Analysis of The Addition of 10% Lime on Unconfined Compressive Strenght Test of Humbang Hasundatan's Soil Peat

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Abstract. Knowledge of Civil Engineering in the field of Geotechnical engineering, especially in terms of soil stabilization, it can be used as the development and utilization of soil materials such as for soil peat in the Humbang Hasundutan district, as utilization of soil in road subgrade construction work that will be tested by Unconfined Compressive Strenght Test. This research was conducted in the laboratory with experimental tests, to get results with the addition of 10% lime from peat soil. From the result of soil testing that is carried out on the addition of 10% lime, it is obtained free compressive strength value of 0.017 kg/cm^2, and it is still classified as very soft soil strength (< 25 kg/cm^2), so it has not met the specification of highways specifications to be used as a subgrade which is categorized as min > 2.00 kg/cm^2

Keywords: Lime 10%, Peat Soil, UCS

1 Introduction

Peatlands in Indonesia are widely spread around 20.2 million hectares or 10.8% spread over Sumatra, Kalimantan and Papua with different depths and density, most of the peatlands are in Sumatra, Riau and Kalimantan [1] From this area, around 7.2 million hectares or 35% are located on the island of Sumatra.One area in Sumatra, the spesific north sumatera that has peatlands is The area of Humbang Hasundutan Regency is around 2,988 hectares. The peat soil area is divided into three districts, namely Doloksangul (1,578 ha), Pollung (931) and Lintong Nihuta (479 ha). And has a medium depth of 100-200 cm, medium category (area 2,118 ha). Depth 200 - 300cm) deep category (area 870 ha). This area of peat soil is generally still forest and grassy swamps and has Not widely used in agriculture [2]. The peat swamp land is part of natural resources that has a function to conserve water resources, flood prevention, prevention of seawater intrusion, support of various life/biodiversity, control climate through its ability to absorb and store carbon) and so on [3].

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Construction development that is always carried out in Indonesia is the construction of highways which are classified in the field of transportation. The most important part of road constructionis the type of soil that is used as a subgrade, because this soil which will support the load on it, either static load or a dynamic load [4]. In the field, technical problems are often encountered that relate about soil. One of the soils that is not good for road construction is soil peat [4] because soil peat is one of the parts of soft soil and belongs to the category of organic soil, soil peat consists of fibrous organic matter that comes from partially decayed plants such as leaves and stems [5]. Peat mostly has organic plant residues, which do not decompose completely due to lack of oxygen. This shows that peat soil is a soil consisting of particulate matter, which is the same as clay soil and sandy soil [6].

Improvements that can be made to improve the technical properties of peat soil are stabilization so that the soil is in accordance with existing conditions and can be used according to its function [7]. Soil stabilization methods are divided into 2, namely mechanical stabilization and chemical stabilization [8]. The stabilization that is chosen by the author in this study is chemical stabilization with using lime. Chemical stabilization is stabilization of soil mixing with certain materials to improve technical properties in order to have good soil bearing capacity [9]. The use of addition of lime because lime reacts with groundwater results in reduced soil moisture and the result is that the soil can expand and shrink as a result of water will reduce [10] and lime has properties as an intermediate binder, plastic, fast and easy to harden, and has good banding power [11], [12], Lime base namely limestone or dolomite, which contains calcium carbonate compounds (CaCO3) [13].

In this research, lime that is used is powdered lime (CaO) or high calcium quicklime which is purchased at a material store. The lime comes from limestone that has been burned up to a temperature of 1000˚C [14]. Quicklime can be used for treating soil that is too wet or dry, for highway application, it is widely used for sub-base or subgrade improvement [7].

One of the design tests for a mixture of soil peat with lime is the Unconfined Compressive Strength Test, that is a test which is carried out in the laboratory for the soil shear strength. This strength test measures how strong the soil accepting the preasure applied until the soil is separated from its grains and measuring soil strain due to preasure applied or when the axial strain reaches 20% [15]. According to the Department of The Army And The Air Force (1994) [16], the minimum requirements for free compressive strength for soil stabilization with cement/lime/lime-cement/lime-cement-fly ash are as in the Table 1 below:

Table 1. Minimum unconfined compressive strength.

Stabilized Soil Layer	Min Unconfined Compressive Strength (Asphalt) Kpa (kg/cm^2)	(Concreate) Kpa (kg/cm^2)
Sub-base	5175 (52,78)	3450 (35,19)
Subgrade	1725 (17,60)	1380 (14,08)

Or if we relate the strain and stress in the soil, the maximum axial stress is the free compressive strength examined so that the shear strength of undrained soil (Cu) can be calculated by the formula:

$$Cu = \frac{qu}{2} \ (\frac{kg}{cm^2}) \quad (1)$$

Soil strength category [17] can be described as very soft soil (< 0.25 kg/cm^2), Soft (0.25 -0.50 kg/cm^2), Firm (0.50 - 0.10 kg/cm^2), Stiff (0.10 – 2.00 kg/cm^2), Very Stiff (2.00 – 4.00 kg/cm^2) and hard (> 4.00 kg/cm^2). Based on the bina marga's specification, the minimum soil strength for subgrade and sub-base layer is in the very stiff category.

2 Research method

2.1 Materials

Sampling for the peat soil to be stabilized came from the Nagasaribu area, Lintong Nihuta District, Humbang Hasundutan Regency, which was taken at s everal observation points using a hoe and hoeed to a depth of 50 cm with the aim of avoiding the roots above the plants. The area where the sampling was taken is usually used by the local community to collect firewood. The peatland area is shown in Figure 1 below.

Fig. 1. Peat soil to be researched

2.2 Research methods

This research is an experimental laboratory which is conducted at the Laboratory of Soil Testing, Universitas Negeri Medan. The research is conducted at a laboratory scale with making test objects.This research was carried out with two variations, namely the first is only native peat soil, and the second is original soil mixed with 10% lime, as shown in the figure below.

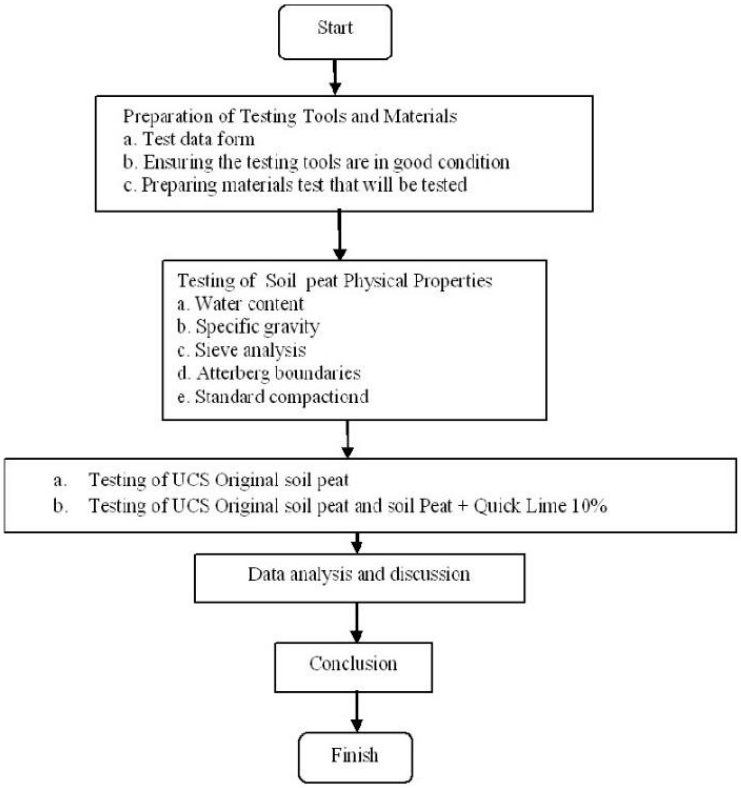

Fig. 2. Research flow step

The test Steps Carried Out are:

a. After taking the sample in the collection area, it is cleaned by drying, after drying, the sample is filtered using filter no. 4
b. Soil moisture content test [18], specific gravity test [19], sieving analysis test [20] liquid limit test and plastic limit test were carried out [21], [22].
c. Proctor test (soil density)[23] and free compressive strength test (UCS) were carried out for native peat soil (0%) [15].
d. Free compressive strength test (UCS) was carried out mixed with 10% lime, based on w_{opt} and γ_{dmax} of the original peat.
e. Analysis of the results obtained.

3 Result and Discussion

3.1 Peat properties

Clay or peat soils are generally classified as peat soils, as shown in Table 2 [24]. Tests carried out in the laboratory are shown, in Table 2 below.

Table 2. Peat Soil Data Without Lime Mix

No	Properties of Soil	Results	Test Method	Physical Properties of Peat
1	Water Content, w	130,26 %	SNI 1965:2008	100 – 1800
2	Specific Gravity, GS	1,4	SNI 1964:2008	1,5 – 1,75
3	Liquit Limit, LL	85,12 %	SNI 1966:2008	50 - 200
4	Pass Filter no.200	3,158 %	SNI 03-1968-1990	-

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Soil peat compaction. The results of research on native peat soils obtained graphs between W_{opt} and γ_{dmax}[23], as shown in Figure 3 below.

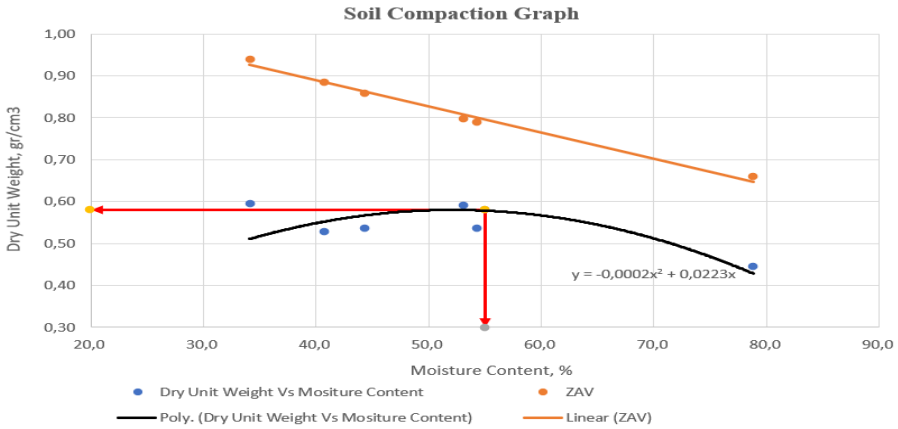

Fig. 3. Proctor test

In Figure 3 above, a Wopt value of 55% and γdmax of 0.58 gr/cm3 is obtained, and the Zav line is in the 0% zone as evidenced by the ZAV line not intersecting with the compaction curve. From the value obtained, it will be used as a reference in testing peat soil mixed with lime as much as 10%.

Unconfined compressive strength test of original soil peat. Unconfined Compressive Strength Test is conducted based on SNI 3638-20212 [15] by making test object of original soil with diameter of 3.33 cm and a length of 8.55 cm, which has been prepared at w_{opt} and γ_{dmax} weight density. The test result is shown in the Figure 4 below

Fig. 4. Unconfined compressive strength test soil peat

The result of UCS Test are written by the shape of the curve diagram that is obtained from relationship between Aksial strain score and soil Aksial stress. The relationship between strain score and soil stress can be seen in the graph on Figure 5 below:

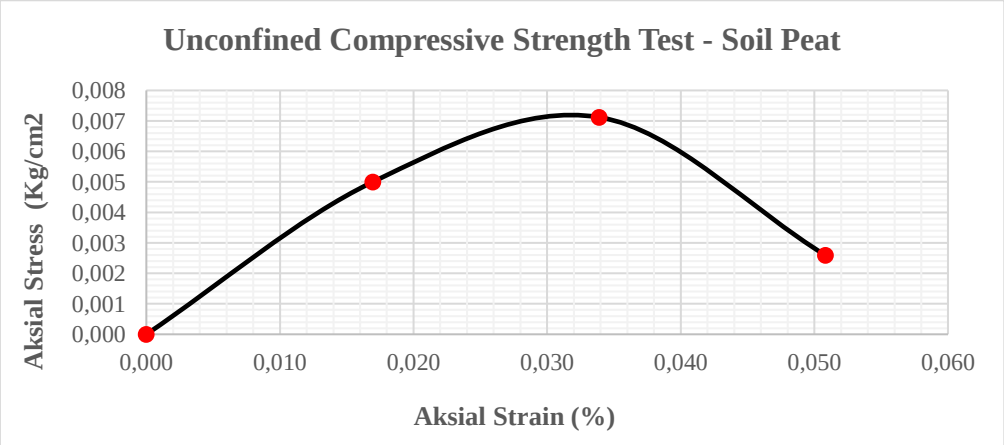

Fig. 5. Graph unconfined compressive strength test – soil peat

From the result of the UCS test, for the original soil peat can the free compressive strength (qu) is 0.0073 kg/cm^2 and the score of direct shear strength (Cu) is 0.00365 kg/cm^2. Based on the results obtained, it turns out that peat is still very soft strength or <0.25 kg/cm^2)

Unconfined compressive strength test of original soil peat + lime 10%. Unconfined Compressive Strength (UCS) Test is carried out based on SNI 3638-20212 [15] by making test object original soil that has been mixed with 10% quicklime with a diameter of 3.33 cm and a length of 8.55 cm which have been prepared at the optimum water content (w_{opt}) and maximum dry weight density (γ_{dmax})of original soil. The test results are as shown in the Figure 6 below

Fig. 6. Unconfined compressive strength test soil peat + lime 10%

The UCS results are described with a curve obtained from the correlation between the strain value and the soil stress value and can be seen in the graph in Figure 7 below:

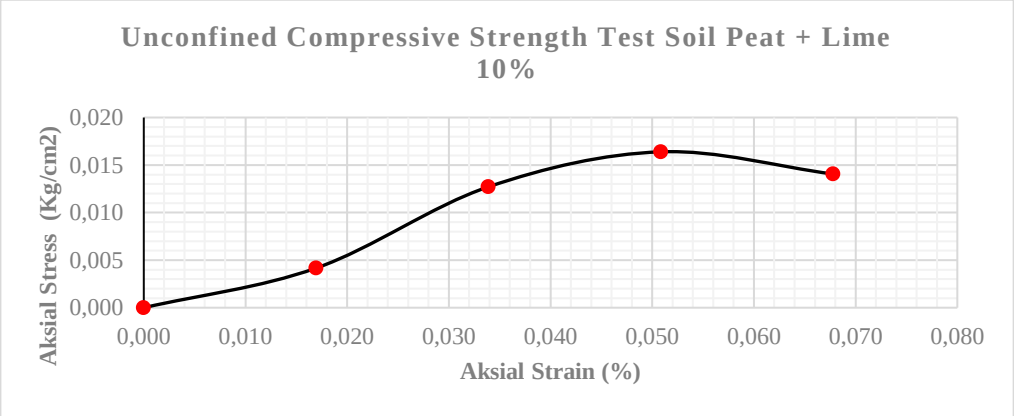

Fig. 7. Graph unconfined compressive test soil peat + lime 10%

From the results of the UCS test, for the original soil peat gets the free compressive strength (qu) is 0.017 kg/cm^2 and the direct shear strength (Cu) is 0.0085 kg/cm^2. Based on the results obtained, it turns out that peat soil that is given lime as much as 10% is still very soft strength or <0.25 kg/cm^2).

4 Conclusion

Mixing peat soils with lime as much as 10% did not show a significant increase, because a compressive strength value of 0.017 kg/cm^2 was obtained which still contained very soft soil specifications with a value still < 25 kg/cm^2, while for standards that met the highways specifications (Bina Marga) for subgrade soil it must be at least 2.00 kg/cm^2. So that in this test it is necessary to increase the addition of lime above 10% to enable the fulfillment of standard values for subgrade.

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