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Effect of Eco-Processed Pozzolan (EPP) Mixed with Calcium Oxide to Dry Density and Physicochemical of Peat Soil

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Abstract

Peat is a problematic soil, and it is a common problem faced by engineers in construction. The characteristics that have been noted before are high moisture content, poor shear strength, great compressibility, and long-term settlement. For this research study, it focuses on stabilizing peat soil using EPP and CaO. There are three main tests that were conducted in this research study: index properties testing, compaction testing, and For Index Properties testing, five (5) experiments were conducted to study the index properties of disturbed peat soil, which are moisture content, fiber content, liquid limit, organic content, pH, and specific gravity. Next, for the Compaction Test, using a 4.5 kg rammer, define the optimum mixture of stabilizer that is mixed with different volumes of 5%, 10%, 15%, and 20% of stabilizer. In this study, the expected result is to inspire an in-depth study of the use of EPP material and chemical CaO as peat soil stabilizers for better utilization of problematic soil. The main finding was that the mixture with the exact amount of moisture, EPP, and CaO helped stabilize the soil and cure peat soil. Thus, this study confirms the idea of treating peat with EPP and CaO, enhancing the properties of peat soil, and sustaining the settlement over loading for a period of time accordingly. 20% mix of EPP and CaO produces the highest dry density, showing that dry density increases linearly with the amount of mixture to stabilize peat. The crystallization process between peat and EPP was pronouncedly observed where smaller particles identified as EPP filled the gaps in between the pores identified from SEM. The silicon (Si content developed from each spectrum ranged from 14.4% to 17.7%. The EDX results show significant results where mineral crystallization occurred in the coagulation process.

Keywords: Peat; Calcium Oxide; Stabilization; Coagulation; Crystalization; Eco-Processed Pozzolan.

1. Introduction

All soils with an organic matter content greater than 20% are called organic soils. Peat is part or all of the decayed remains of dead plants that have accumulated under water for tens of thousands to thousands of years. Due to various factors such as source fiber, temperature, and humidity, the content of peat soil varies from place to place. Peat soil is organic soil with an organic content of more than 75% [1]. Peat is a mixture of fragmented organic matter formed in wetlands under appropriate climatic and topographical conditions. It comes from vegetation that has undergone chemical changes and fossilization [2]. The soil is usually used for the construction of dams, dikes, and other soil structures. Foundation improvement is a fast-growing area because the good sites that can be built are increasingly limited [3].

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Therefore, soil is a key component of the construction industry. Soft soil has high water content and low workability, which will increase the cost and duration of soft soil projects [4]. It is known that soft soil has low strength and high compressibility, and the known water content almost reaches its liquid limit [5]. Peat soil was originally problematic and belongs to high-organic soil [6]. Due to its abnormally high water level, peat will deform greatly under an applied load. High content and organic nature are also peat soil characteristics. Compared with mineral soils with similar water content, peat also has very high strength. In order to build a safe, stable, and usable road, road engineers must overcome these engineering problems and find suitable solutions to build roads on peat soil. Peat is affected by instability issues, such as local subsidence and the development of sliding damage. Even in the case of a moderate increase in load, it will withstand a very large one-time and long-term settlement. Peat soil is a problematic soil that will become more complicated during the construction process, for example, for buildings and roads [7].

All soils with an organic matter content greater than 20% are called organic soils. Peat is part or all of the decayed remains of dead plants that have accumulated under water for tens of thousands to thousands of years. Due to various factors such as source fiber, temperature, and humidity, the content of peat soil varies from place to place. Peat soil is organic soil with an organic content of more than 75% [1]. Peat is a mixture of fragmented organic matter formed in wetlands under appropriate climatic and topographical conditions. It comes from vegetation that has undergone chemical changes and fossilization [2]. The soil is usually used for the construction of dams, dikes, and other soil structures. Foundation improvement is a fast-growing area because the good sites that can be built are increasingly limited [3]. Therefore, soil is a key component of the construction industry. Soft soil has high water content and low workability, which will increase the cost and duration of soft soil projects [4]. It is known that soft soil has low strength and high compressibility, and the known water content almost reaches its liquid limit [5]. Peat soil was originally problematic and belongs to high-organic soil [6]. Due to its abnormally high water level, peat will deform greatly under an applied load. High content and organic nature are also peat soil characteristics. Compared with mineral soils with similar water content, peat also has very high strength. In order to build a safe, stable, and usable road, road engineers must overcome these engineering problems and find suitable solutions to build roads on peat soil. Peat is affected by instability issues, such as local subsidence and the development of sliding damage. Even in the case of a moderate increase in load, it will withstand a very large one-time and long-term settlement. Peat soil is a problematic soil that will become more complicated during the construction process, for example, for buildings and roads [7].

Eco Process Pozzolan (EPP) is made by calcining Spent Bleaching Earth (SBE), which is a by-product of the edible oil manufacturing process. It is recently used as a blended cement, and the pretreatment method of palm oil generates SBE as waste material in the refinery plant [10]. Peat soil treated with EPP will transform its qualities from peat to usable soil. However, the presence of moisture will reduce the mixture's ability [11]. Peat is considered one of the most problematic soils in the construction industry due to its poor physical, mechanical, and dynamic properties [12].

Cement stabilization is the most common stabilization method adopted for soil treatment. Chemical stabilization is a major category of soil stabilization that involves the use of chemical reagents to trigger reactions in the soil to change its geotechnical engineering characteristics [13]. In this study, the chemical stabilizer used is Calcium Oxide (CaO). CaO is naturally absorbent. For instance, at room temperature, CaO will spontaneously absorb carbon dioxide from the atmosphere, thereby reversing the reaction. It also absorbs water, converts itself into calcium hydroxide, and releases heat in the process. The bubbling that accompanies the reaction is the source of its name, "quick" or live lime. There is no study before using Cao as a stabilizer. The only calcium used for stabilizer before was Calcium Hydroxide (CaOH). Soil compaction is the process by which the soil is subjected to mechanical stress and is densified. Soil consists of solid particles and voids filled with water and air. Soil compaction is used to compact the soil by reducing the void space, or air volume, between soil particles [14]. This test is usually conducted in the lab using compactor equipment. The soil will be compacted, and its strength will be tested. In other words, soil compaction occurs when soil particles are pressed together to reduce the space between them. The resulting highly compacted soil has very little space and has a higher unit weight than non-compacted soil. On the other hand, the strength of stabilized peat increased with an increase in cement dosage and curing days [15]. Obviously, peat is in the category of problematic soil because it has low shear strength and high compressibility [16]. Furthermore, Peat has excellent water-holding characteristics and is highly fibrous due to the presence of a lot of decomposed materials and organic matter, which makes it highly compressible, weak at shear strength, and low in bearing capacity [17], which is due to the fact that peats originate from plants and denote the various stages in the humification process [18].

Peat soil is problematic soil, as every engineer has tried to avoid doing work involving this type of soil. Many problems may happen as the main cause is peat soil, such as slip failure, local sinking, and long-term settlement when load increases. Stabilizing seems like the way to solve this problem.

CaO and EPP are the chemical substances that can be used as stabilizers in order to improve shear strength and soft condition especially in very low hydraulic conductivity soils. The mixes were examined using Scanning Electron Microscopy (SEM) and X-ray powder diffraction (XRD) for phase identification of a crystalline material between peat and EPP relationships [19]. A previous study (Sulaiman et al. [20]) stated that the decrease in voids was caused by the presence of EPP in the soil mixture. It can be concluded that the presence of EPP, with its smaller particle size, has filled the previously existing void, thereby assisting in the stabilization of the peat soil. The result of this research is to inspire and in-depth study the use of EPP material and chemical Cao and calcium oxide as soil stabilizers for peat soil for better utilization of problematic soil. In addition, this research extends the previous research on peat soil and provides a method to find the possible suitable behavior of peat soil by using lime as a stabilizer and combining EPP and cement to improve its performance. The purpose of this research is to fill the gaps in the study of peat soil settlement behavior with a certain concentration of stabilizers and binders. So far, no researchers have explored this relationship between EPP and CaO to develop soft soil properties. This stabilization will help engineers understand the problems of peat soil and, in the same way, establish a new industry approach. This study was conducted based on research carried out on peat soil compaction characteristics and physicochemical changes treated with Eco-Processed Pozzolan (EPP) [11].

2. Testing and Method

Figure 1 shows the flow diagram methodology for this soil analysis. Supporting the baseline, the sequences of this analysis study were abstract theology of the matter statement, essential analysis, and also the thought that was systematically retrieved by many researchers compared to previous studies to outline their findings and judge the precise method of implementation. There were three types of testing performed to work out the objectives of this study. One of the tests is index properties testing. Index properties testing was performed to determine the wet content, liquid limit, specific gravity, pH, fiber content, and unit weight. For soil compaction tests, the testing used is with customary proctor penetrometers. The treated soil with different concentrations of EPP and CaO bears equivalent testing, and therefore the result is documented. Beaufort of Sabah is emphasizing the role of peat deposits at Klias and recently studied Sabah's peat soil from an engineering perspective. Based on some of Sabah's troublesome areas for treating peat soils, this location is recognized as a peat deposit area. The peat specimen symbol marked by the position is shown in Figure 2. The study was conducted in the Beaufort area of southern Sabah in eastern Malaysia, where there is a vast wetland area. Often referred to as the Klias Peninsula, this wetland lowland plain. Beaufort covers an area of approximately 466,804 hectares. The annual rainfall in this area is as high as 2,500 to 3,000 mm. The remaining areas of the Klias Peninsula formed larger wetlands and formed a "core" "buffer". It faces the South China Sea to the west, is surrounded by the administrative boundaries of Beaufort and Kuala Penyu District, and borders Kimanis Bay to the north and Brunei Bay to the south. This area is often referred to as a forest reserve (the red border is represented by the forest reserve in Figure 2). Some are regarded as fully covered peat swamp forests (level 1), located between 115˚.45'-115˚.72'N and 5˚.42'-5˚.15'E.

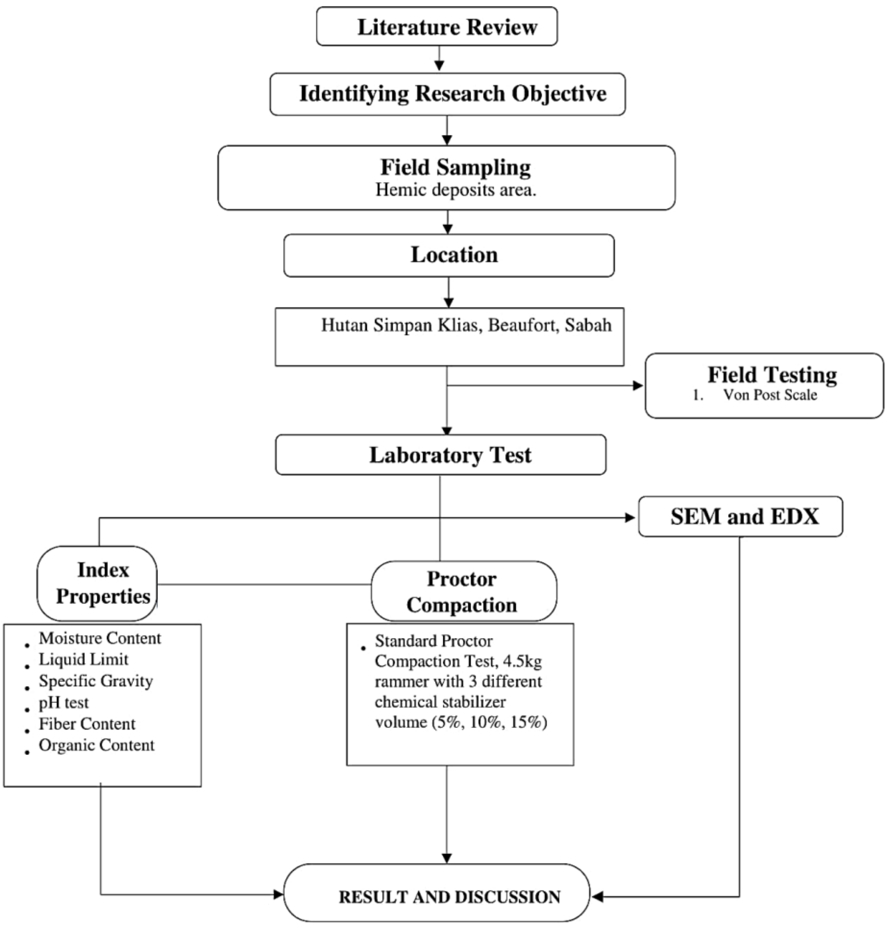


Figure 1. Flowchart of Research

Figure 2. Location of Klias Peninsular, Sabah, Malaysia

Soil samples had been taken using the excavated method. All the accrued soil was installed in numerous massive containers. The handiest trying out that is held at Klias is the Von Post Test. It takes miles to determine the humification scale of the peat soil. The Von Post scale is easy to use. A handful of moist soil (small enough to cowl with the palms on one hand) is squeezed very hard until as much as feasible has extruded through the palms. Color and viscosity of exudate, share and situation of last fiber, and different characteristics are noted. Standard Proctor compactor for peat samples conducted for the determination of dry density. The standard Proctor test is performed to study and understand the compaction properties of soil at different moisture levels and is designed to estimate the maximum load that the soil can withstand and ultimately reduce the voids present in the soil. The method used is a 4.5kg rammer. The index properties of peat soil, such as specific gravity, moisture content, particle size distribution, in-situ density, consistency limits, and relative density, were analyzed according to BS 1377. The chemical stabilizers used are Calcium Oxide (Cao) and Eco-Processed Pozzolan (EPP). By compaction test, peat soil, EPP, and Cao were mixed and hammered using a 4.5kg hammer to test the peat soil strength after treatment with 5%, 10%, 15%, and 20% volumes of stabilizer. Loss of Ignition is one of the methods for confirming the organic content of soil. Sequential loss on ignition (LOI) is a common and widely used method to estimate the organic and carbonate content of sediments. Sequential loss on ignition (LOI) may be a common and widely used technique for estimating organic and carbonate content in sediments [21, 22]. In the first reaction, organics are converted to carbon dioxide and ash at 500–550 °C. In the second reaction, carbon dioxide is released from the carbonate at 900–1000 °C, leaving the oxide. The load loss throughout the reaction can be well measured by considering the samples before and after heating and is closely related to the organic and carbonate 102 content in the sediment [21, 22]. The method was evaluated, and it was believed that LOI provided a fast, inexpensive means of accurately determining the carbonate and organic content of clay-poor chalk sediments and rocks, while many other fine earths the same goes for chemical methods [22]. Scanning Electron Microscopy (SEM) is conducted on peat soil samples by using a focused beam of high-energy electrons to generate a variety of signals at the surface of peat specimens. With magnification 3000 times at 1 ɥm size, the energy applied is 5.0 kv. SEM tests were carried out for all peat and peat mixed with EPP specimens. Energy dispersive X-Ray (EDX) composition analysis was carried out on all design peat specimens in this research. The EDX was conducted simultaneously with the SEM.

3. Results and Discussions

It has been discovered that the moisture content of the Klias peat sample is 572.5%. The moisture content that has been observed in the previous study ranges from 491.16% to 985.3% [21]. When the ground temperature is lower, the amount of water in the soil grows and shear strength decreases; when the ground temperature is higher, the amount of water in the soil decreases and shear strength rises [23]. These discrepancies in results are due to climate change as a result of changes in temperature, precipitation, and rainfall influencing soil saturation intensity, where the water table forms in a horizontal plane and may emerge at a level greater or less than the actual water table [24]. For this research study, data has been obtained, and a graph between average penetration and moisture content has been plotted. The graph was directly proportional. It can be observed that the average moisture content among the four tests is 205%. The range of liquid limits for peat soil is 190% to 360% [25]. A study of peat soil in Parit Nipah, Johor, also discovered that peat soil liquid limits ranged from 252% to 261% [26]. In this research, the result for the fiber content test was 71.47%, which can be categorized as fibrous peat. In the study of Santisteban et al. [21], the fiber content of peat ranged from 61.61% to 79.40%.

The fiber content determined from the study is 70.45% to 76.66% [27]. The average specific gravity value obtained for peat samples is 1.47. The author discovered the specific gravity in Kampung Medan Sari Johor is 1.63, while [28] obtained a 1.24 to 1.44 specific gravity value for peat soil in Lumadan, Sabah [21]. From the previous studies, it can be compared that specific gravity for this research study is still in the range of 124 to 1.63. It can be observed that the average loss of ignition for this research study is 96%. Peat is defined by soil scientists as organic soil with a level of more than 35% organic matter. A geotechnical engineer, on the other hand, considers all soils with an organic content of more than 20% to be organic soil, whereas "peat" is an organic soil with an organic content of more than 75% [28]. Table 1 shows the index properties of peat from Klias, Sabah.

Table 1. Index properties of Klias peat soil

Properties	Value
Natural Moisture Content, w (%)	572.5
Specific Gravity (Gs)	1.47
Liquid limit, %	205
Acidity (pH)	2.3
Organic Content (%)	96
Fiber Content (%)	71.47

For this research study, the average pH value obtained was 2.3. Comparing to past studies, this research has the lowest pH value because [21] obtained peat pH values from 4 to 4.9 and [27] discovered that peat pH ranges from 3,16 to 3,71. The rate of organic decay and the depth of peat may impact the peat soil's pH variability. The breakdown indication was the von Post scale. The peat soil in KPSFC can be characterized as H6–H7, which indicates muddy to strongly muddy for the peat based on the von Post scale during the site inspection. Compaction is a mechanical procedure that increases soil density while also removing air. There is no change in the size of the individual soil particles, and no water is lost. The goal of purposeful compaction is to increase the strength and stiffness of the soil. A laboratory compaction method is employed, which is based on the Proctor Method and uses a 4.5 kg rammer. Referring to past studies, the moisture content of peat is more than 100%. Zolkefle (2014) [29] discovered that the peat moisture content (untreated) in Parit Nipah, Johor, is 315%.

The moisture automatically decreases because of the drying process that hydrates the moisture in peat soil. Next, due to the compaction process, all air voids and moisture decreased because it was compacted using a 2.5 kg rammer. Figure 3 shows the relationship between moisture content and dry density. The graph trend seems inversely proportional, which means that if the moisture content of peat increases, the dry density decreases. At low moisture content, the soil particles get lubricated. The soil mass becomes more workable, and the particles have closer packing. Lastly, the R^2 value in the graph is 0.9939.

Chemical stabilization is one of the most common types of soil stabilization, and it involves the application of chemical agents to start reactions inside the soil that change its geotechnical properties. In this study, Cao and EPP were used to treat peat soil in order to reduce moisture content and increase dry density. The treatment strategy was replacement, with 5 percent, 10%, 15%, and 20% of CaO and EPP in the peat sample being replaced. The highest moisture content calculated from four tables was 116.67% with 20% replacement peat, and the lowest was 47.73% with replacement of 5% EPP and CaO. The replacement of CaO and EPP should strengthen the bond between the soil particles and hydrate the moisture from peat. Some of the moisture content for treated peat in this research still shows a high percentage. This issue arose as a result of CaO's reaction with water. According to the modern view of chemical reactions, bonds between atoms in the reactants must be broken, and the atoms of the molecules must be reassembled into products by forming new bonds. As a result of the CaO reaction with a large amount of water, the particles of water become larger and the peat moisture increases. The mixture also became warmer as a result of the exothermic reaction that occurred during the CaO reaction with water. The amount of water applied also contributes to the peat's moisture content. Instead of adding 50 ml of water continuously until 200 ml, it should be adjusted to have water added just to trigger the mixture and chemicals added to react with the peat soil. The suggested value of water added is 100 ml. Other than that, the reaction time may not be enough to make sure the chemical reacts or reaches its full potential to stabilize the soil. The peat soil was immediately tested after being compacted.

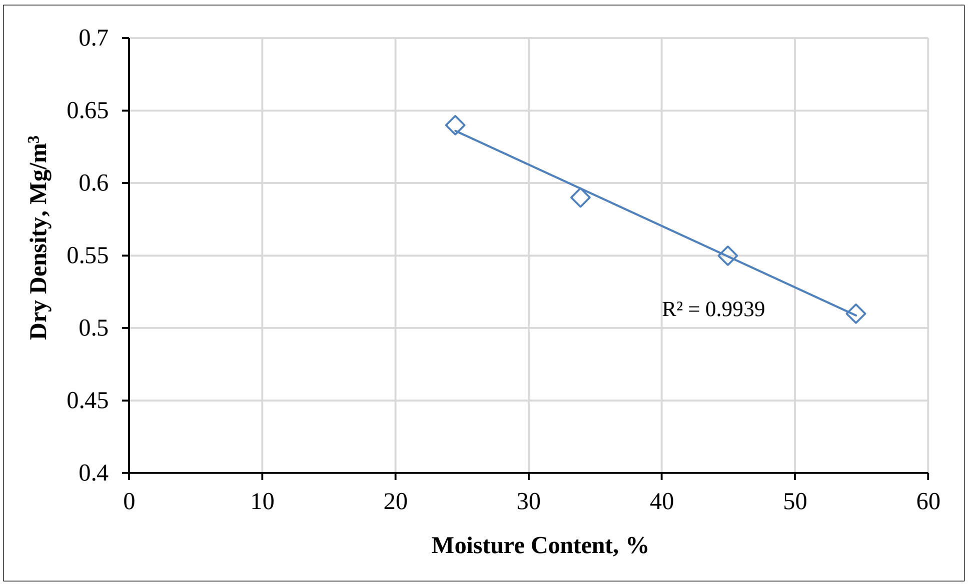


Figure 3. Graph Moisture Content vs. Dry Density (Untreated Peat)

Figures 4–7 show a graph between moisture content and dry density. After the peat samples were treated with CaO and EPP using the replacement method, respectively, 5%, 10%, 15%, and 20%, according to Figure 8. The highest dry density obtained from these 4 different percentages of replacement peat with chemicals and binder was 0.57 at 5% and 20%. All the graph trendlines show the same trend, which is inversely proportional. The r2 value obtained for 5% of replacement was 0.9898, 10% of replacement was 0.9989, 15% of replacement was 0.9812, and 20% of replacement was 0.9830. For dry density in the research study, the trendline in the comparison graph is decreasing. The optimum was taken from the middle because of the decreasing trendline. Dry density cannot be too high and too low. It is because if the soil is too dry, then any construction is not suitable to be held on it. From this research, the optimum mixture for EPP and CaO is 15%.

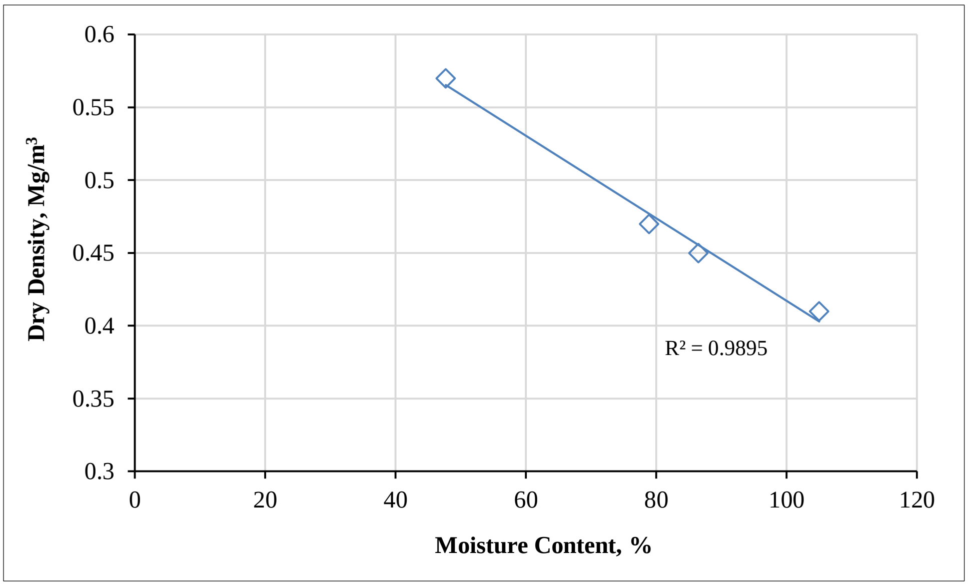


Figure 4. Moisture Content vs. Dry Density (5% CaO)

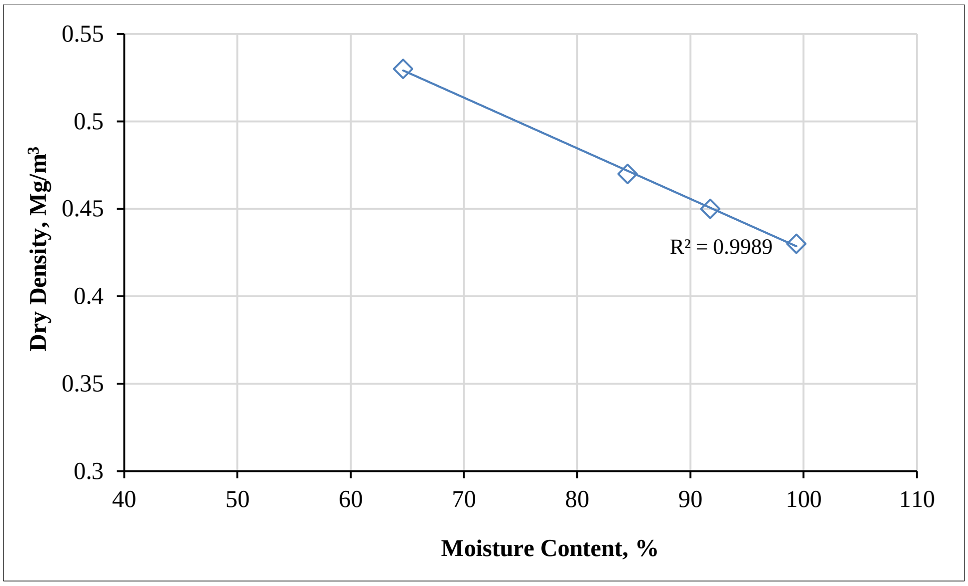


Figure 5. Graph Moisture Content vs. Dry Density (10% CaO)

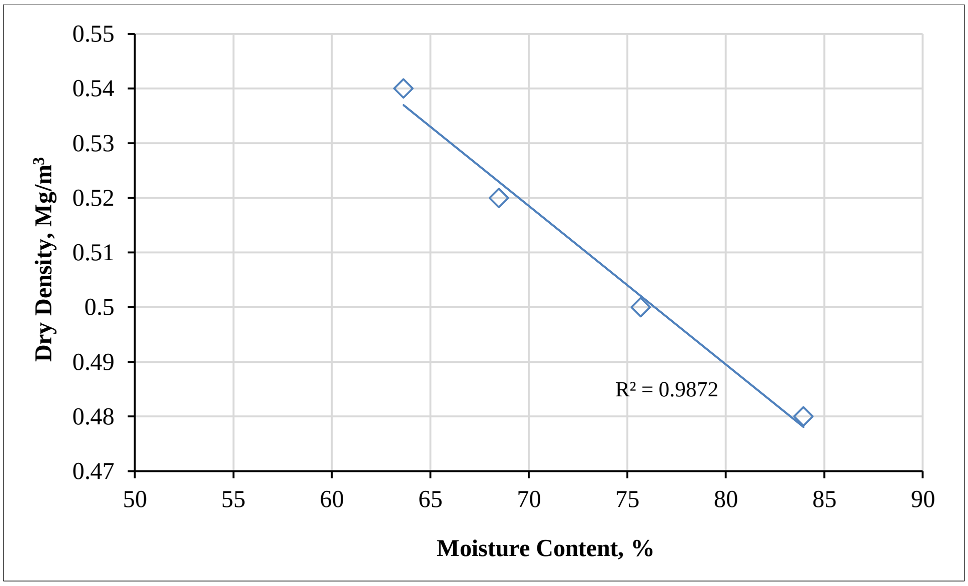


Figure 6. Graph Moisture Content vs. Dry Density (15% CaO)

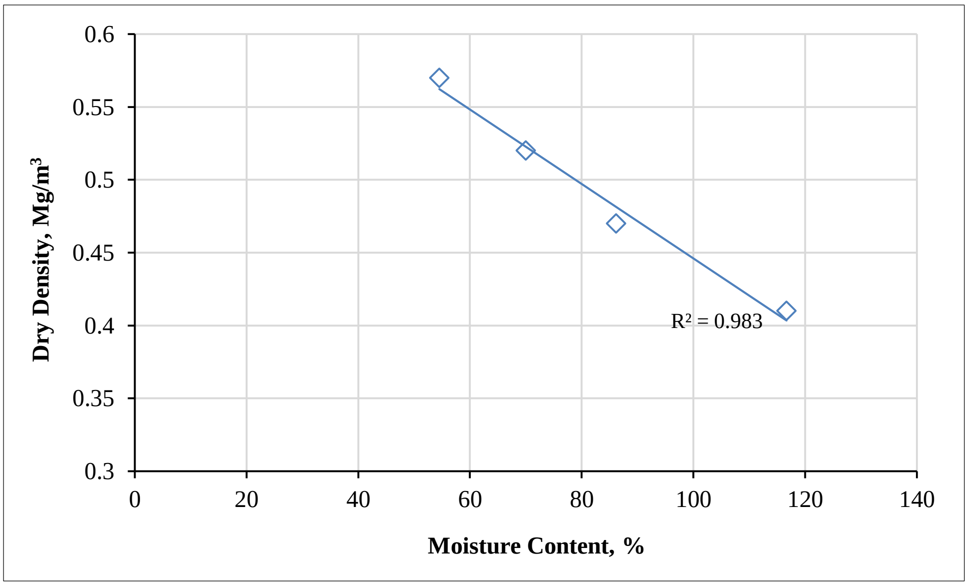


Figure 7. Graph Moisture Content vs. Dry Density (20% CaO)

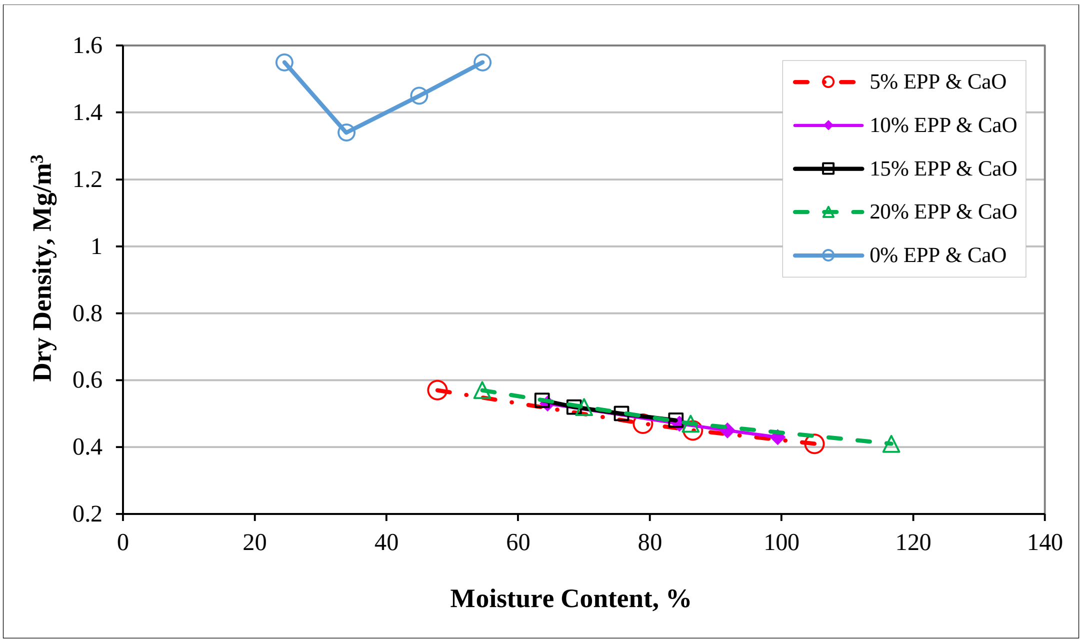


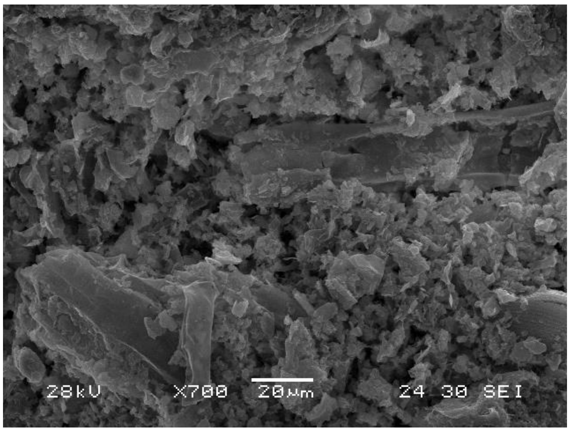
Figure 8. Graph Moisture Content vs. Dry Density (5%, 10%, 15%, and 20%)

There are past research studies proving that stabilizing peat soils using chemical stabilizers is successful. Lime, in the form of quicklime, is Calcium Oxide (CaO), and hydrated lime is Calcium Hydroxide (CaOH2). Both can be used to treat soils, as stated by the National Lime Association (2004). Sometimes the term "lime" is used to describe agricultural lime, which is generally fine limestone, a useful soil amendment but not chemically active enough for soil stabilization. In other words, Lime (Calcium Oxide), which is derived from limestone, chalk, or (where available) oyster shells, continued to be the primary pozzolanic, or cement-forming, agent until the early 1800s, as stated by Encyclopedia Britannica. Quicklime is manufactured by chemically transforming Calcium Carbonate (CaCO3). Hydrated lime is created when quicklime reacts with water. Lime has a considerable influence on decreasing the limits of liquid and plasticity. The result is shown in Figures 9 and 10.

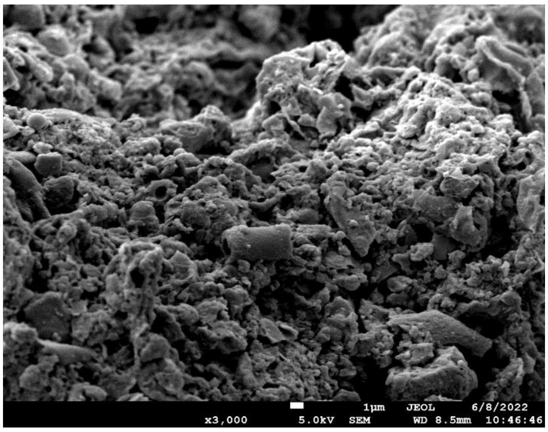
Providing that, the scanning Electron Microscopy (SEM) images for all designated samples are shown in Figure 9. As a result, Figure 9-a shows the untreated peat sample without EPP. The origin peat observed highly voids, pores, and spaces in between the peat structure. It has unrecognized materials. However, the improvement is seen throughout the specimens treated with EPP, as shown in Figures 9-b to 9-e, coagulated with CaO and EPP particles. This statement is in line with finding [18]. The crystallization process between peat and EPP was pronouncedly observed where smaller particles identified as EPP filled the gaps in between the pores. The higher the amount of CaO and EPP, the more specimens coagulated with peat. This process is believed to be the crystallization of minerals between peat and EPP elements. The coagulation process between peat and EPP produces mineral combinations with various elements, as shown in Figure 10. The Energy dispersive X-ray analysis (EDX) spectrum of peat and CaO + EPP residue adsorbent is depicted in three (3) spectra. Each mineral seen was developed from spectrum 1 to 3, as shown in Table 2. The higher the CaO and EPP ratio mixed in peat, the lower the carbon and c content in the studied specimens.

Table 2. Peat soil chemical elemental treated with CaO

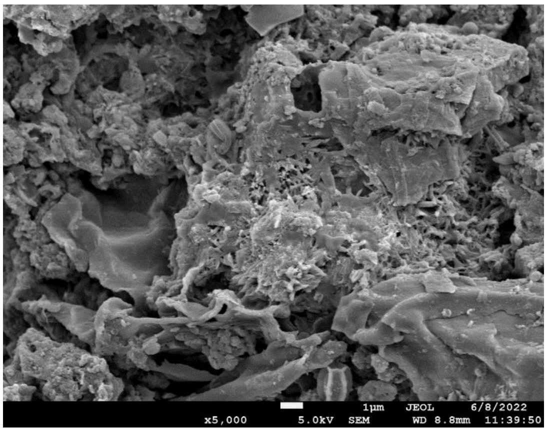
Properties	Peat soil + 5% CaO			Peat soil + 10% CaO			Peat soil + 15% CaO			Peat soil + 20% CaO		
Spectrum	1	2	3	1	2	3	1	2	3	1	2	3
C	81.2	69.8	69.2	68.4	74.5	40.9	37.3	17.0	23.3	33.3	31.5	32.0
O	16.1	27.7	29.1	20.7	22.4	35.8	42.1	52.5	55.4	40.3	27.3	30.3
Ca	0.9	1.8	1.1	0.9	2.4	3.3	0	0.8	1.8	1.1	1.9	5.4
Si	0.8	0.4	0	0.2	0.1	2.6	3.4	17.9	14.3	14.4	22.6	17.7
P	0.5	0.1	0	0.9	0	1.3	0.8	1.4	0.9	1.6	0	1.6
S	0.4	0.4	0.3	0.6	0.3	0	0.4	0	0.2	0	0	0.5
Mg	0.1	0.1	0.1	0.1	0.2	2.4	0.7	2.5	0.8	1.8	2.2	2.1
K	0.1	0	0	0.3	0	0.5	0	1.0	0.2	1.0	0.7	1.3
Fe	0	0.1	0.1	0.1	0.1	3.3	0.6	2.1	0.6	2.6	7.0	5.1
Ai	0	0	0.1	0	0.1	2.6	0.7	4.6	2.6	3.6	6.4	3.7



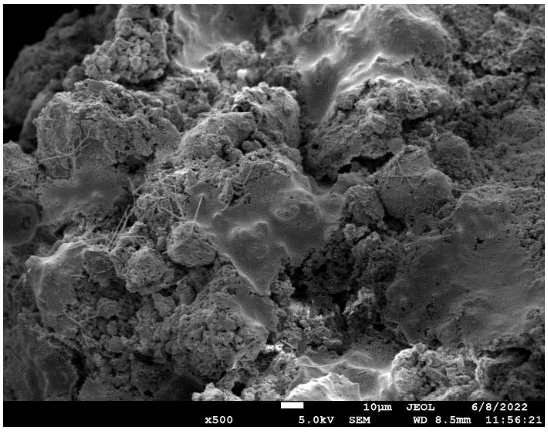
(a) Peat soil



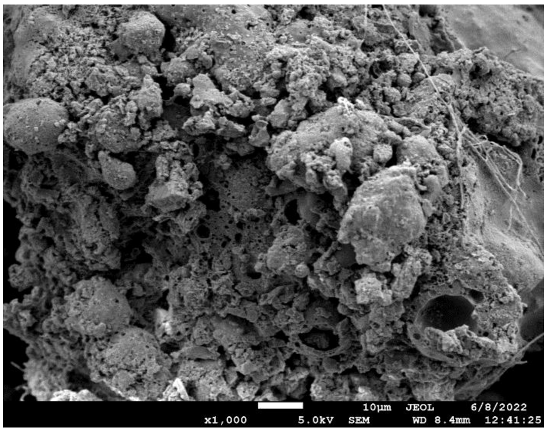
(b) Peat soil + 5% CaO



(c) Peat soil + 10% CaO

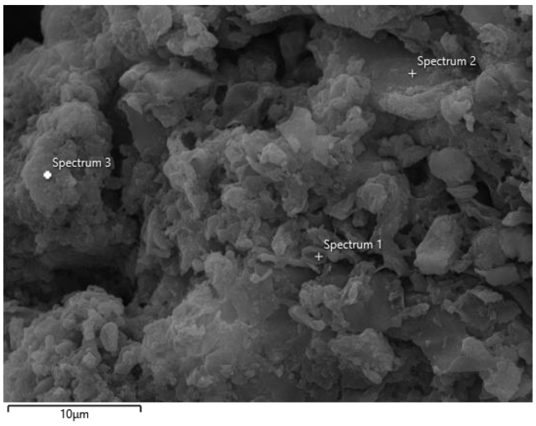


(d) Peat soil + 15% CaO

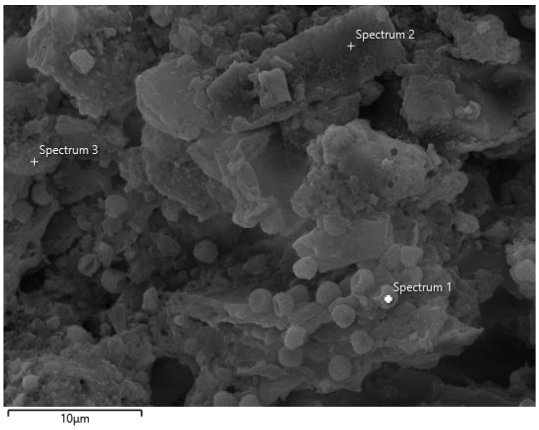


(e) Peat soil + 20% CaO

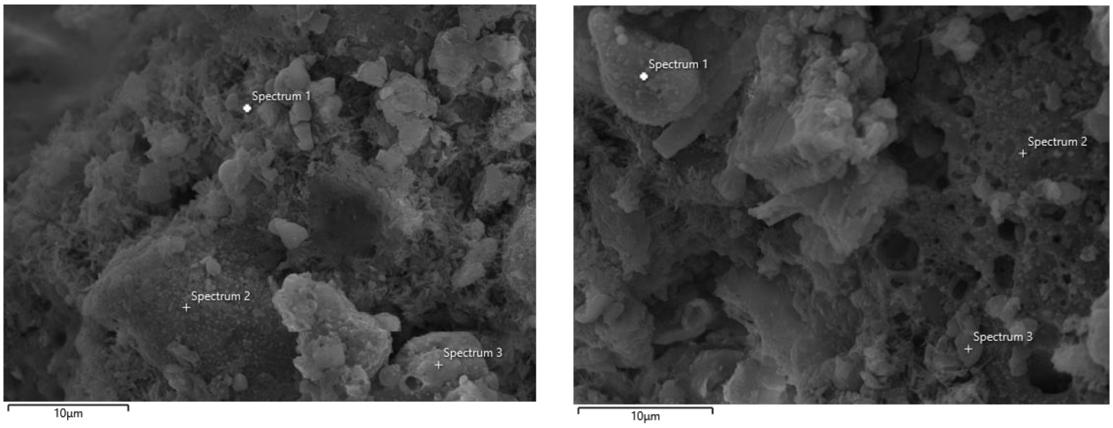
Figure 9. SEM Images for treated peat with CaO and EPP



(a) Peat soil + 5% CaO



(b) Peat soil + 10% CaO



(c) Peat soil + 15% CaO (d) Peat soil + 20% CaO

Figure 10. Energy dispersive X-ray analysis (EDX) spectrum of peat and CaO and EPP residue adsorbent

The silicon and Si content developed from each spectrum, as can be seen in Table 2. The higher the CaO + EPP ratio, the more Si content developed. This reaction is parallel to the crystallization process that binds CaO + EPP with a peat-derived structure. It has been proven that the coagulation process developed between peat and CaO + EPP, and somehow, other elements seen as inconsistent show the peculiarity of peat soil. Peat soil seems to be different after being stabilized with an admixture. For this research, the author applied Calcium Oxide and EPP as stabilizers. The potential of CaO and EPP as stabilizers has been discovered in the peat stabilization process. However, a recent study conducted [15] to stabilize peat using cement found that adding cement to natural peat changed its strength and structure. It was also discovered that increasing the cement dosage and extending the curing period resulted in treated peat soil with higher strength for all types of peat. While the improvements identified in the phase of a crystalline material between peat and EPP and cement in peat soil [13, 30]. As shown in Figure 9, the SEM Images for treated peat with CaO and EPP show both materials well compacted and bonded together. The void between peat particles is filled with mixtures of EPP and CaO, as shown in Figures 9b to 9d. The crystalline process is shown in Figure 10, where the Energy dispersive X-ray analysis (EDX) spectrum of peat and CaO and EPP residue adsorbent are well blended as the additive materials attached to the peat particles. This shows that both additives' materials can be bonded with the peat particles and fill the gap.

4. Conclusion

Moisture content, pH, specific gravity, liquid limit, organic content, and fiber content are among the index qualities tested. The result of this research shows that the moisture content of the sample is 572.5%. The results are then compared to previous studies to ensure that the value obtained is within the acceptable range (and to make sure there was no error during the testing). Following that, four samples of peat soil were analyzed for pH to determine the peat's average pH value. The average peat pH is 2.3, which is due to the high acidity content of peat. For this study, a liquid limit test was performed utilizing the cone penetration method. The relationship between average penetration and moisture content is represented on a graph. According to previous studies, the moisture content of the liquid limit is 205% and is still within range. Furthermore, a simple calculation was used to determine the fiber percent in the fiber content test. The type of peat can be determined by the fiber percent, and the peat soil in this study is fibrous since the value is greater than 67%, and this research obtained 71.47% as the fiber content value. The specific gravity value for this study was 1.47, which is still within the range of previous studies. Organic content testing utilizing Loss of Ignition (LOI) revealed a value of 96%, which is still within the range of previous tests. Peat soil can be confirmed as a problematic soil as compared to regular soil based on the findings of this study. All of the testing results were deemed acceptable because the values were nearly identical to the earlier findings. Some factors, such as site location and agricultural operations, have an impact on the little difference in value obtained.

Peat soil has been categorized as a soil with high settlement when subjected to loading for a period of time because of its properties. This finding has revealed that there is only a small difference that can be seen after the peat soil has been stabilized. CaO and EPP are added to the peat, changing the properties of the peat. The result showed positive changes in peat behavior after treatment. Despite the positivity, peat also increases the water content with the addition of moisture. The evidence from this research suggests that peat soil treated with EPP and Cao will change the properties of peat into usable soil, but the addition of moisture will lower the ability of the mixture. The main finding was that the mixture with the exact amount of moisture, EPP, and CaO helped stabilize the soil and cure peat soil. Thus, this study confirms the idea of treating peat with EPP and CaO, enhancing the properties of peat soil, and sustaining the settlement over loading for a period of time accordingly because if the dry density is high, the moisture content will be low. From the SEM results, each mineral seen was developed from spectra 1 to 3, which are related to the coagulation and crystallization processes for stabilizing peat soil. The higher the CaO and EPP ratio mixed in peat, the lower the carbon and c content in the studied specimens. The EDX results show significant results where mineral crystallization occurred in the coagulation process. The elements improved from spectrum 1 to 3, respectively.

5. Declarations

5.1. Author Contributions

Conceptualization, H.M.M. and M.S.J.; methodology, H.M.M.; investigation, M.S.J.; writing—original draft preparation, H.M.M., M.S.J., S.N.F.Z., A.E.A., T.N.M.F., and A.Z.; writing—review and editing, H.M.M., M.S.J., S.N.F.Z., A.E.A., T.N.M.F., and A.Z. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available in the article.

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5.5. Conflicts of Interest

The authors declare no conflict of interest.

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