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The stabilization effect of peat soil using an effective microorganism reviewed from CBR Value

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Abstract. The behavior of peat soil's physical characteristics and the mechanism are extremely influenced by the decomposition degree. This study aims to know a physique range alteration and mechanism of the peat soil fibrous reviewed from the enhanced value of California Bearing Ratio (CBR) after it is stabilized using Effective Microorganism (EM). The volume of EM inserted and combined are 20% and 40% that ripened for 14 and 21 days. Then the peat soil and EM are mixed with water content close to original peat soil volume. The results showed that the most significant change in peat soil's physical characteristics and the mechanism is 40% EM solution with maximum decomposition rate occurs at the 14-days ripening period. The fiber content is reduced from 60% to 52%, and decomposition rate 0% fiber/day to 0.57% fiber/day, and the increased value of unsoaked CBR 3.28% to 7.47% and 3.01% to 6.11% in wet conditions.

Keywords: the soil peat fibrous; decomposition; Effective Microorganism (EM); California Bearing Ratio (CBR).

1. Introduction

South Kalimantan has a pretty abundance of peat soil, predicted as 475.628.000m3 and spread in four districts, including Banjar, Tapin, Hulu Sungai Utara, and Balangan [1]. According to Ma'ruf and Yulianto [2], the large peat soil area represents an obstacle in developing infrastructure territory. The peat soil is a very

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soft soil with low bearing capacity and has an ease compressed feature if there is a weight load. Therefore, peat soil is a land problem that needs repair [3].
The decomposition value's degree influences peat soil's physical characteristics and mechanisms. If the higher the decomposition degree, the lower the fiber content within. Less fiber content may cause the compressed process to become faster. The land subsidence becomes smaller when the land receives a load [4]. The decomposition of peat soil is often obstructed because the bacterium that decomposed lignin and cellulose decomposition on peat soil is limited. Another main problem is the acidity level of peat. Most bacteria live in a neutral optimum pH, while those that can survive in acidic conditions are limited [5].
According to Prativi [4] one way to speed the decomposition process in acquiring the degree of a higher peat soil decomposition is by adding decomposer microorganisms that can parse cellulose and lignin of peat soil fiber. The Effective Microorganism (EM) is a bacterium that can live in acid conditions and decompose cellulose and lignin until the ripeness level of peat or decomposition process can be accelerated. In the construction field, the peat soil condition with a high decomposition degree is needed to avoid land compression after the construction operates. Meanwhile, Yusof et al. [3] found an additional 10% of EM with controlled water content controls for 50%, which can increase the significant Unconfined Compressive Strength test (UCS) value of peat soil by 44% up to 65% after ripening for 21 days.
As a result, the study aims to enhance peat soil stability using an eco-friendly substance, Effective Microorganism, since it can accelerate the breakdown process of peat soil. This study also describes the influence on physical change and power enhancement of peat soil using the Vane Shear test and California Bearing Ratio (CBR) test.

2. Materials and methods

The sample of peat soil takes in Malintang, Tipe A Gambut Barakat terminal in Km.17 Gambut district, Banjar regency, South Kalimantan, Indonesia. The test samples are fiber peat soil widely spread in Banjar Regency. The retrieval of land samples conducts in two ways; disturbed and undisturbed. The disturbed sample gets manually to use strainer because the peat soil has submerged water. While taking an undisturbed sample, use the paralon or uPVC pipe because a sample of peat soil belongs to the highly tender soil. The Effective Microorganism (EM) uses is the EM4 of conventional farming shapes and quickly obtain liquid in the farm market. The composition of Lactobacillus sp. bacteria as 1,09 x 107cfu/ml and Saccharomyces sp. bacteria as 4,30 x 107cfu/ml are the functional bacteria remodels a material organic such as cellulolytic and lignin lytic with negative pathogenicity.
The sample of initial peat and compost with the mix of EM is done the physique nature test and mechanism. All laboratories' activities to test physique parameters and mechanisms will do in the Laboratory of Soil Mechanics Faculty of

Engineering, Lambung Mangkurat University, Banjarbaru. The total test sample for every analysis in this research was 156. The examination of physical characteristics involves:

2.1. Water content test

The standard used to test the water content of organic soil was ASTM D 2974-87.

2.2. Ash and organic content test

ASTM D 2974-87 was used to test the organic content. Organic content is a part of the burnt peat soil at the temperature of 440℃, which then obtained the ash content by comparing ash mass towards the dry weight of oven 105. At the same time, the remaining is considered as the organic percentage.

2.3. Weight volume and atteberg limit test

To test the weight volume (γ), the standard used is ASTM D 4253-91. Meanwhile, in *the atteberg limit* examination, the peat soil was not drying by the air. It was pounded since the land of peat would not absorb the water again. The limit *atteberg* examination done was PL, LL, and PI tests. The standard used for a limit *atteberg* was ASTM D 4318-84.

2.4. The specific gravity test (Gs)

The soil needs to be put in an oven at 105℃ temperature to dispose of the soil water content in specific gravity examination. Then, the soil is filtered with filter number 40. This experiment used kerosene instead of pipe water because pipe water cannot precipitate peat soil. It means the pipe water cannot enter the air cavity. This examination was using ASTM D 854-83 standard.

2.5. The fiber rate and fiber distribution of peat soil test

The standard used to do this experiment was ASTM D 1997-91.

2.6. The standard proctor test

The standard discussed of examination was ASTM D 698.

2.7. The vane shear and CBR test

The standard examined of test was SNI 03-2487-2008 referred to ASTM D 2573-72. The standard discussed of test was ASTM D-1883.

The stabilization method used in this study was based on the weight of dry (v/w). The first weight volume test was to know the weight volume of initial peat soil from the undisturbed sample. After the peat weight volume is disturbed, then the proctor standard compaction test is done to know the water rate that needs to be mixed by taking the value of drier content weight close to the initial volume. The authors used the water rate as the design water rate mix controlled. Then, prepare a mixture of EM with the variation of volume 20% and 40 %. The stir of each aqueous EM the concentration to the peat soil, afterward mix evenly used by hand. The peat of land had stabilized with the variation of Effective Microorganism volume, then closed with plastics and put a hole above as the curing air of survival the bacteria.

3. Results and discussion

Based on Table 1, the peat soil is classified as the hemic fiber based on the degree decomposition, as the medium ash peat based on the ash content value of H_4-H_6 type in Von Post scale.

Table 1. The Recapitulation Result of EM Influence towards the Test Sample.

Parameter	Unit	Initial	EM20%-14	EM40%-14	EM20%-21	EM40%-21
Γ	t/m^3	1.06	-	-	-	-
LL	%	114.30	92.71			
PL	%	NP	NP	NP	NP	NP
PI	%	-	-	-	-	-
Gs	%	1.86	1.20	1.27	1.28	1.26
E	%	6.46	4.14	4.08	4.04	3.80
w natural	%	326.56	-	-	-	-
Ac	%	13.98	11.59	10.46	10.58	9.75
Oc	%	86.02	88.41	89.54	89.42	90.25
Fc	%	60.00	53.33	52.00	52.67	49.33
- Rough Fiber	%	52.10	49.70	45.82	48.68	43.69
- Mediu m Fiber	%	26.60	31.10	42.50	32.87	42.54
- Soft Fiber	%	21.30	19.20	11.70	18.45	13.77
w_{opt}	%	61.52	59.79	57.32	56.75	56.04
γ dry max	t/m^3	0.82	1.01	1.29	1.23	1.38
CBR unsoaked	%	3.28	4.91	6.63	5.32	7.47
CBR soaked	%	3.01	3.72	6.09	4.41	6.11
Vane Shear Test	kPa	55	72	98	84	106
Classification (ASTM D 4427-92)		*Hemic, Medium Ash Peat*				

3.1. The Influence towards a Fiber Content Value *(Fc)*

Adding 40% of EM showed that the most decreased fiber content was 52% in 14 days. Moreover, 49.33% of curing periods in 21 days mean as much as 18% of

fiber test sample decomposed from the first condition if compared with the percentage, 20% EM = 53.33% in 14 days and 52.67% of curing periods on 21 days reduction of 12%. Fast decomposition, peat soil can parse lignin, and cellulose was the main element formed of peat fiber [4]. The decreased fiber content amount curing periods on 21 days indicated in the long curing periods of test sample then higher of decrease fiber content happen. Kalantari and Prasad [6] found that the long curing periods during sustainability save of decomposer microorganism guaranteed and it was getting bigger of fiber content would decompose.

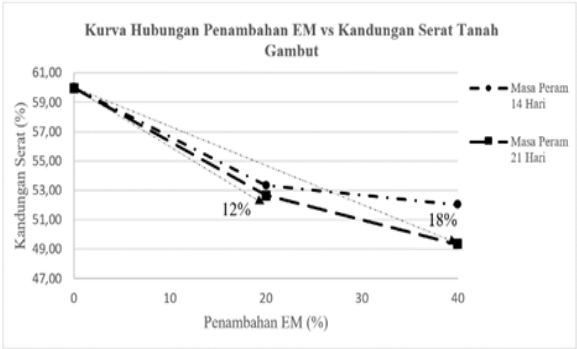

Fig 1. Replenishment Influence of Effective Microorganism towards the Amount of Fiber Content Peatland

3.2. The Influence of decomposition content

In figure 2, the fiber content of the test sample experienced a decrease in curing periods up to 14 days. The decline of fiber content happened in a pretty large curing period. Many bacteria in Effective Microorganism (EM) are activated to process the lignin decomposition and cellulose on the fiber of peat soil in the curing process. It showed the maximum decomposition rate in curing of 14 days.

Subsequently, with increasing the curing periods up to 21 days, reduction of fiber content seems less. It showed that getting the curing periods, the possibility of bacteria totals in Effective Microorganism (EM) capable of living in the sample becomes less. The rating process of decomposition slows down.

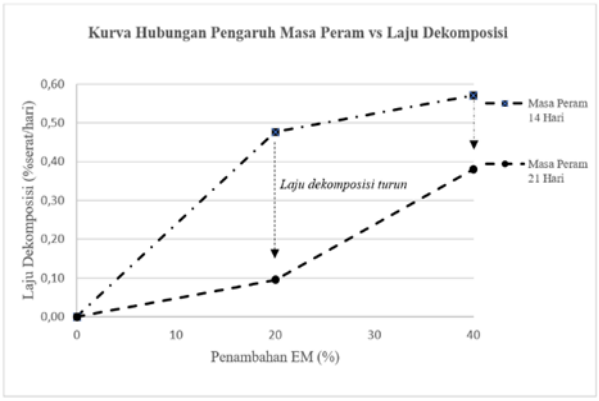

Fig 2. The leverage of Curing Periods towards the Amount of Peatland Fiber Content.

3.3. The impact towards value of void ratio (e)

The curve of relation influenced curing periods towards vid ratio value (e) in Figure 3. The value of the void ratio (e) at first when Microorganism (EM) added up to curing periods for 14 days tends to decrease in the value of tiny vid ratio around 2% only. The value of specific gravity (Gs) peat on EM20% and EM40% curing of 14 days was not much different was 4.14 and 4,08. The differences on curing of 21 days, the value of void ratio expertized a pretty significant increase. It can be seen from the peat land sample that adding EM20% and EM40% curing of 21 days had a constantly void ratio value of 4,04 and 3,80. Intercalation EM20% caused the reduction of void ratio (e) of 37%, while EM40% of outstanding was 41%. The fiber of peat soil decomposes results of other Effective Microorganism (EM) caused the value of specific gravity (Gs) when the sample dropped. Hence, the value of the void ratio also passed.

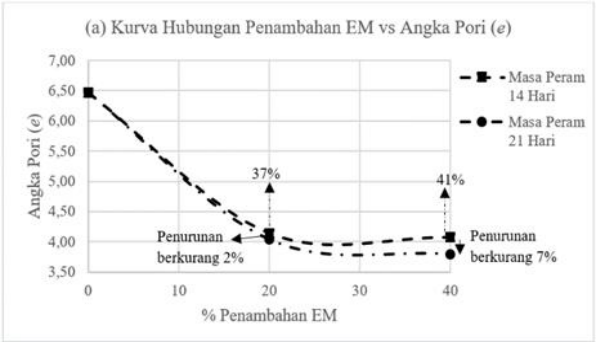

Fig 3. The Influence of additional EM towards (e)

3.4. The effect of ash content value

Concerning curve effected curing towards ash levels value (Ac) in Figure 4, the value of ash content (Ac) every test sample constantly was decreased. The peat of soil added EM 20% during curing, which experienced a reduction of 17.1%, and up to curing periods 21 days of 8.7%. Reduction of ash content value (Ac) the great happened on test sample add EM40%, was decreased 25.2% during the curing 14 days and up to 6.79% on curing periods 21 days. Widaningrum et al. [7] and Karina et al. [8] said that ash content showed the material's great mineral content because a mineral was an organic substance not burned during the combustion process. The higher the ash content generated, the higher the mineral content. Puspitasari and Mohammad [9] said that microorganisms needed a specific mineral to grow and metabolize. It verified that increasing the ash content (Ac) value on the test sample may affect the bacteria viability in EM. It also may cause the decomposition rate on the test sample also experience a reduction.

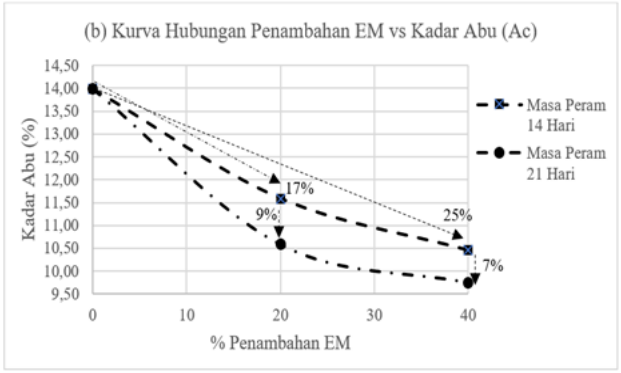

Fig 4. Effect of Additional EM towards Ac

3.5. The leverage towards value of organic rate (Oc)

The relation curve affected curing periods against the value of organic content (Oc) in Figure 5 showed that the percentage of organic (Oc) on every test sample encountered an escalation. It was an augmented EM20% and constantly improving 2.78% and up to 21 days of curing as much as 1.14%. The organic rate increment (Oc), the prominent test sample that happened on additional samples 40% EM, was profuse of 4.09% and constantly improved during the curing in 21 days of 0,79%. The higher the organic levels (Oc), the better the soil if reviewed from soil biochemical activity. The organic rate also influenced peat pH value. It identified the effectiveness of Effective Microorganism (EM), especially the EM4 purposed in this study, increased the peat fertility by reorganizing an organic material transform into organic elements.

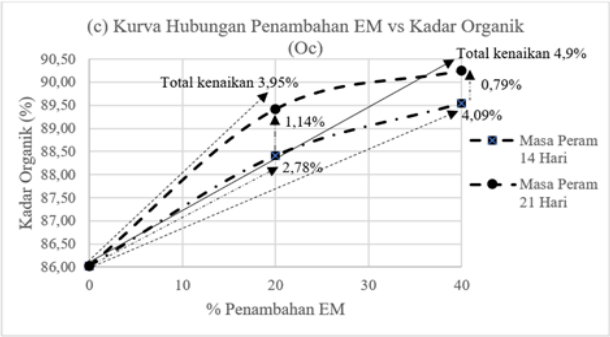

Fig 5. The Influence of additional EM towards Oc

3.6. The affect towards the su value of vane shear test

In figure 6, enhancement of shove strength value from the great of vane shear test added EM 20% and EM40% in curing periods 21 days was constantly 84kPa and 106kPa.

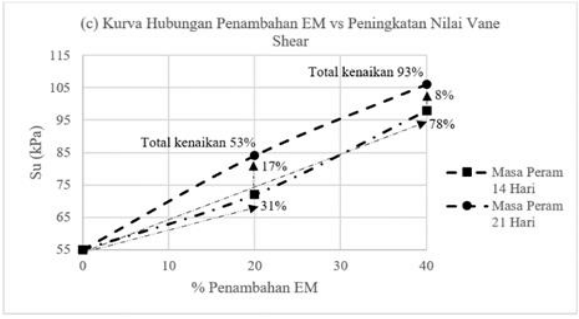

Fig 6. The Influence of Additional EM towards shear strength undrained (Su) from vane shear test

3.7. The impact towards CBR value

Figure 7 showed the great CBR value shown on test sample add Effective Microorganism (EM) 40% in curing 21 days around 7.47% to unsoaked condition and 6,11% to wet condition. Escalation of the great CBR value happened on the test sample of unsoaked condition CBR added EM40% on curing 14 and 21 days. Proving that an Effective Microorganism (EM) improved the strength of peat land viewed from the enhancement of CBR value.

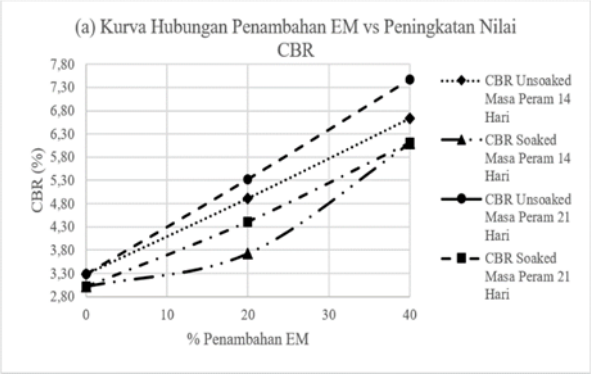

Fig 7. The Impact of Additional EM towards Increment of CBR value

3.8. The influence towards compact value

In figure 8(a), the reduction of optimum water content value (*w* opt) in the test sample added EM always happens, which similar to the study by Karisma [5]. The significant percentage added then it would bigger of decreasing. In line with enhancement of CBR value, because it was optimum of the smallest water content value than bigger of the weight value of drier content the maximum (γ_{dry}) getting from solidification test (Figures 8 (b)).

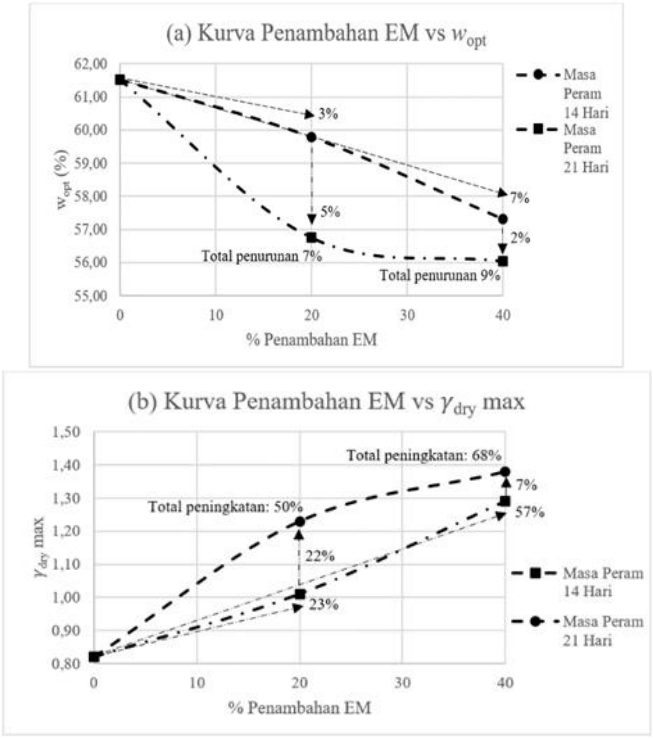

Fig 8. The Influence of Additional EM towards Compact Value

4. Conclusion

The study's goal is to learn about the effect of peat soil stabilization using eco-friendly materials based on CBR value. According to the results, the peat soil from Malintang, Type A Baccarat Peat terminal at km.17, Gambut District, Banjar, South Kalimantan is classed as hemic fiber peat soil based on its decomposition degree and medium ash peat soil based on its ash content value types H4-H6 on the von Post scale. Furthermore, it has been discovered that applying EM may lower the quantity of peat soil fiber content at over 40% with a ripened length of 14 days. Suppose the ripened time is longer and the decomposition pace is slow. In that case, the bacterium's life span within EM could be decreased. Decomposed peat soil fiber because of EM caused the specific gravity value (Gs) on the sample to decrease, and the void ratio value (e) also decreased. At the same time, the decrease of ash content (Ac) affects the bacteria's life-span, which may lead to a slow decomposition rate.

The percentage of organic content (Oc) in every test sample had increased. The organic rate increased (Oc) the great in test sample happened on the additional sample 40% EM was 4,09% and up to increase during the curing in 212 days of 0,79%. The improvement of the great CBR value showed on sample test the additional of Effective Microorganism (EM) 40% during curing of 21 days was

7,41% unsoaked condition and 6,11% to soaked condition. The improvement of slide strength value from vane shear test showed on the test sample added EM40% in curing 21 days was 106kPa. The value of optimum water content dropped (w opt) on the test sample that added the Effective Microorganism (EM), the more significant percentage added then the largest falls. It was the most significant of drier content weight value maximum (γ_{dry}), obtained from the compaction test.

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