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TENSILE STRENGTH OF AALCALIZED OIL PALM EMPTY FRUIT BUNCH FIBER AND ITS IMPACT ON FIBER RESISTANCE IN SOIL

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ABSTRACT

Soil is a material that has an important role in a construction or foundation, so that soil with good technical properties is needed. However, in reality, soil properties are often found to be unfavorable. The use of natural fibers, especially the fiber of oil palm empty fruit bunches (OPEFB) is used for soil stabilization, where there are two mechanisms to increase soil strength, namely tensile strength and soil fiber friction.

This study aims to test the tensile strength of fibers that have been alkalized with NaOH compounds. Next, the OPEFB fiber is added to soft soil, compacted statically, and its compressive strength is tested. All test results were compared with the results of previous studies where the fibers used were not treated.

The tensile strength of the fiber treated with curing in the soil from 1 day to 28 days old, both open and closed conditions was constant and increased up to 7.23%, this condition was better than untreated fiber where the tensile strength decreased with increasing fiber age. when soaked in the soil decreased by 60.11%. Meanwhile, the compressive strength increased with increasing age of the samples both in closed and open conditions, using a mixture of OPEFB fibers that had been treated and without treatment, the compressive strength samples aged 1 day to 7 days experienced an increase of 81.46%.

Keywords : soil stabilization, soft clay soil, the tensile strength of fibers, durability

1. INTRODUCTION

Indonesia has varied soil conditions. Soil is a material that has an important role in a construction or foundation, so soil with good technical properties is needed. However, in reality, soil properties are often found to be unfavorable. Sometimes, like in Indonesia, due to limited land for development, it is unavoidable to carry out construction on soft clay soil. Because of this, it is necessary to improve soil properties by adding certain materials. Stabilization is one option to overcome this condition. Soil stabilization is intended to improve the properties of the original soil by adding natural fiber from oil palm empty fruit bunches (OPEFB), which results in changes to the properties of the original soil (Arifin et al., 2019). Research on the use of empty palm fruit bunch fiber for soil stability has been done before. The research focused on the strength of a mixture of soft soil and empty oil palm fruit bunches. The strength of the soil mixed with fiber has increased due to the process of increasing soil strength with time, which is followed by an increase in the shear stress between the fibers and the soil (Astawa, 2021). From previous studies, it is known that OPEFB fiber in a mixture of soft soils can increase soil strength, and it is also known that the increase in shear stress between the fibers and the soil is known. It's just that in that study, the fiber used was not treated. Even though the results of this study can be improved by adding treatment to the fiber of empty palm oil bunches, Sodium Hydroxide has been used for delignification with different concentrations and temperatures, so the highest yield was obtained at 30˚C with 90 minutes in NaOH N, with lignin that was reduced in the fiber of empty oil palm fruit bunches by 45.8%, hemicellulose that decreased by 35.6%, and increased cellulose by 15.6% (Tsabitah et al., 2014). Based on the facts above, soil stability using OPEFB fiber is influenced by fiber content, fiber length, water content, fiber characteristics, fiber diameter, soil properties, and stress conditions (Arifin et al., 2019). This study aims to test the tensile strength of fibers treated with NaOH. Next, the OPEFB fiber is added to soft soil, compacted statically, and its compressive strength is tested. All test results were compared with the results of previous studies where the fibers used were not treated.

2. THEORETICAL STUDY

Soft Clay Soil

Soft clay soils are new alluvial deposits, which are thought to have formed over the past 10,000 years by visualizing the flat and amorphous surface of the soil. Soft clay soils have low shear strengths (c_u < 40 kPa) and high compressibilities (c_c between 0.19 and 0.44). Soft clays usually have a high natural moisture content (usually around 40–60%) with a plasticity index of around 45–65%. Soil with the characteristics listed above will cause serious problems in geotechnical engineering, such as problems with stability and settlement of the soil. One problem that often occurs is in highway construction, namely problems with soft subgrades (Karim et al., 2016).

Soil Stabilization

Soil stabilization is an effort made to improve a layer of soil and increase the carrying capacity of the soil by giving special treatment to the soil layer. The goal of stabilization is expected to fulfill one of the following four goals: first, to increase the carrying capacity of the soil. Second, to reduce (improve) subsidence.Third, to improve or decrease the soil's permeability and swelling potential. Fourth, to maintain the potential of the existing land (existing strength), of the four objectives for soil stability above, they are very rarely fulfilled simultaneously, but efforts are always made to achieve the desired parameters without causing damage to other parameters (Panguriseng, 2001). In general, in geotechnical engineering, soil stabilization is divided into three types: mechanical methods, chemical methods, and physical methods. Compaction and consolidation are mechanical methods based on mechanical efforts. By increasing the most commonly used soil density, the compressibility of the soil is reduced, which is followed by an increase in the carrying capacity and stability of the soil. The addition of additives in the form of binders (cement, lime) is mixed in the soil, which then changes the properties and strength of the soil in a chemical way. While the physical method involves strengthening the soil with materials such as geotextiles arranged in soil layers (Arifin et al., 2019).

Soil Improvement with Waste Material (Waste Mix)

Many innovations have emerged that have been developed by many people for improving soil by mixing waste material with layers of soil that have a small carrying capacity, such as peat and clay soils. (Arifin et al., 2019) conducted a study using natural fiber from empty oil palm bunches for stabilization of soft soil, showing that the soil density increased to 7% fiber content with a density of 0.92 g/cm3. A smaller density is obtained at 8% fiber content. When the soil has started to become plastic (i.e., the water content is less than the liquid limit), bonds between the fibers and the soil have started to form. The more fibers, the higher the bonding of soil fibers due to pulling. whereas at 8% fiber content, the interaction between soil and fiber decreases because the amount of fiber reduces the bond between soil and fiber. In this condition, compaction is difficult, and large pores appear in the sample. The compacted cob mixture succeeded in increasing the shear strength and bearing capacity of soft soil, as indicated by the results of the UCT, laboratory propeller, and CBR tests. The soil consistency changed from soft to medium soil.

Oil Palm Empty Fruit Bunches

Oil palm (Elaeis guineensis Jacq) is a monocot plant that usually grows to about 20 m in height. Indonesia and Malaysia are the world's two largest palm oil producers. The waste from oil production in the form of empty palm oil bunches is biomass waste that is burned as the main energy source for power generation at the palm oil mill itself or commonly used as organic fertilizer through natural decomposition (Paridah et al., 2015).

Natural Fiber Treatment Methods

The remaining waste from the processing of palm oil into various types of food is left behind. Some of the residue from the processing of oil palm is usually used for plantation and livestock purposes. As for one of the remaining solid wastes from palm oil processing, namely empty palm fruit bunches (EFB), Besides being easy to obtain, OPEFB fiber is an economical material as an alternative mixing agent to stabilize clay soils, which is expected to increase soil strength. With different concentrations and temperatures of sodium hydroxide for delignification, the highest yield was obtained at 30 C with 90 minutes on 1 N NaOH, which reduced lignin in OPEFB fiber by 45.8%, hemicellulose by 35.6%, and cellulose by 15.6% (Tsabitah et al., 2014).

3. RESEARCH METHODS

1. Preparation of tools and materials
2. Separation of OPEFB fiber samples
3. Testing the property index of soft clay soil samples in the Soil Mechanics Laboratory, Faculty of Engineering, ULM, Banjarbaru.
4. SEM characteristics test on OPEFB fiber
5. Alkalization treatment with a 1 N NaOH solution on OPEFB fiber
6. Test the SEM characteristics again on the treated OPEFB fiber samples.
7. Preparation of samples of the tensile strength of ripened OPEFB fibers
8. Preparation of soil compressive strength samples with a mixture of fibers
9. Testing the tensile strength of the ripened OPEFB fiber samples
10. Testing the compressive strength of soil samples with fiber mixtures

4. RESULT AND DISCUSSION

In this study, the material in the form of soft clay was taken by hand boring (UDS) at a depth of 0.4 to 0.6 meters and taken with a hoe (DS) located on Jl. Gubernur Sarkawi, Banyu Hirang, Gambut, Banjar, South Kalimantan, and the empty palm fruit bunches (EFB) fiber were taken at the palm oil mill of PT. Padang Rumpun Suburabadi, Angsana, Tanah Bumbu, South Kalimantan. Regarding the research results from material property tests, fiber tensile strength tests were carried out at the Soil Mechanics Laboratory, Faculty of Engineering, Lambung Mangkurat University. Testing the tensile strength of OPEFB fibers that have been treated and aged in the soil at 1, 7, 14, and 28 days Previously, the tensile strength of the fiber had been tested. It's just that the fiber is still in a condition that requires treatment. Table 1 and Figure 2 show the data and fiber behavior with and without treatment.

Table 1 Calculation of the Tensile Strength of 1 Strand Fiber

1 Strand Without Treatment						
Number	Strand	Age (Days)	D (mm)	A (mm^2)	ε (%)	σ (N/mm^2)
1	1 Strand	1	0.3	0.0707	1.72%	116.26
2		7	0.3	0.0707	2.10%	102.11
3		14	0.4	0.1256	2.20%	57.435
4		28	0.5	0.1963	3.60%	46.949
1 Strand with Treatment						
Number	Strand	Age (Days)	D (mm)	A (mm2)	e (%)	σ (N/mm2)
1	1 Strand	1	0.226	0.0401	7.82%	179.58
2		7	0.261	0.0535	12.37%	192.61
3		14	0.262	0.0539	14.85%	168.88
4		28	0.158	0.0196	1.86%	316.38

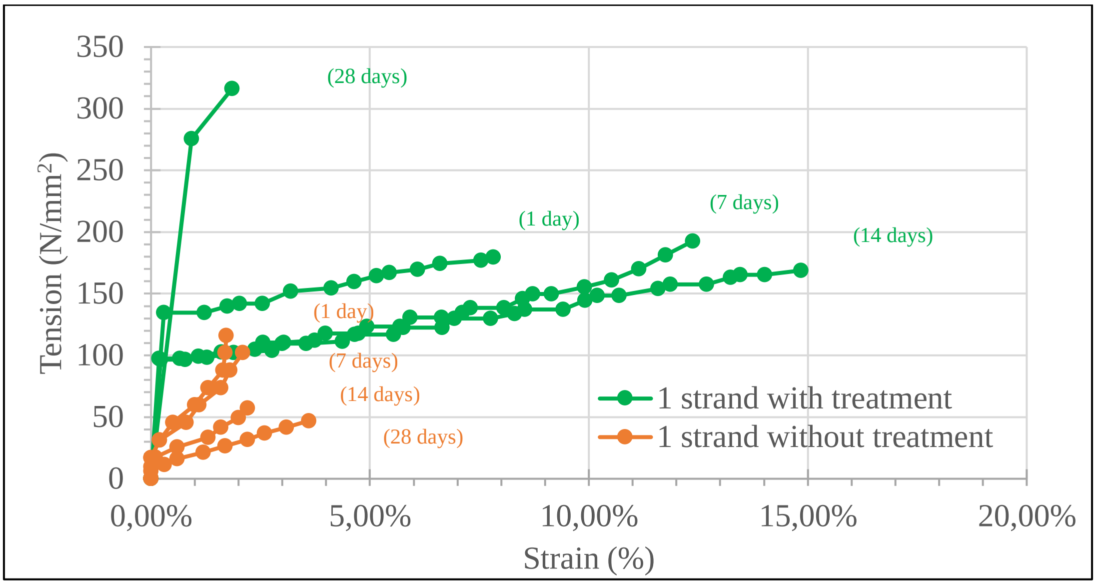

Figure 2 Graphs of Tensile Stress and Strain for 1 Strand Open Condition Without Treatment (Astawa, 2021) & with Treatment

5. CLOSING

Conclusion

The physical shape of the fiber after being treated, based on the results of SEM photos, looks finer and denser than the untreated fiber. This is because the lignin and wax layers on the fibers disappear and make the fibers stronger and slow down decay when they are aged in the soil. Meanwhile, the tensile strength of the fiber treated with curing in the soil until it was 28 days old, in both open and closed conditions, was constant and increased up to 7.23%; this condition was better than untreated fiber, where the tensile strength decreased with increasing age when the fiber was ripened in the soil, which decreased by 60.11%.

Suggestion

Following research with fiber tensile tests in woven form to describe the function of fiber in application in the field.

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