, 20% and 30% from wet unit weight. Each variation sample is cured during 0, 14, 28, 42 and 56 days then subjected to viability, pH, decomposition velocity, and decreasing fiber content test. As the result, the addition of endogenous aerobic decomposer bacteria consortium causes the peat soils decomposition velocity to increase. The maximum decomposition velocity is shown on 14 days curing period. Besides that, adding 10% bacteria solution gives the most effective result of acceleration peat soil decomposition process.*

Keywords: *peat soils, decomposition, endogenous aerobic decomposer bacteria, decomposition velocity, fiber content.*

1. Introduction

Peat soil is soil with an organic content more than 75%. This soil formed by accumulation of decomposed plant with slow decomposition velocity. Decomposition velocity is slow because peat soils tend to be on wet land which contains little oxygen (anaerobic). Hoobs (1986) inside Pichan, S and B.C O'Kelly (2012) states that decomposition process will become anaerobic and bacteria activities is slowly in the environment with poor oxygen. As the increasing of soil depth, the oxygen contains and microorganism activities will be decrease at the peat wetland. Therefore, the fiber content will be increase as the depth of soil.

Naturally, decomposition inside peat soil occurs as long as the decomposer microorganisms get food for its metabolism. Balittanah (2006) states that aerobic decomposition process produce CO_2, H_2O, heat, nutrient, and some humus. Besides that, decomposition changes fiber size and causes peat soil compressed continuously and shear strength decreasing. Decomposition effect will be so clear when ground water table on the peat wetland decreasing, that is subsidence. Because of the effect of decomposition is not satisfied for construction, its process should be accelerate and completed before construction started. Therefore, compression process and shear strength decreasing would not be happened anymore when construction have operated.

2. Specimen and Methodology

Peat soil which used on this studied were obtained from Bereng Bengkel village, Palangkaraya, Center Kalimantan. Specimen were taken with disturbed conditions which water content were kept as like as its field conditions. The depth of collected specimen were 0.5 until 1 meters from ground surface.

Bacteria which used on this research are endogenous aerobic decomposer bacteria consortium. This consortium contain some aerobic decomposer bacteria which taken from peat soil studied. Identification process did in Biology Laboratory at Institute Technology of Sepuluh Nopember. Breeding were held until bacteria density reach around 3.2 x 10^8 cell/ml. Bacteria density is calculated using Spektrofotometer equipment with 600nm wave length.

As the specimen preparation at laboratory, disturbed peat soil were put on box with had some aerasion hole on its cover. Then, bacteria consortium solution were poured with adding variations 0%, 10%, 20%, and 30% from peat wet unit weight. Specimen testing which conducted are bacteria viability using Total Plate Count (TPC) method; soil pH using soil pH meter with brand Takemura; unrubbed fiber content refer to Peat Testing Manual (1979); and decomposition velocity.

3. Physical Properties of Peat Soil

Physic behavior parameter which studied showed on TABLE 1. Refer to ASTM D 4427-92, peat soil studied clasified as sapric from its fiber content. From pH and water absorbent capacity, peat studied clasified as highly acidic and moderately absorbent.

TABLE I: Initial Physical Properties

Physical properties	Value
Wet unit weight	1.036 gr/cm^3
Specific gravity (G_s)	1.457
Water content (w_c)	614%
Fiber content (f_c)	32%
pH	3.2

4. Result and Discussion

4.1. Bacteria Viability

Bacteria viability test is aimed to know aerobic decomposer bacteria ability to alive inside specimen. Viability value expressed with Colony Unit From (CFU)/ml. Viability test results are on TABLE 2 and Fig. 1 and showed that there are aerobic decomposer bacteria which could alive inside specimen. But its value could not give the appropriate information about the amount of bacteria which live on the specimen. Viability test conducted on curing period 14 and 28 days have showed that aerobic decomposer bacteria could adapted and life inside specimen. So, viability test have not to be conduct on another curing period anymore.

TABLE II: Viability Test Results

% Addition Bacteria	Bacteria Viability on curing period (CFU/gram)	
	14	28
0%	5.00E+02	3.13E+03
10%	2.70E+03	5.55E+02
20%	1.00E+03	1.85E+03
30%	8.00E+02	5.25E+02

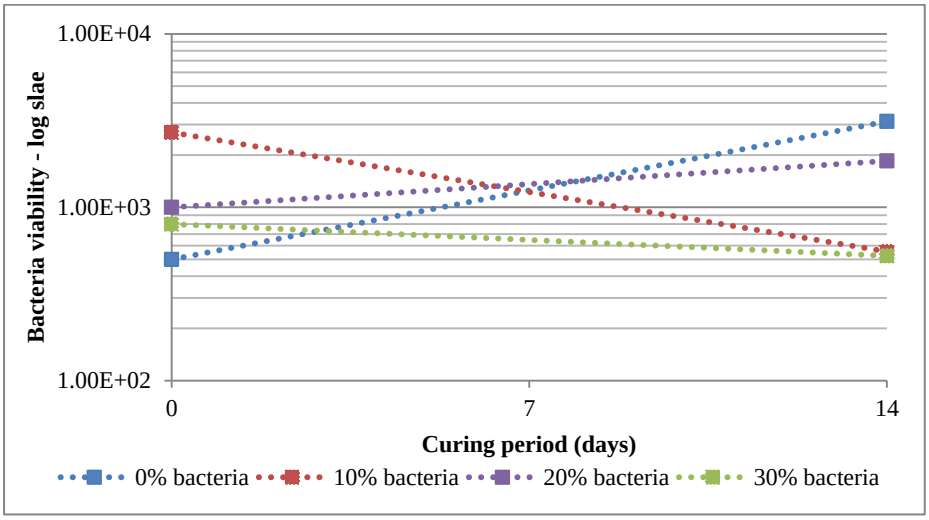

Fig. 1: Influence of addition bacteria and curing period to bacteria viability

4.2. Soil pH

The changes of soil pH value is one of decomposition process indicator. Soil pH during curing period which showed on TABLE 3 and plotted on Fig. 2 inform that specimen without adding bacteria have pH that changed tend to be neutral as the increasing curing period. In the other hand, specimen with adding bacteria shows fluctuation soil pH value. In the 14 days curing period, soil pH become more acid than its initial. It is happened because adding bacteria makes bacteria activities increasing and it activity produce a lot of CO_2 gas. This CO_2 gas dissolves into the water and become carbonate acid and make the soil pH increasing.

TABLE III: Specimen pH Reading Results

% Addition Bacteria	pH during curing period (days)				
	0	14	28	49	56
0%	3.20	3.00	4.00	5.0	5.60
10%	4.9	3.8	5.7	5.7	5.4
20%	5	4	4.5	5.6	5.4
30%	4.8	3.4	4.5	5.8	5.6

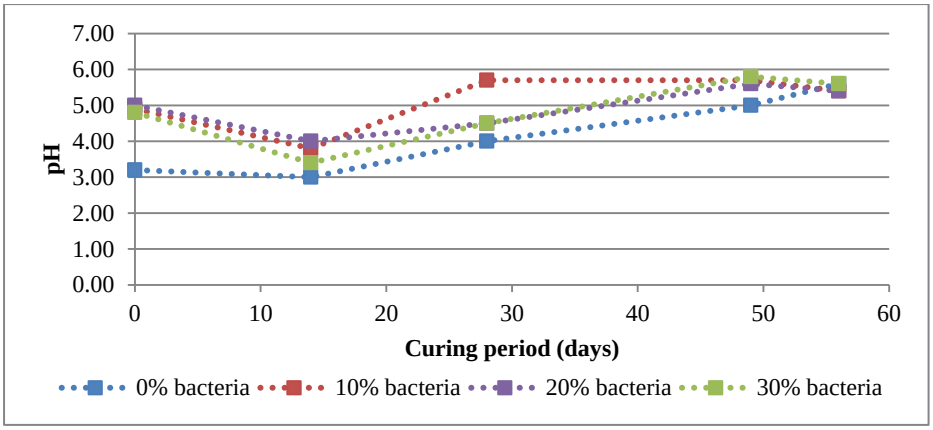

Fig. 2: Influence of addition bacteria and curing period to the soil pH

During 14 until 49 days curing period, specimen pH with adding bacteria tend to increase and shows that decomposition process lower than before. Slower decomposition process causes the amount of dissolved CO_2 gas into water which produced by bacteria activity smaller than CO_2 gas released into air and then soil pH tend

to be neutral. The tendency of wet specimen pH become neutral may inform that the amount of aerobic decomposer alive decreasing.

4.3. Fiber Content

Result of fiber content test with variation adding bacteria showed on Fig. 3. Plotting data show that all of specimen fiber content tend to decreasing until 56 days curing period. Fiber content of specimen without adding bacteria decrease less than specimen with adding bacteria. It means that peat without adding bacteria still have own decomposer bacteria which actively decomposed peat fiber. But the adding bacteria process would decompose fiber more quickly.

Specimen with 10% and 30% bacteria addition have higher fiber content on 28 days curing period than 14 days curing period. It might be happened because peat soil formed by plant's fragments such as leaves, trenches, and roots. Every fragment has different ability to decompose. Therefore, the fiber content in the same or near area is heterogenic. Then if the fiber content test value higher than previous curing period, it value would be considered as same as previous period.

TABLE IV: Fiber Content Results

% Addition Bacteria	Fiber content on curing period				
	0	14	28	49	56
0%	32%	28%	25%	25%	23%
10%	33%	24%	28%	21%	20%
20%	33%	24%	24%	22%	20%
30%	32%	24%	27%	20%	17%

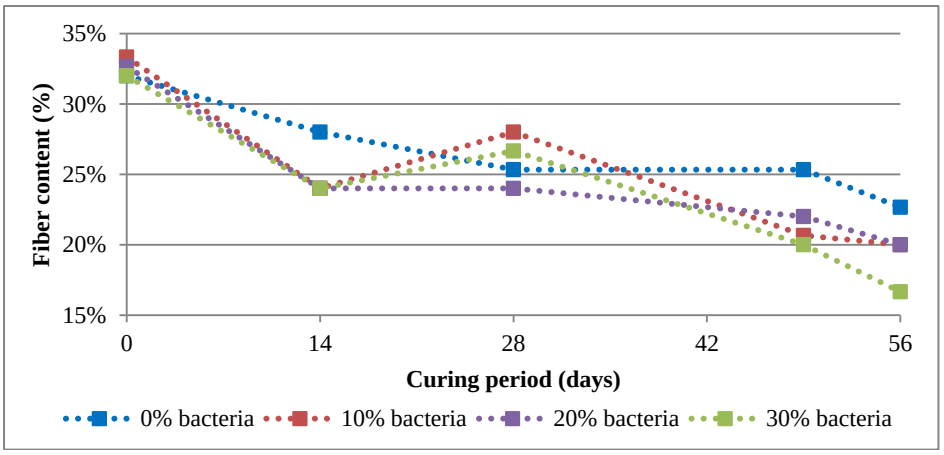

Fig. 3: Influence of addition bacteria and curing period to fiber content

Specimen fiber content significantly decreasing during 14 days curing period. Decreasing fiber content means that bacteria addition causes bacteria activity increase and decomposition process become more quickly. Same as previous explanation, increasing bacteria activity is followed by the changes of soil pH which become more acidic as the effect of increasing amount of dissolved CO_2 gas into water. On the acid environment, endogenous bacteria should be easily to breed. But in fact, decreasing fiber content on 14 until 28 days curing period is tend to be lower or constant than 0 until 14 days curing period. It might be happened because of addition bacteria increase the competition between bacteria to get nutrition which needed to stay alive and breed. While in this studies there is no addition bacteria nutrition on this studied such as nitrogen (N), phosphor (P), and carbon (C). Thus, although the soil pH becomes acidic, many bacteria die because of malnutrition. On 28 until 56 days curing period, there is decreasing fiber content but less than 14 days curing period. It might be happened because of died bacteria on the previous curing period become the carbon (C) source for another bacteria which can stay alive. Alive bacteria are breeding and the bacteria activity increasing followed by pH

soil tend to be acidic. The changes of fiber content are used to calculate decomposition velocity on the next section.

4.4. Decomposition Velocity

Decomposition velocity referred to this studied is amount of decreasing fiber content (%) during interval time curing period (days). Relation between curing periods to decomposition velocity with various addition aerobic decomposer bacteria showed on Fig. 4. Decomposition velocity on each variation specimen is increasing during 14 days curing period. But the decomposition of specimen without addition bacteria is slower than specimen with addition bacteria.

During 14 until 28 days curing period, decomposition velocity is decreasing significantly on the specimen with addition bacteria (10%, 20%, and 30%). It is indicated that almost decomposer bacteria die during this period. As discussed before, tight competition between bacteria to stay alive and decreasing amount of nutrition causing many bacteria become dead. Even though the bacteria addition increasing, there will be no different result if the amount of nutrition is same. Besides that, addition bacteria solution larger than 10% causing the puddle getting thick and diffusion access of O_2 gas to reach peat soil become more difficult. Thus, the specimen environment is dominantly anaerobic. While the aerobic bacteria activities might be less in the anaerobic environment. The live bacteria would be breed again and decomposed fiber to its metabolism activities. Therefore, decomposition velocity is increasing again on 49 and 56 days curing period. Based on the decomposition velocity analysis of specimen with addition bacteria, the optimum addition is 10% solution from wet unit weight of peat soil.

TABLE V: Decomposition Velocity Calculation Results

%Addition Bacteria	Decomposition velocity (%fiber/days) on curing period				
	0	14	28	49	56
0%	0.00	0.29	0.19	0.00	0.38
10%	0.00	0.67	0.00	0.35	0.10
20%	0.00	0.62	0.00	0.10	0.29
30%	0.00	0.57	0.00	0.32	0.48

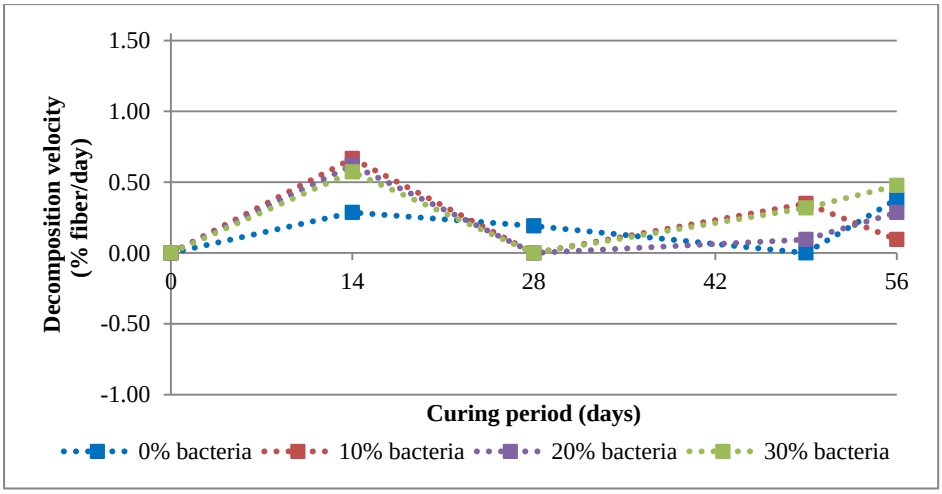

Fig. 4: Influence of addition bacteria and curing period to the decomposition velocity

On the other hand, decreasing velocity of specimen without addition bacteria is slow or not significant. Decomposition velocity is decrease slowly during 14 until 49 days curing period. It means that competition of bacteria to stay alive less than specimen with addition bacteria. Then the alive bacteria is breed again and decomposition process increasing again during 49 until 56 days curing period.

5. Conclusion

The studied peat soil from Bereng Bengkel village, Palangkaraya, Centre Kalimantan classified as sapric from its fiber content, highly acidic based soil pH, and moderately absorbent based water absorbent capacity. The adding aerobic decomposer bacteria consortium as stabilization method causes decreasing fiber content and increasing decomposition velocity which the optimum value reached on 14 days curing period. During that curing period, the amount of dissolved CO_2 gas into water larger than released CO_2 gas into air then specimen pH become more acidic. Soil pH, fiber content, and decomposition velocity are affected by bacteria life cycles. The optimum percentage adding aerobic decomposer bacteria consortium is 10% from peat wet weight.

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