

PARAMETERS CHANGES OF STABILIZED FIBROUS PEAT WITH ENVIRONMENTALLY FRIENDLY MATERIALS DUE TO WATER FILTRATION FROM THE SURROUNDINGS ON DIFFERENT OF AREA STABILIZATION

Faisal Estu Yulianto¹, Noor Endah Mochtar², Fuad Harwadi³

¹Civil Engineering Departement, Engineering Faculty, Universitas Madura, Pamekasan, Indonesia.

²Faculty of Civil, Planning and Geo-Engineering, Institut Teknologi Sepuluh Nopember, Indonesia

³ Engineering Faculty, Universitas Borneo, Indonesia

*Corresponding Author, Received: 15 Aug.2022, Revised: 16 Nov. 2022, Accepted: 27 Nov.2022

ABSTRACT: Fibrous peat soil is very soft soil that a very low bearing capacity, with a large uneven settlement that occurs over a long period. Furthermore, several techniques were used to improve the physical and engineering characteristics of this soil, one of which is stabilizing with lime CaCO₃ and fly ash. The use of CaCO₃ lime and fly ash as stabilizing agents have often been used with good results. However, the research conducted has not yet modeled the real conditions in the field where the stabilized peat area is only in a certain area. Based on this, this study was conducted to determine the effect of water filtration on the parameters of peat soil stabilized by 10% admixture. This research laboratory model is in accordance with the real conditions in the field. The stabilized peat was placed among the initial peat, having water contents that were kept constant following the initial conditions. The physical and engineering properties of the stabilized soil were evaluated between 30 and 180 days. The test results showed that the physical and engineering properties improved if compared to the initial conditions, especially after the stabilization had lasted 90 days and above. Furthermore, changes in the stabilized soil's characteristics were influenced by the stabilization area's width where the peat with a 2L- width stabilization area gave better values than the L-width area. Lastly, the water conditions in the peat pore significantly influenced the formation of CaCO₃ gel which filled the pores and wrapped the peat fibers.

Keywords: Stabilization, Fibrous Peat, Water Filtration, Wide Stabilization Area

1. INTRODUCTION

Fibrous peat soils are classified as soft soils because of their very low bearing capacity, and uneven settlement, to very soft clays [1, 2]. This characteristic results from the fact that this soil is formed by the weathering of tropical plants submerged in water. Furthermore, this type of soil consists of high organic contents and low acidity, making it unfavorable for the construction of civil buildings [1, 2, 3]. Therefore, it is important to improve the soils' properties and various improvement techniques have been widely used.

The peat soil stabilization method has been widely applied to improve the soil's physical and engineering properties. Several environmentally friendly stabilizing agents such as rice husk ash, CaCO₃, and fly ash have been used to increase these parameters [4, 5, 6, 7] with satisfactory results. Different research has been conducted concerning fibrous peat soils' stabilization and a comparison of these results showed that among other stabilizing materials, the use of fly ash was much more satisfying [5, 6, 8]. Therefore, stabilization using fly

ash as the primary component is still being developed under the actual field conditions.

According to previous research [5, 6, 8], changes in the parameters of stabilized fibrous peat soils are significantly influenced by water filtration from the environment. These changes are unpleasant as they decrease the quality of the stabilized parameters [5, 6, 8, 9]. Therefore, this research was conducted to ascertain the impact of the width of a peat soil area that had been stabilized using a mixture of Lime CaCO₃ and fly ash at a specific percentage and for a considerable amount of time. The research model is modified to reflect the actual field circumstances where changes in the parameters of stabilized fibrous peat are significantly influenced by water filtration.

2. RESEARCH SIGNIFICANCE

Soil stabilization of peat with a mixture of lime CaCO₃ and fly ash has been carried out but still does not include the effect of water filtration from around the peat (initial peat) on the stabilized peat. This laboratory research continues previous

research where peat soils were stabilized only in certain areas according to real conditions in the field. Changes in the parameters of the stabilized peat were observed for up to 180 days and the water content of the surrounding peat was kept the same as conditions in the field

3. STABILIZATION MATERIAL

As in previous research [1, 2, 5, 6, 8, 9] samples of fibrous peat soil were also collected from Palangkaraya, Central Kalimantan. a disturbing sample (Figure 1) was used to identify the physical and engineering properties of the fibrous peat soil in its initial conditions. However, the undisturbed sample (Figure 2) was combined with the stabilizing substance, which is a mixture of CaCO₃ Lime and Fly Ash.



Fig 1. A sampling of Fibrous Peat Soil in an Undisturbed Condition



Fig 2. A sampling of Fibrous Peat Soil in a Disturbed Condition

The following laboratory tests were performed on the undisturbed peat samples: soil unit weight (γ_t), specific gravity (Gs), water content (Wc), organic content (Oc), fibers content (Fc), peat fibers distribution, direct shear, and the compression tests. Furthermore, the American Standard Testing

Manual/ASTM [11] and the fibrous peat testing standard [10] served as the foundation for all laboratory tests. The results are shown in Table 1.

According to the findings observed in Table 1, the Palangkaraya peat soil has fiber contents above 20% and water contents of 598%, respectively. This indicated that the fiber contribution has a significant impact on the behavior of peat soil even though the majority of the material is in liquid form. Peat with a medium rate of decomposition typically has low acidity, and this is a sign that decomposition is still occurring. However, the organic contents of the fibrous peat soil experimented on were greater than 70%, which is considered very high.

Table 1 Parameter of initial peat soil

Soil Parameters	Unit	Findings from this research
Specific Gravity (Gs)	-	1.51
Void ratio (e)	-	7.5
Unit Weight (γ_t)	t/m ³	0.981
Water Content (Wc)	%	598
Organic Content (Oc)	%	98
Ash Content (Ac)	%	2
Fiber Content (Fc)	%	56.22

As depicted in Table 1, the findings obtained from testing for the physical properties of the soil were compared with previous research. In addition, the hemic peat contains very little ash, is highly acidic, and has fiber with a medium absorption rate [11]. Its engineering properties can be determined by conducting either direct shear or single-stage consolidation tests. Furthermore, these tests were carried out because the peat is very soft soil, with a permeability coefficient similar to sand and different behavior from soft clay [1, 6, 8]. The direct shear test results showed that the internal shear angle (ϕ) varies between 22° to 35° and this variation is due to the different fiber distribution in each test object (sample). Furthermore, the consolidation test on the fibrous peat was conducted using a single-stage load for 14 days. This was carried out by experiments conducted in previous research to determine the compression behavior of fibrous peat soils [1, 5, 6, 8]. Figure 3 shows the consolidation curve of fibrous peat with 56,22% fiber content and 598% water content.

The 14-day consolidation test was conducted using previous findings [1, 5, 6] as well as test standards for fibrous peat soils [11, 12] with a fixed load of 50 kPa (fill load and traffic on the road). The compression stages of the peat soil were divided into four namely immediate compressions (Si), primary compression (Sp), secondary compression (Ss), and tertiary compression (St). This is similar to other previous research [1, 9, 13] on the compression of fibrous peat soils (St).

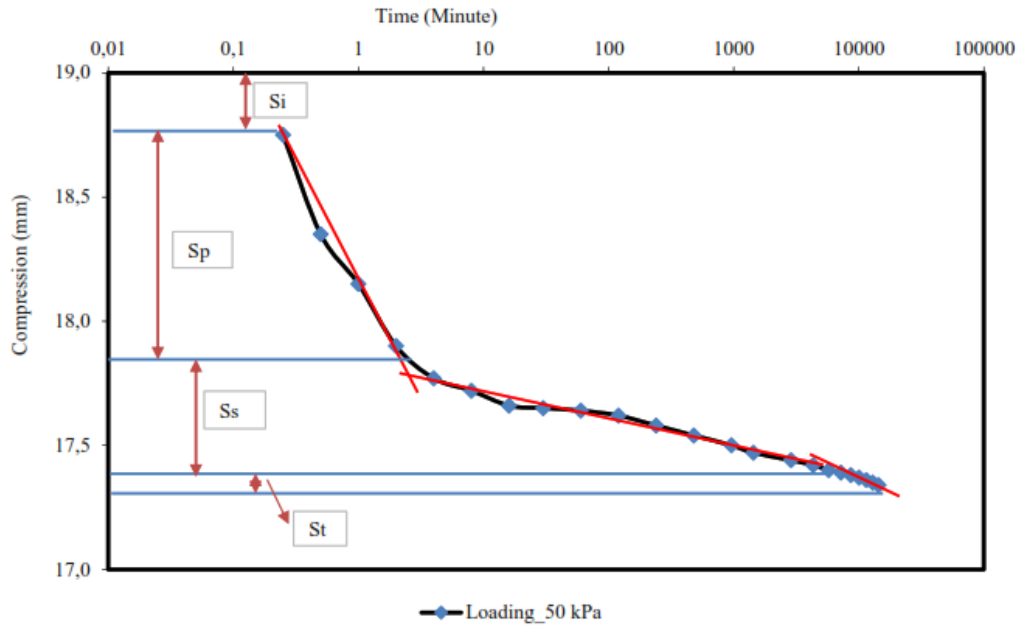


Fig 3. Curve of fibrous peat soil consolidation one-step loading ($\Delta\sigma = 50$ kPa)

The stabilizing agents utilized in this research are CaCO_3 (a side-product of the fertilizer industry) and fly ash (a side-product of power plants) which were obtained from PT. Petrokimia Gresik industry and the Paiton Steam Power Plant (PLTU). These stabilizing materials were classified as industrial waste because of how enormously each year and yet not being used to their full potential [5, 6, 8]. Tables 2 and 3 show the outcomes of analyzing

Table 2 Chemical Constituent of Lime

Parameter	Result (%)
Ca	91,6
S	5,98
Sr	0,772
P	0,67

Table 3 Chemical Constituent of Fly Ash

Parameter	Result (%)
Si	25.4
Al	9,42
Ca	21
K	2,43
Ti	1,81

the stabilizing material's chemical composition. Table 2 shows that Ca is the most dominant chemical compound among the lime CaCO_3 chemical composition materials, amounting to 70%. They can restore soil's low pH level to normal, neutralize toxic. Following this, silica is the most predominant compound in the chemical makeup of fly ash. It is anticipated that the relatively high silica content will be able to form CaSiO_3 gel (together with CaCO_3). In addition, it can wrap the peat fibers, fill the peat pores, and form crystals [5, 8, 14] that can withstand water filtration coming into the

peat fibers and pores as well as improve the fibrous peat soil's stabilized parameters.

According to Indonesian regulations, fly ash is classified as hazardous waste. Therefore, it is only used for the Toxicity Characteristics Leached Parameter (TCLP) test. The results of the TCLP test are shown in Table 4. It was reported that all the heavy metal contents present were in fly ash. The test results showed that all the heavy metal content of fly ash is still below the threshold permitted by the Indonesian government [15]. Therefore, it is not included in the environmentally toxic waste.

Table 4. Result of the TCLP Analysis of Fly Ash Studied

Parameter	Unit	Maximum Allowable	Detection Limit
Mercury (Hg)	Mg/l	0.2	0.0014
Plumbum (Pb)	Mg/l	5.0	0.406
Cadmium (Cd)	Mg/l	1.0	0.01
Chrome	Mg/l	5.0	0.0198
Copper (Cu)	Mg/l	10.0	0.0196

3. RESEARCH METHODOLOGY

This is a Laboratory Research that modeled actual conditions in the field with a scale of 1:100. The stabilized fibrous peat soil was placed in the middle of the initial peat soil (Figures 4 and 5) with a measure of 30 cm (L) and 60 cm (2L) in width, which was a simulation of the highway's width based on actual field conditions. Furthermore, the initial peat soil (not stabilized) was always maintained in its initial state, particularly concerning its water content ($\text{WC} \pm 598\%$).

This was conducted in addition to the fact that the model was being used in the field because the

water filtration will continuously enter the stabilized peat during the CaSiO_3 gel formation process. The modeling box in which the fibrous peat soil was placed was impermeable (Figure 6).

engineering characteristics of the peat were monitored after 30, 60, 90, 120, 150, and 180 days.

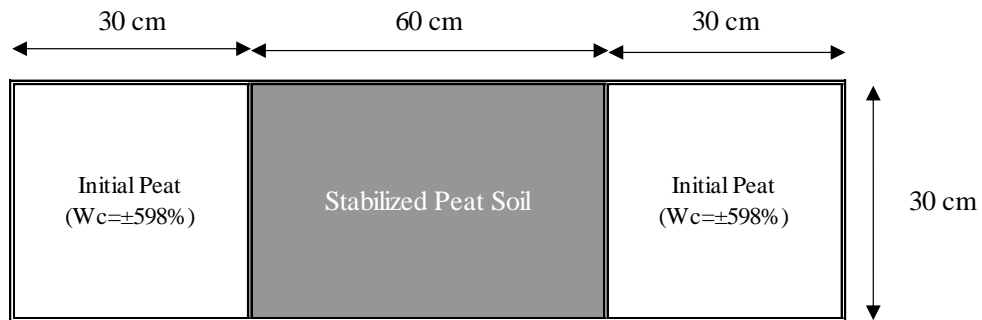


Fig 4. Top view of the physical model 2L of fibrous peat soil, which was stabilized in the laboratory

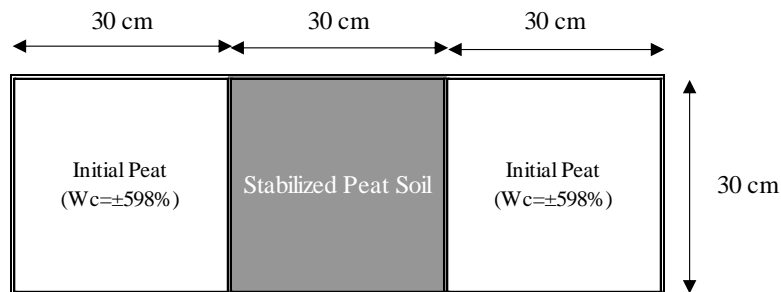


Fig 5. Top view of the physical model L of fibrous peat soil, which was stabilized in the laboratory



Fig 6. Box of stabilization model of fibrous peat soil

Also, the amount of stabilizer used was 10% of the initial unit weight of the peat soil (γ_t) and this is the experiment conducted in previous research [1, 6, 9]. CaCO_3 lime and fly ash were mixed first outside the modeling box and then added with initial peat soil. To determine the changes in the physical and engineering properties of the stabilized fibrous peat soil, tests were carried out following the ASTM D-4427-2018, Peat Testing Manual, and the Indonesian National Standards [10, 11, 12]. Furthermore, with test samples collected from the stabilized peat, changes in the physical and

4. RESULTS AND DISCUSSION

Tests were conducted to determine the various physical and engineering properties of the stabilized fibrous peat soil. These properties include the unit weight (γ_t), water content (WC), specific gravity (G_s), void ratio (e), shear strength (τ), and compressibility (Δh). The value of the unit weight of the stabilized peat soil automatically increased with the addition of the stabilizing materials (Figure 7). However, the stabilizing agent used the water in the peat pores to react in the initial stages of the formation of calcium silicate gel (CaSiO_3), which caused a decrease in the unit weight after 30 days. Meanwhile, the initial peat, which provides the water source, took up to 90 days for the peat pores to be stabilized. This change was more stable at a wider stabilization area (2L) than data smaller one (L).

This phenomenon is reasonable because the closer the initial peat (smaller stabilization area L), the faster the water filtration fills the peat pores. Furthermore, the formation of calcium silicate gel was predicted to occur 90 days after stabilization. This is evident from the unit weight value of stabilized peat soil, which increased at the early stage of the stabilization and tended to stabilize after 90 days. Although the unit weight of stabilized peat with a width of L tends to decrease slightly

compared to that with an area of 2L, their values started equalizing from 120 days above after the stabilization process.

occur at the early stabilization stage but this was caused by the peat's increased water content. In addition, it is a plausible behavior because

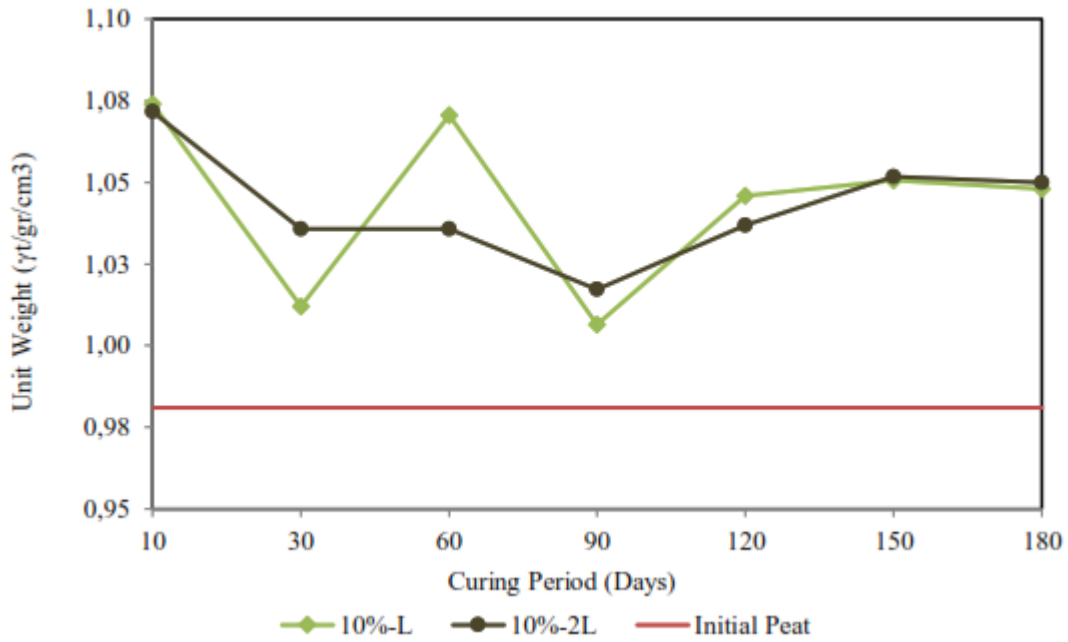


Fig 7. Unit Weight of Stabilized Fibrous Peat (γt)

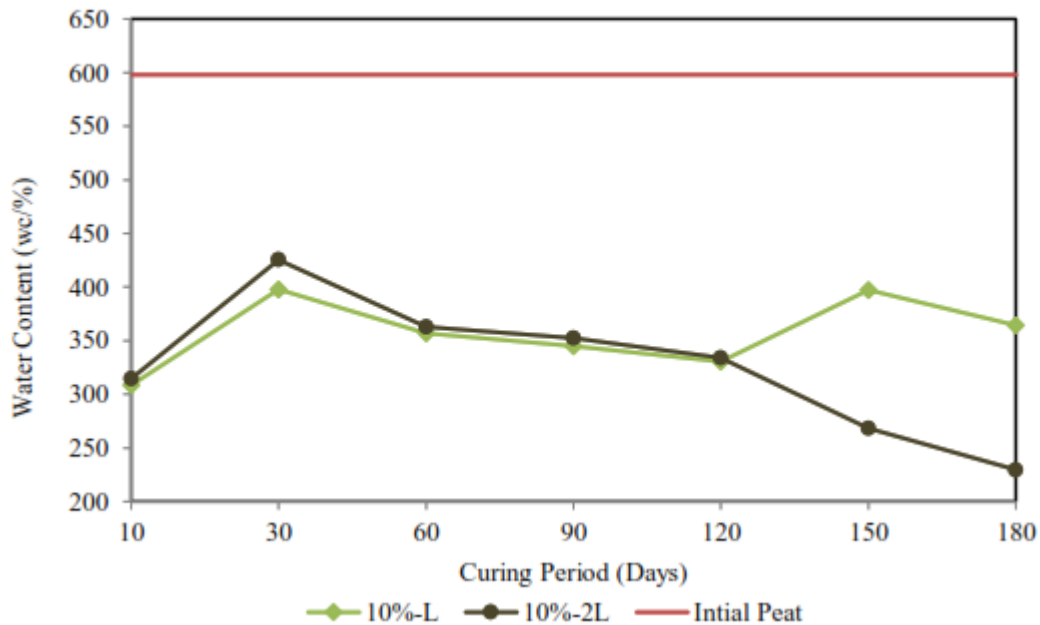


Fig 8. Water Content (Wc) of Stabilized Fibrous Peat Soil

Following this, the addition of a mixture of CaCO₃ lime and Fly Ash significantly affected the water content (Wc) of the stabilized peat soil (Figure 8). The stabilized peat's water content value dropped sharply by more than 45% from its initial state, or from 598% to roughly 310% for the entire area's width. This phenomenon does not usually

the formation of CaSiO₃ led to a significant decrease in the peat pore's water content. As a result, the volume of the pore space increases. Another effect of the gel formation is the decrease in the unit weight (Figure 8), which was caused by the increase in pore space and the incomplete filling of the pores by the CaSiO₃ gel that had formed.

In addition, the peat's water content continued to decline once the post-stabilization period exceeded 30 days. This process continued for 180 days after stabilization (for the 2L stabilization area). This behavior was predicted to occur because the water was still being used to form the CaSiO_3 gel in the peat pores. Meanwhile, a different behavior occurred in stabilized peat with an L-width and this was because the width of the stabilization area was smaller, thereby causing the water filtration to easily reach the pores.

Also, the application of stabilizing agents increased the value of the stabilized peat's specific gravity (G_s) from an initial value of 1.5 (Figure 9). Previous research [1, 5, 6] claimed that the peat soil's mixed mineral content was the cause of the increased G_s value. Even though the values unit weight and peat moisture content values were utilized, the G_s value remained unstable until after 120 days. This behavior is similar to the CaSiO_3 gel formation which began to stabilize after 120 days. However, there is only a slight difference between the G_s values of the L and 2L stabilization areas. Also, the G_s value of the two different stabilization areas was both stabilized after 150 days. This was possible because the formed CaSiO_3 gel had also started to stabilize. The stabilized peat's G_s value with a 2L stabilization area did, however, slightly decrease at the 150th day and remained that way.

Lastly, the changes in the stabilized peat's void ratio (e) are shown in Figure 10. In the early days of the stabilization period, the soil with an additional stabilizing agent displayed an inappropriate behavior in the pores of the stabilized peat. The peat pores were getting bigger, particularly in stabilized peat with a 2L stabilization area, and had lasted for up to 90 days.

This behavior occurred due to the continued use of water in the peat pore to form CaSiO_3 gel. This makes the pore space bigger even though the gel growth at the beginning of stabilization was very slow [14]. In contrast, the peat pore in the L stabilization area shrunk because water filtration was easier due to the difference in the width of the stabilized area.

When the stabilization period exceeded 90 days, different treatments were observed between the L and 2L stabilization areas. There was a decrease in pore values of the stabilized peat having a 2L area. However, when the peat's area was L, the void ratio was unstable. This was because the CaSiO_3 gel formation process of the smaller stabilization area was easily disturbed since it was more easily accessed by water from the surroundings (initial peat). The phenomenon of unstable physical properties of the stabilized peat with an L stabilization area also occurred at the values of γ_t (Figure 7), W_c (Figure 8), and G_s (Figure 9).

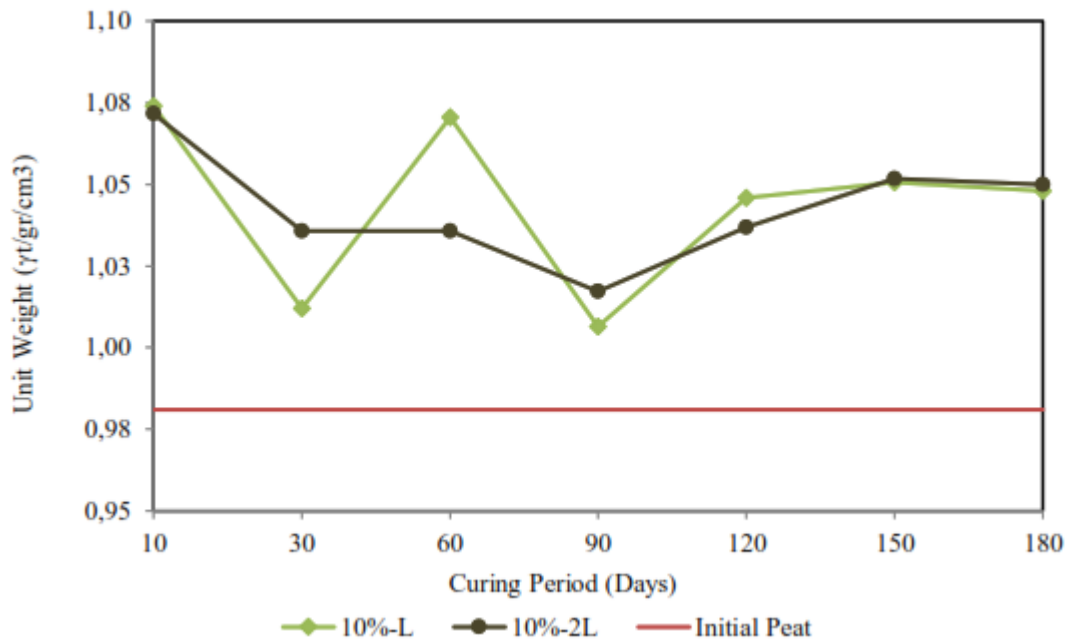


Fig 9. Specific Gravity (G_s) of Stabilized

This was possible because the CaSiO_3 gel's formation was slightly hampered by the water level in the peat pore, which continued to decrease (Figure 8), thereby affecting the G_s value.

This leads to the initial conclusion that the stabilization area significantly impacts the peat's physical characteristics.

The engineering properties of the stabilized peat were examined by the following: direct shear

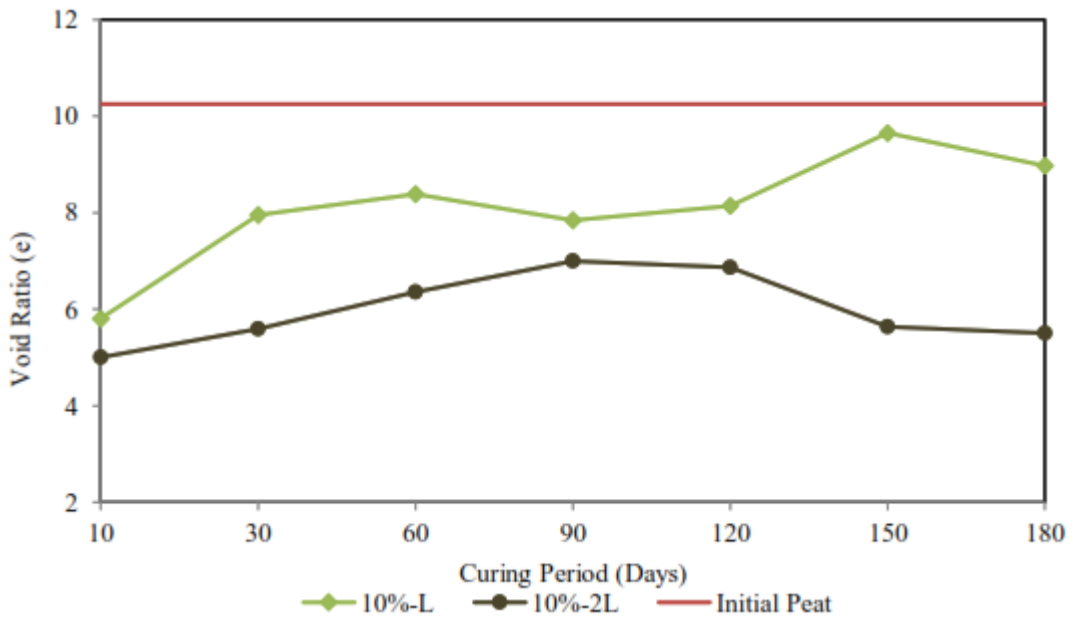


Fig 10. Void ratio (e) of Stabilized fibrous peat soil

testing to calculate the value of the internal shear angle (ϕ), the stabilized peat's shear strength using Coulomb's theory, and the use of two-dimensional consolidation to determine the amount of compression that occurred. According to previous research [7, 9, 16, 17, 18, 19, 20], the degree of peat decomposition, the distribution of the fibers within the peat, and the peat's water content all have a significant impact on the shear strength of the core peat soil. Figure 11 shows the value of the shear strength of stabilized peat with a traffic load of 50 kPa.

At the beginning of the stabilization, there was an increase in the shear strength value of the peat soil. However, these values were not constant, specifically for a period of fewer than 90 days. The shear strength behavior earlier claims that the CaSiO_3 gel formation process, which filled the peat pores and enclosed the peat fiber, was in the early stages of development and easily influenced by water filtration from the environment [5, 14].

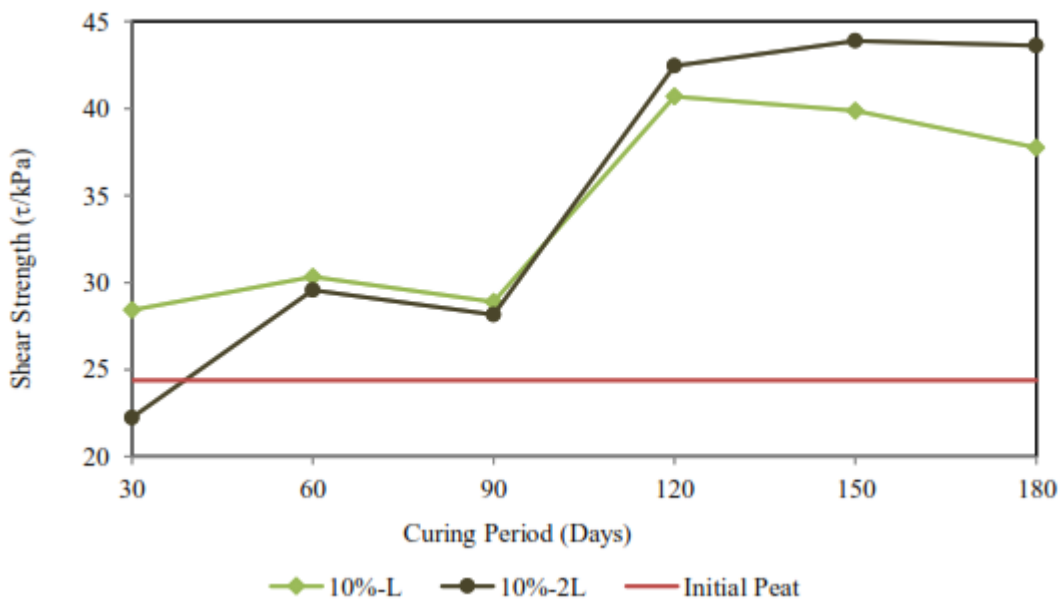


Fig 11. Shear Strength (τ) of Stabilized

When the peat soil has been stabilized for longer than 90 days, an increase in shear strength was more noticeable (120-180 days). However, there was a slight decrease in the stabilized L-width peat's shear strength value after 120 days (although still above the initial shear strength). This behavior indicated that the formation of CaSiO_3 gel is significantly influenced by the stabilization area's width and the amount of water present in the peat pores. This assertion is supported by the shear strength value, which decreased slightly due to unstable water conditions in the peat pores during the stabilization period of 180 days.

The compression behavior of stabilized peat is shown in Figure 12. Furthermore, the degree of compression of stabilized peat soil at the early days of the stabilization (90 days) varied much similar to the behavior of other stabilized peat soil parameters. There was also a decrease in the compaction of the stabilized peat soil when the stabilization period was above 90 to 120 days, where the CaSiO_3 gel formed could withstand the working load. At 180 days, the value of the stabilized peat compression increased very slightly. This was caused by either the availability of excess water in the peat pore of the L-width stabilization area or the lack of water in the peat pore of the 2L-width area.

perfect because of the influence of water filtration from the surrounding peat in the process of forming calcium silicate crystals.

2. The peat soil's engineering and physical properties can be greatly enhanced by stabilization.
3. The width of the stabilization area is quite influential on the values of the physical and engineering properties of the stabilized peat soil, specifically on the availability of water in the peat pores.
4. The physical and engineering properties of the stabilized peat soil began to stabilize after 90 days and this was because the CaSiO_3 gel formation also began to stabilize. However, it remains reliant on the water in the peat pores.

6. ACKNOWLEDGEMENTS

This research was funded by the Directorate General of Higher Education, Ministry of Education and Culture of the Republic of Indonesia, through Basic Competitive Basic Research Grant Fund 2022. This research is the first year of a two-year plan. We are very grateful to the Directorate General of Higher Education for the funds provided to be able to continue previous research which is expected to be able to contribute to the development

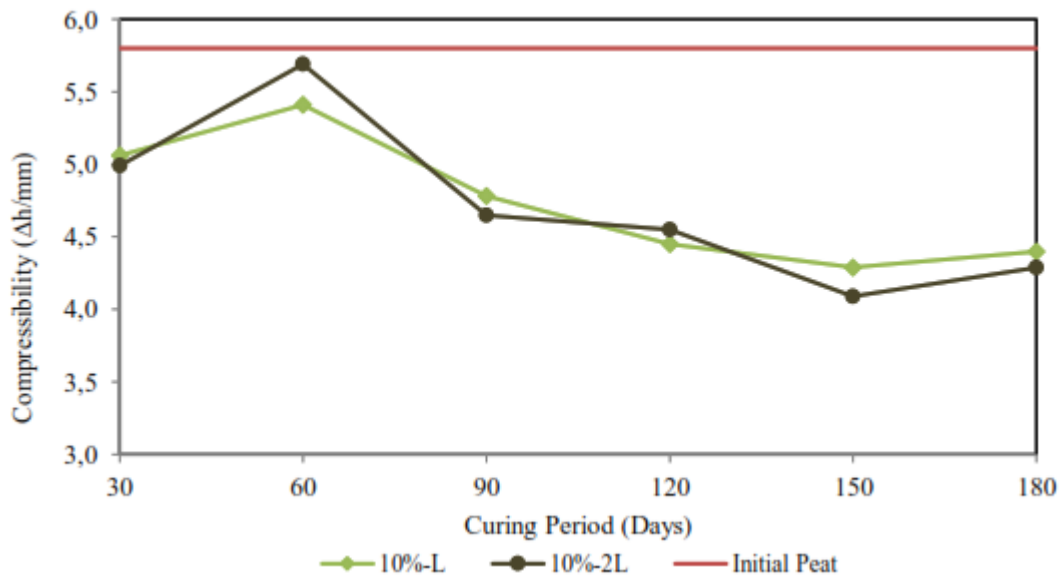


Fig 12. Compression (Δh) of Stabilized Fibrous Peat

5. CONCLUSION

The following conclusions can be drawn from the physical and engineering behavior of peat soil stabilized with a mixture of lime (CaCO_3) and fly ash:

1. The addition of stabilizer can form a calcium silicate gel (CaSiO_3) which can fill the pores and wrap the peat fiber even though it is not

of peat soil improvement technology for highway construction.

7. REFERENCES

- [1] Yulianto, F.E. and Mochar. N.E. (2016). The Effect of Curing Period and Thickness of The Stabilized Peat Layer to The Bearing Capacity and Compression Behavior of Fibrous Peat.

- ARPN Journal of Engineering and Applied Sciences, Vol. 11, No. 19, October 2016. Page: 2150-2153.
- [2] Ma'ruf, M.A., Faisal Estu Yulianto, Mila Kusumawardani, (2022). Utilization of Lime and Rice Husk Ash for Peat Soil Stabilization in Different Water Content, Condition. IOP Conf. Series: Earth and Environmental Science 999 (2022) 012028., doi:10.1088/1755-1315/999/1/012028.
- [3] Yulindasari Sutejo, Anis Saggaff, Wiwik Rahayu, and Hanafiah, (2017). Physical and chemical characteristics of fibrous peat. AIP Conference Proceedings 1903, 090006 (2017); <https://doi.org/10.1063/1.5011609>.
- [4] Ali Hauashdh, Radin Maya Saphira Radin Mohamed, Juanidah Jaelani, and Junita Abd Rahman, (2020), Stabilization of Peat Soil Using Fly Ash, Bottom Ash and Portland Cement: Soil Improvement and Coal Ash Waste Reduction Approach., IOP Conf. Series: Earth and Environmental Science 498 (2020) 012011 doi:10.1088/1755-1315/498/1/012011.
- [5] Mochtar. N.E. and Yulianto, F.E. (2017), Behavior Change in Peat Stabilized with Fly Ash and Lime CaCO₃ Due to Water Infiltration, ARPN Journal of Engineering and Applied Sciences, Vol. 12, No. 17, October 2017. Page: 4967-4972.
- [6] Yulianto, FE., Mochtar, NE., (2018). Compression of Fibrous Peat Stabilized with Admixtures of Lime CaCO₃ Rice Husk Ash and Lime CaCO₃ Fly Ash, International Journal on Advanced Science Engineering Information Technology, Vol. 8, No. 3.
- [7] Mohammed, K.H. Radwan, Foo Wei Lee, Yoke Bee Woon, Ming Kun Yew, Kim Hung Mo, and Soon Han Wai, (2021). A Study of the Strength Performance of Peat Soil: A Modified Cement-Based Stabilization Agent Using Fly Ash and Polypropylene Fiber. *Polymers Journal* 13, 4059. <https://doi.org/10.3390/polym13234059>.
- [8] Mochtar, NE, Yulianto, FE., Satria, TR., (2014), Pengaruh Usia Stabilisasi pada Tanah Gambut Berserat yang Distabilisasi dengan Campuran CaCO₃ dan Pozolan, *Jurnal Teknik Sipil ITB (Civil Engineering Journal ITB)*, Vol. 21, No. 1, Hal 57-64.
- [9] Yulianto, F.E., Mochtar. N.E., Ma'Ruf, M. A., (2022). Physical And Engineering Properties of Peat Soil Stabilized with The Admixture of CaCO₃+Rice Husk Ash Due To Water Infiltration From Surrounding Areas. *Journal of Applied Engineering Science*, Paper number: 20(2022)1, 929, 276-284, doi:10.5937/jaes0-32003.
- [10] Brendan C. O'Kelly, (2017), Measurement, interpretation and recommended use of laboratory strength properties of fibrous peat, *Geoengineering Research*, Volume 4 Issue GR3.
- [11] ASTM Annual Book (2018), Standard Classification of Peat Samples by Laboratory Testing (D4427-2018). Book of Standards Volume: 04.08, DOI: 10.1520/D4427-18, ICS Code: 65.080.
- [12] Standar Nasional Indonesia/indonesian national standard (SNI 8460-2017), Persyaratan Perancangan Geoteknik, Badan Standar Nasional Indonesia.
- [13] Adnan Zainorabidin, Mohamad Niizar Abdurahman, Azman Kassim, Mohd Firdaus Md Dan Azlan, Siti Nooraiin Razali, and Engku Shahrulerizal Engku Ab Rahman, (2019), Settlement Behaviour of Parit Nipah Peat Under Static Embankment, *International Journal of GEOMATE*, Aug 2019, Vol.17, Issue 60, pp.151-155
- [14] Yulianto, F.E., and Widodo, B., Modelling of Crystal Growth in Peat Soil Stabilized with Mixing of Lime CaCO₃ and Fly Ash, *International Journal of Civil Engineering and Technology*, Volume 10, Issue 03, March 2019, pp. 349-360, ISSN Print: 0976-6308 and ISSN Online: 0976-631.
- [15] Peraturan Menteri Lingkungan Hidup Dan Kehutanan Republik Indonesia Nomor 6 Tahun 2021 Tentang Tata Cara Dan Persyaratan Pengelolaan Limbah Bahan Berbahaya Dan Beracun (Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 6 of 2021 concerning Procedures and Requirements for Management of Hazardous and Toxic Waste)
- [16] S.N.M. Razali, A.Zainorabidin, I. Bakar, and H.M. Mohamad., (2017), Strength Changes in Peat – Polymer Stabilization Process; An Introduction of New Material for Peat Condition, *International Congress on Innovations in Civil Engineering –ICE 2017*.
- [17] Nadhirah Mohd Zambri; Zuhayr Md. Ghazaly. (2018) Peat Soil Stabilization using Lime and Cement., *E3S Web of Conferences* 34, 01034 (2018), <https://doi.org/10.1051/e3sconf/20183401034>.
- [18] Norhaliza Wahab; Mohd Khaidir Abu Talib; Munzilah Md Rohani. (2019). An Introduction of Tropical Peat and Its History Of Shear Strength In Malaysia. *International Journal of Civil Engineering and Technology (IJCIET)*, Volume 10, Issue 05, May 2019, pp. 695-705, Article ID: IJCIET_10_05_071.
- [19] Ratna Dewi, Wiliam Morgan, Ira Zunita, Yulindasari, and Maulid M. Iqbal, (2019). Effect Of Deep Soil Mixing to Increasing

Bearing Capacity on Peat Soil. International Journal of GEOMATE, Nov. 2019 Vol.17, Issue 63, pp. 126 -132; ISSN: 2186-2982 (P), 2186-2990 (O), Japan, DOI: <https://doi.org/10.21660/2019.63.24554>.

- [20] Anis Anisha Suhaimi and Habib Musa Mohamad., (2021). Settlement Behaviour of Stabilised Peat: An assessment With Eco-Processed Pozzolan (Epp) In Modified Electro-Osmotic Triaxial Cell. International

Journal of GEOMATE, Dec. 2021, Vol.21, Issue 88, pp.86-96 ISSN: 2186-2982 (P), 2186-2990 (O), Japan, DOI: <https://doi.org/10.21660/2021.88.j2296>

Copyright © Int. J. of GEOMATE All rights reserved, including making copies unless permission is obtained from the copyright proprietors.
