Compressive strength value of clay soil stabilization with palm oil fuel and cement

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Abstract. Mixing native soil with empty oil palm ash bunches and cement is an attempt to increase the clay soil bearing capacity. The purpose of this study was to determine the effect of adding 5% of oil palm ash and cement bunches of 0%, 5%, 7.5%, and 10%, respectively, to the value of free compressive strength. The contribution of this research can later become recommendations for handling soil improvement. The method used is the testing of the compressive strength-free soil stabilization in a laboratory that refers to SNI 3638: 2012. The results showed that the clay studied was high clay plasticity with a liquid limit value of 55.3%. The addition of empty oil palm bunches ash and cement tends to reduce the value of the soil liquid limit to 41.77% at a percentage of 5% empty oil palm bunches ash and 10% cement. The strength value of soil bearing capacity increased to 4.90 kg/cm² on 5% ash of empty oil palm bunches and 10% of cement at 0 days ripening. The carrying value of native soil is 1.96 kg/cm². The conclusion is that the addition of oil palm bunches and cement bunches ash tends to reduce the value of soil consistency and increase the value of the compressive strength of the soil. Addition of Empty oil palm bunches ash and cement can be an alternative to stabilizing clay soils.

1. Introduction

The land is a construction material whose function is as a foundation to support existing buildings or constructions. To be able to support the burden on it, the land must have good characteristics and have a good carrying capacity. Not all soil types have good soil characteristics, so they have a poor carrying capacity. High plasticity clay is one of which has a fine grain size.

Increasing the carrying capacity of soft soils by improving the soil using soil stabilization with palm oil ash and cement. Mixing native soil with empty oil palm ash bunches and cement is an effort to increase the clay soil bearing capacity. The purpose of this research is to know the effect of adding 5% of oil palm ash bunches ash and cement, respectively 0%, 5%, 7.5%, and 10% to the value of free compressive strength.

Several existing studies [1] analyze the effect of adding 7.5% of Oil Palm Bunches and 5%, 7.5%, and 10% of cement in clay soils to the CBR value [2]. Conduct an analysis of variations of the palm shell ash on clay soil [3]. Conduct an analysis of soft soil stabilization using palm fiber ash to the value of California Bearing Ratio (CBR) of land [4]. Researching about soft soil stabilization using waste paper sludge ash (WPSA) to determine compressive strength, total shear strength and effective shear strength on soft soil [5]. Research on the effectiveness of using a mixture of lime with palm fly ash to evaluate the value of California Bearing Ratio (CBR) [6]. Conduct expansive soil stabilization analysis using a mixture of bagasse ash and lime [7]. Researching the calm use of fly ash against expansive soil shrinkage by conducting California Bearing Ratio (CBR) testing [8]. Evaluate the strength and change...
characteristics of soil sediment residues mixed with bentonite (s1) when treated with three different enzymes to the free compressive strength test (UCS) [9]. The use of fly ash in soil stabilization against the California Bearing Ratio (CBR) value and the soil consistency limit [10]. Increasing expansive soils as construction materials using rice husk ash and fly ash against stress and strain values as well as the California Bearing Ratio (CBR) value [11]. Utilization of the new ternary mixed cement binder produced from high calcium laying ash (HCFA), palm oil fuel ash (POFA), and rice husk ash (RHA) for soft soil stabilization [12]. Researching soil stabilization with cement to increase soil compressive strength [13]. Researching about clay soil stabilization using oil ash to the value of compressive-free soil strength [14]. Researching clay soil stabilization with cement and nanotechnology-based additives called Road Cem (RC) [15]. Examined peat soil improvement using POFA by testing the water content, consistency limits, compaction, and compressive strength of the soil [16]. Researching about stabilization of Sarawak loam soil with fly ash on the value of compressive-free soil. The difference with previous research is the effect of adding 5% ash of oil palm and cement bunches of 0%, 5%, 7.5%, and 10%, respectively, to the value of free compressive strength.

2. Research methodology

2.1. Clay soil sample
Soft soil samples were taken in the Limbungan area of Rumbai Pesisir, Pekanbaru City at a depth of 2 m from the ground surface. Soil property testing to determine the physical properties of clay soil and compressive strength free test of clay using SNI 3638: 2012 standard.

2.2. Oil palm bunch ash and cement
Oil palm bunch ash is the main additive used for soil stabilization. Oil palm ash and empty obtained from palm oil waste and burned to get the ashes. Cement is also the main additive for soil stabilization mixtures. Testing the consistency of Atterberg clay soil stabilization with empty oil palm and cement empty ash bunches based on SNI 1966: 2008. Stress-free soil compressive strength stabilization test with empty oil palm and cement empty ash bunches based on SNI 3638: 2012. The composition of each test was 5% oil palm empty fruit bunch ash and 0%, 5%, 7.5% cement.

3. Results and discussion
The results of testing the original soil properties, the liquid limit value (LL), plastic limit (PL), and plastic index (PI) obtained from the soil taken from the Danau Buatan area of the Rumbai Pesisir of Pekanbaru City. The results can be seen in the Table 1.

**Table 1.** Properties of Pekanbaru artificial lake clay.

| Properties                  | Score  |
|-----------------------------|--------|
| Liquid Limit, LL (%)        | 55.53  |
| Plastic Limit, PL (%)       | 49.36  |
| Plastic Index, PI (%)       | 26.17  |
| Specific Weight, Gs         | 2.5    |
| Water content (%)           | 27.31  |

From the results of testing the soil properties that the Danau Buatan clay has an increase in the value of the liquid limit (LL) of 55.53%. The effect of adding 5% ash of oil palm and cement bunches of 0%, 5%, 7.5%, and 10% respectively to the soil consistency can be seen in the Table 2.
Table 2. Consistency of soil stabilization with oil palm and cement bunch ash.

| Limits of Consistency | Cement Levels (%) |
|-----------------------|-------------------|
|                       | 0                 | 5       | 7.5     | 10      |
| Liquid Limit, LL (%)  | 51.14             | 46.30   | 44.31   | 41.77   |
| Plastic Limit, PL (%) | 39.97             | 39.05   | 38.62   | 37.80   |
| Plastic Index, PI (%) | 20.69             | 18.70   | 17.21   | 16.42   |

The relationship between soil stabilization with 5% oil palm empty fruit bunch ash with 0%, 5%, 7.5%, and 10% cement to the liquid limit (LL) is shown in Figure 1.

![Figure 1. Effect of adding 5% oil palm ash bunches and 0%, 5%, 7.5%, and 10% cement to the liquid limit (LL).](image)

In general, Figure 1 shows that the increase in ash content of oil palm and cement bunches tends to reduce the liquid limit value. This is caused because oil palm and cement bunch ash can cause the soil to become larger grains so that the attractive force between particles in the soil decreases.

The relationship between soil stabilization with 5% oil palm empty fruit bunch ash with 0%, 5%, 7.5%, and 10% cement to the plastic limit (PL) is shown in Figure 2.

![Figure 2. Effect of adding 5% ash of oil palm head bunches and 0%, 5%, 7.5%, and 10% of cement to the plastic limit (PL).](image)
The addition of oil palm and cement bunches ash tends to result in a decreased plastic limit value. This is because the addition of oil palm and cement bunches ash can absorb water causing the soil to approach semi-solid. The relationship between soil stabilization with 5% oil palm empty fruit bunch ash with 0%, 5%, 7.5%, and 10% cement to the plasticity index (PI) is shown in Figure 3.

![Figure 3](image_url)

**Figure 3.** Effect of adding 5% ash of oil palm bunches and 0%, 5%, 7.5%, and 10% of cement to the plasticity index (PI).

From the Figure 3, it can be seen that there is a decrease in the value of the soil plasticity index with the addition of ash and oil palm and cement. This is due to a decrease in the value of the liquid limit (LL) and the plastic limit (PL) resulting in a decrease in the value of the plasticity index (PI).

In general, the picture of the decrease in soil consistency due to the addition of 5% ash of oil palm bunches and 0%, 5%, 7.5%, and 10% of cement can be seen in Figure 4.

![Figure 4](image_url)

**Figure 4.** Effect of adding 5% ash of oil palm head bunches and 0%, 5%, 7.5%, and 10% of cement to soil consistency.

The addition of empty oil palm bunches ash and cement tends to reduce the value of the soil liquid limit to 41.77% on the percentage of 5% empty oil palm bunches ash and 10% cement. Decrease in the liquid limit value due to the addition of oil palm and cement bunches ash can result in larger grains occurring so that the pulling force between particles in the soil decreases.

Here is a table of the results of the free compressive strength test on native soil that has been stabilized with 5% empty oil palm ash (ATSK) and 0%, 5%, 7.5%, and 10% cement (PC).
Table 3. Compressive strength value free of soil stabilization with palm bunch ash and cement.

| Sample                      | $q_u$ (kg/cm²) |
|-----------------------------|----------------|
| Native land                 | 1.96           |
| 5% (ATSK) + 0% (PC)         | 2.06           |
| 5% (ATSK) + 5% (PC)         | 3.72           |
| 5% (ATSK) + 7.5% (PC)       | 4.26           |
| 5% (ATSK) + 10% (PC)        | 4.90           |

The free compressive strength value of native soil is 1.96 kg/cm². The figure below shows the increase in the value of free compressive strength with the addition of oil palm and cement bunches ash.

![Figure 5. Effect of adding 5% ash of oil palm bunches and 0%, 5%, 7.5%, and 10% of cement to the value of free compressive strength.](image)

From the picture, it can be seen that increasing the ash content of oil palm and cement bunches can increase the value of the free pressure. The increase in the value of free compressive strength is greater to the level of 5% ash of oil palm bunches and 10% of cement by 4.90 kg/cm². This is due to the addition of ash of oil palm bunches and cement to the soil causing large clay soils to increase the compressive strength of the free.

4. Conclusion
This study concludes that the addition of oil palm and cement bunches ash to high clay plasticity can change the soil consistency which tends to reduce the soil consistency value. In the compressive-free soil strength, the addition of oil palm and cement bunches ash can increase the value of compressive-free soil.

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