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Stabilization of Peat Soil with Vegegrout

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Abstract:. A common issue in the construction industry is peat soil. Peat soil is very soft soil with a very low bearing capacity and is quickly compressible if the load is acting on it. Peat soil can produce significant ground settlement when loaded. This study added bacteria-producing vegetable waste to peat soil in order to assess how this addition affected the compressive strength of the peat soil. Vegetable waste is sourced from traditional markets in the city of Pekanbaru, while the original peat soil was acquired from Kualu Nenas Village, Kampar Regency, Province Riau. CaCl2 and urea are the additives that are employed. The variants of Vege waste to the specimen in the amounts of 0%, 15%, 20%, 25%, and 30%, the shear strength test was conducted. Results testing the physical properties of the original peat soil found that the soil originated from the village location Buana Makmur km 55, Dayun District, Siak Regency, is a type of peat soil with a water content of 351.092% and specific weight (Gs) = 1.530. the highest shear strength value is found in the addition of 20 % vege waste of 0,98 kg/cm^2

Keywords: Peat soil, vege-grout, bearing capacity, shear strength, vegetable waste

1. Introduction

One of the predominant terrain types in Southeast Asia is peatlands. There are 35 million hectares of this type of land in the region, the most of which is in Indonesia, Malaysia, Brunei Darussalam, Thailand, and Vietnam, with lesser areas in Myanmar, Lao PDR, and the Philippines. The location and condition of peatlands in these wetland forests primarily emerged between large rivers in coastal lowland plains. Southeast Asia had a peat soil pattern for the past 18,000 years, while the peat in Indonesia was consistent with 5,000–8,000 years ago. This peat soil is framed in areas that have been submerged in water for a considerable amount of time. With 20 million hectares of peatland, Indonesia ranks fourth worldwide in the broadest category of peat land, behind Canada, Russia, and the United States. In particular, Sumatra accounts for 35%, Kalimantan for 32%, Sulawesi for 3%, and Papua for 30% of Indonesia's peatland circulation. Peatlands typically occur in the 7.2 million hectare-sized wetlands along the east coast of the island of Sumatra. Riau is the province having the most peatland on Sumatra Island. [1], [2], [3], [4], [5].

A common issue in the construction industry is peat soil. Peat soil is very soft soil (very soft soil) with a very low bearing capacity and is easily compressible if the load is acting on it. Peat soil can produce significant land settlement when loaded. The higher the organic content, the lower the bearing capacity and shear strength, and the greater the compression, which poses a basic issue as a result of the loading on the peat soil layer. In contrast to clay soil, where compression happens quickly, peat soil undergoes a slow process of compression, the degree of compression brought on by a soil layer's consolidation. [6], [7],[8]

Chemical grouting has been researched for its many potential uses, including the preservation of limestone monuments, blocking the pores of oil recovery reservoir rocks, removing contaminants from groundwater systems, mending concrete cracks, lowering the potential swelling of clayey soil, mitigating the potential liquefaction of soil, and controlling and improving soil permeability.[9], [10], [11]

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Calcite precipitation techniques have been proposed as the alternative method for improving the engineering properties of soil. Enzyme-mediated calcite precipitation (EMCP) may be one of the promising methods. The unconfined compressive strength of treated sand ranging from 200 kPa to 1.6 MPa, depending upon the amount of precipitated calcite, can be achieved, and the permeability of the improved samples can be reduced by more than one order of magnitude. In this technique, an enzyme of urease is employed to dissociate the urea into ammonium and carbonate ions. The produced carbonate ions are precipitated as calcium carbonate crystals in the presence of calcium ions. [12], [13], [14]

The Bio-Vege Grout contains microorganisms which precipitate the calcite or calcium carbonate (CaCO3) around each and every particle of the soil by going through some chemical reactions. Thus, this method is economical and at the same time has low impact on the environment. Bacteria and fungi are most commonly found in the waste as the waste starts to decompose. This formation of calcite on the grain will increase the stiffness and the cohesiveness among particles. A thin layer of calcite will form on the particle and the gap and voids between the particles which water can fill during an earthquake leading to liquefaction. Indirectly, the strength of the soil will increase in order to withstand the loading. [15], [16], [17], [18], [19], [20]

An enzyme-reagent mixed solution from bacteria (i.e., purified urease and CaCl2-urea), that created the hastened calcite after the substance response, is infused into the dirt. The hastened calcite may give spans between the grains of sand, confining their development, and thus, improving the solidness and the strength of the dirt. A schematic of the entire interaction recorded above, and grouting instrument expected are represented in Fig. 1. [19], [20]

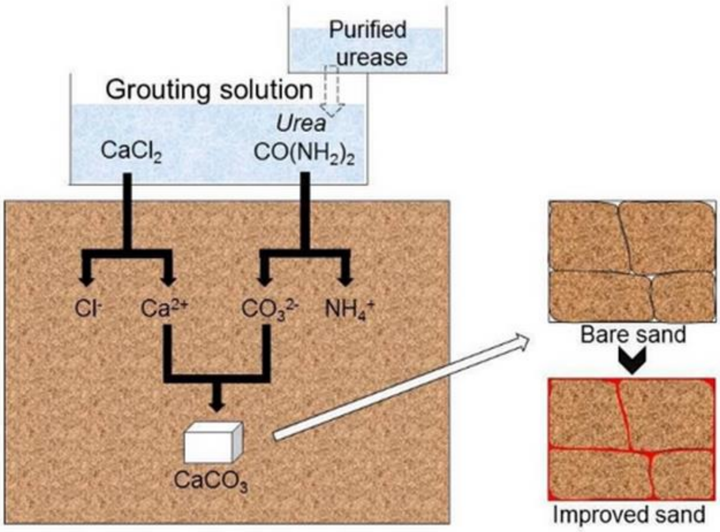

Fig. 1 - Process of calcite precipitation process on MICP technique [14]

2. Material and Method

2.1 Material

2.1.1 Peat Soil

The soil sample (see Fig. 2) that the researchers will use in this research is peat soil. Sample of peat soil used for research is in non submerged conditions and in a wet state. Soil samples were taken at a depth of ± 50 cm from ground level. After the soil sample taker is located, it is then taken to a civil engineering laboratory. The soil sample is exposed to sunlight in order to dry. After the soil sample is dry, it is then filtered using sieve no.4. The purpose of filtering is to separate waste or roots that are still in the soil sample.

Fig. 2 - Peat soil

2.1.2 Reagent

The reagents used in this research are CO (NH2) urea, and CaCL2, and vegetable waste is used as a grouting material as seen in Fig. 3. Urea is a chemical compound containing high level Nitrogen (N). The Urea looks like white crystal grains. Urea has the chemical formula NH2 CONH2, which is a compound easily soluble in water, and can easily absorb water (hygroscopic). The vegetable grout used comes from waste mustard greens, which are have been fermented and left for several days.

(a) (b) (c)

Fig. 3 - Reagents include CaCL2 (a) vege waste (b) CO (NH2) urea (c)

2.2 Method

2.2.1 Preliminary Testing

The initial research process was carried out by a preliminary test which was a test to obtain the physical properties of the soil. This test aims to check the soil conditions to match the ground conditions in the field. Water content testing (ASTM D 2216-98) was carried out to obtain the percentage of water weight against the dry soil weight. Examination of specific weight (ASTM D 854-02) test was carried out to obtain the specific weight of the soil, which is the ratio of soil weight to water weight. Testing of the soil mechanical properties was carried out with the Proctor test (ASTM D 698) to obtain the optimum moisture content and maximum density. Then the data was used as a comparison to the soil density in the test.

2.2.2 Making Sample

The steps for making a sample of the compressive strength of the soil according to the sample size on the unconfined compression strength test (UCS) are mentioned below:

1) Soil samples that pass sieve No.4 were taken according to the bulk density which had been obtained as 48.7 gr, then added with the optimum water content, which is 41.3 gr. In compaction standard, the total sample weight was 90 gr. Then the sample was stirred until evenly distributed.

2) The sample that had been stirred evenly was then divided into 3 portions, with a weight of 30 grams each, and then put into a cylindrical tube divided into 3 layers gradually, one layer at a time. After that, the sample was pressed with a sondir tool to the limit which is determined.

3) Samples that were completed were then removed from the cylinder tube as seen in figure 4.

Fig. 4 - Making of soil sample

2.2.3 Making Sample of Vegetable Grout from Vegetable Waste and Reagent

The process of turning vegetable waste into bacteria was as follows:

1) Collection of mustard greens waste. Mustard vegetable waste was obtained from the local market.

2) Cleaning up the mustard greens waste that had been collected

3) Decomposition of mustard greens waste. After the mustard greens waste was clean, it was drained, then put into plastic bags and closed tightly so that no dirt or insects could enter, which might interfere with the process of fermentation of the vegetables.

4) Waste mustard vegetable extraction process. After the vegetables experienced decay, they were then cut and put in the blender, given a little water to facilitate the crushing process, and blended. After that, the blended mixture was filtered in order to separate vegetable extracts from vegetable waste. Then, urea and calcium chloride were dissolved in the vegetable extract liquid. The new mixture of vegetable waste extract and urea and calcium chloride was then stored in jerry cans, closed tightly, and covered with tarpaulin to protect it from sunlight. See Figure 5.

Fig. 5 - Vege Grout from vege waste

2.2.4 Mixing of Soil Sample and Vegetable Grout

The steps for mixing the test object with Vege grout were as follows:

1. The test object had been inserted into an airtight plastic bag was removed and weighed. Then, it was returned into the plastic bag.

2. The weight results of the specimen were multiplied by the percent Vegetable grout. In this test, mixtures of Vege grout (15%, 20%, 25% and 30%) were used.

3. The vegetable grout was then dropped onto the sample whose weight was 90 grams and this weight was multiplied variations percentage (15% = 13.5 ml, 20% = 18 ml, 25% = 22.5 ml, 30% = 27 ml), by dripping it from the upper surface of the test object until the Vege grout seeped into the ground.

4. After it finished dripping, the airtight plastic was closed again, then it was stored for 14 days.

2.2.5 Main Testing

The main test was carried out after the preliminary and process tests of mixing the test object using Vegetable grout. Tests were carried out to determine the compressive strength of peat soil that had been mixed with Vege grout. In this test the mixing of Vege grout on the test object with variations percentages 0%, 15%, 20%, 25% 30% of the weight of the test object. This test started from the test object that has 0% Vege grout or the original soil test object up to the test object mixed with 30% Vege grout. The following were the work steps for testing the shear strength of the test object using triaxial:

1. The first thing to do was check the tools before use, and also prepare silicon to be used.

2. Installation of silicone on the sample before being placed on the test equipment.

3. Samples that had been installed with silicone then placed on the tool test, lowering the glass cover first.

4. After being placed on the test equipment, then the sample to be tested was tightly closed with a glass tube.

5. Furthermore, the sample to be tested was fully immersed in water in the glass tube.

6. When it was up to standard, the ON button was pressed to start the test.

7. Then the researcher read the movement of the numbers seen up to later the sample being tested experienced a decreasing value from its maximum value.

8. After completing the test, the tested sample came out of the triaxial tool seen in figure 6.

Fig. 6 - Main testing of compresive strength by triaxial test

3. Result and Discussion

3.1 Preliminary Testing

Preliminary testing was carried out before the implementation of the test major in Civil Engineering Laboratory of Islamic University of Riau. Preliminary testing The tests carried out include compaction testing (Proctor Test), specific weight testing (Gs), and testing of original soil moisture content (peat soil).

3.1.1 Compactor Test (Standard Proctor)

Compaction Test / Proctor Test, Compaction testing was carried out in accordance with ASTM standard procedures D698-78 provided that soil compaction was carried out in the laboratory to determine the optimum moisture content and maximum dry density . The results of the compaction test (proctor test) can be seen on the compaction test graph in Figure 5.1.

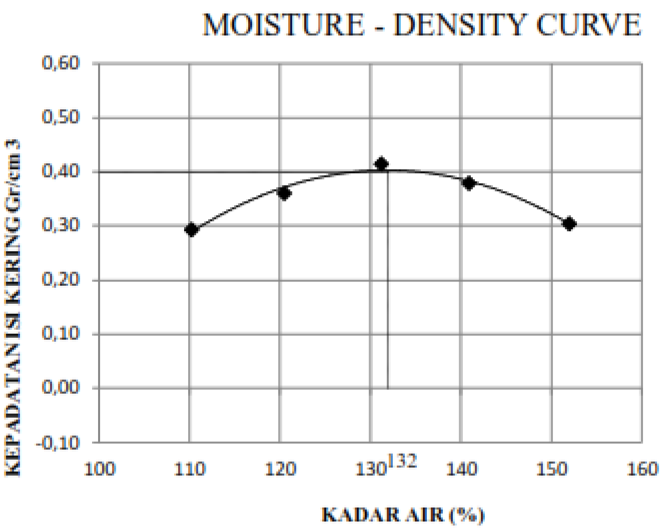

Fig. 7 - Proctor Standar

3.1.2 Soil Physical Properties

Based on the results of the tests that were carried out, Soil physical properties can be summarized. The results of the physical properties of peat soil can be seen in the table.

Table 1 - Physilcal propertiles of peat soil

No	Physical Properties	Magnitude	Unit
1	Specific Gravity	1,53	-
2	Water Content	351,092	%
3	Unit Weight	0,4	Gr/cm^3
4	Optimum water content	132	%

3.1.3 Grain Size Distribution Test

Examination of the gradation of the test object was carried out according to ASTM D-1140 procedures to determine the division between fine and coarse aggregate grains (gradations) with using a filter. In this test the weight of the test object was 134.5 gr. The results of the sieve analysis examination of the test object on filter No.4, No.10, No.20, No.40, No.80, No.100, and No.200 obtained grain diameter sizes according to SNI 3423-2008. In figure 8 it can be seen that the largest percentage the amount of soil that passes in this test is found in sieve no.4, was 100%, while the largest percentage is retained by peat soil found in sieve no.200 was 3.05%. The results can be seen in figure 8 below.

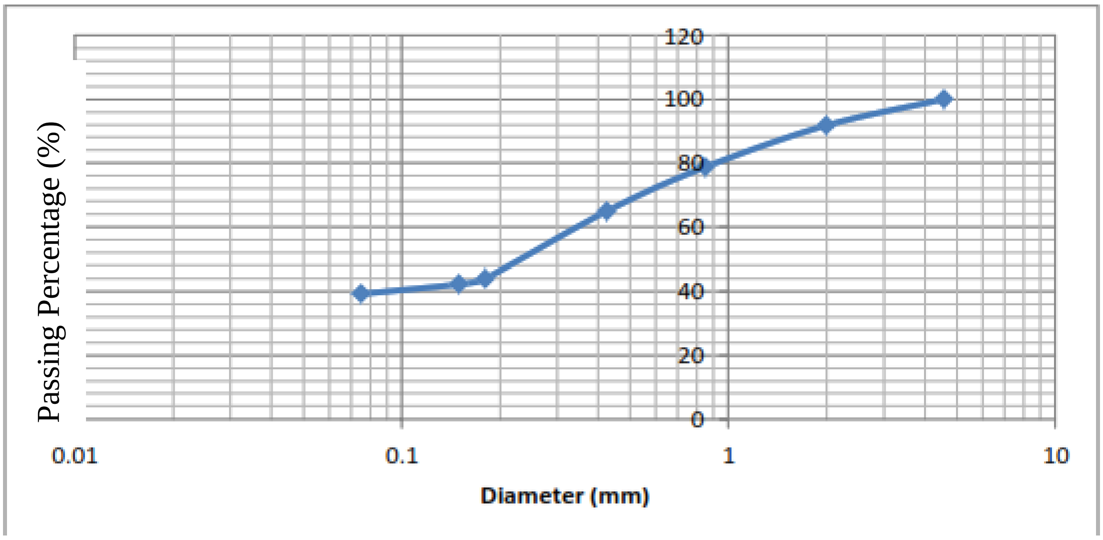

Fig. 8 - Grain Size Distribution Result

3.2 Main Testing

This test was carried out using the Vege grout method with inject mustard greens waste which is made into cementation solution with peat. The following is the percentage of addition of cementation solution to test object, which is equal to:

1. Sample A = 0%
2. Sample B = 15%
3. Sample C = 20%
4. Sample D = 25%
5. Sample E = 30%

Unconsolidated undrained type triaxial testing on samples with 1three percentage samples, namely for cell stress (σ3)=0.5kg/cm2 , cell tension (σ3)=1kg/cm2, cell tension (σ3)=2kg/cm2. Triaxial testing aims to get the value of the cohesion parameter (c) and the internal shear angle (φ). Results testing can be seen as follows.

Table 2 - Result of Shear Strength Parameter

No	Sample	Variation %	inner shear angle (φ).	Cohession (kg/cm^2)
1	Sample A	0	2,366	0,022
2	Sample B	15	4,486	0,051
3	Sample C	20	21,538	0,231
4	Sample D	25	11,409	0,550
5	Sample E	30	15,417	0,014

Shear strength analysis was carried out for the coulomb formula assuming the normal stress on the failure plane (σ) was constant at 2 kg/cm2 seen in table 3.

Table 3 - Calculation of shear strength analysis on the UU Triaxial Test

Sample	c (kg/cm^2)	φ (˚)	τ (kg/cm^2)
A	0,022	2,366	0,10
B	0,051	4,486	0,20
C	0,231	21,538	0,98

D	0,550	11,409	0,94
E	0,014	15,417	0,55

From the results of the shear strength analysis obtained in this study, the peat soil injected with Vege grout experienced an increase compared to the original soil. The highest shear strength value was found in peat soil injected with 20% mustard greens vege grout, which was 0.98 kg/cm2. on peat soils that were not injected with vege grout, mustard greens obtained a shear strength of 0.10 kg/cm2.

4. Conclusion

From the results of the research conducted, the effect of the addition of vegetable grout on the shear strength of peat soil by testing the triaxial test and the results obtained were that there was an increase in the shear strength value at the percentage of 20% vegetable grout, and after that there was a decrease, but the value of shear strength at a percentage of 25%, 30 % is greater than 0%. The shear strength results without 0% mustard greens vegetable grout treatment were 0.10 kg/cm2. The highest shear strength value was found in the addition of 20% vegetable out of 0.98 kg/cm2. Whereas in the 15% treatment it was 0.20 kg/cm2, and the 25% treatment was 0.94 kg/cm2, and the 30% treatment was 0.55 kg/cm2. Based on the results of the study it can be concluded that the addition of vegetable grout to peat soil has an effect on the shear strength given to the test object, as it was found that there was an increase in shear strength in peat soil injected with vegetable grout according to the percentage variation that had been set.

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