Laterite Soil Behavior - Geotextile (Study of Laterite Soil, Tanah Laut District)

I Setiawan*, I Muzaidi and M Fitriansyah

Department of Civil Engineering, Faculty of Engineering, Universitas Muhammadiyah Banjarmasin, Indonesia

*Email: ichwansetiawan83@gmail.com

Abstract. Land has different specifications and characters from each type. The land has the main function is as a support of a building construction be it buildings, roads, etc. Seeing from the function is inseparable from the mechanical properties of the soil such as cohesion (c) and soil shear angle (ϕ) where the higher the carrying capacity of the soil the better. The contact force (interface) between the soil surface and the surface of the soil reinforcement material is very dependent on the type of soil. Soil-geotextile contact will influence the carrying capacity of the soil, especially shear strength and soil cohesion. At present research on contact style interface (δ) of laterite-geotextile soil. The method used in this research is to use laboratory-scale experimental methods. This research was conducted with the condition of the soil sample not submerged in water (unsaturated). The test results may be known laterite in Tanah Laut has value ratio δ/ϕ of 0.89 for the type of woven geotextile (HRX250), while the value of the ratio δ/ϕ of 0.86 for the type of nonwoven geotextile (TS600).

1. Introduction

The land is an inseparable part of the construction of civil buildings because all city buildings are more on the ground. Land has different specifications and characteristics of each type. The land has the most important function as supporting the foundation of building construction is its buildings, roads, etc. Judging from the function is inseparable from the mechanical properties of the soil such as cohesion (c) and soil shear angle (ϕ) the higher the carrying capacity of the soil the better.

The contact force (interface) between the soil surface and the surface of the soil reinforcement material is very dependent on the type of soil. Laterite or red soils are known to have diverse soil aggregates. Laterite soils are currently widely used as piles for road construction. As a reinforcement material for road structures geotextiles are usually used. Soil-geotextile contact will influence the carrying capacity of the soil, especially shear strength and soil cohesion. Currently, research on the interface friction (δ) of laterite-geotextile soils.

According to [9], Geotextile is a synthetic geo-material that is impermeable to water. This material can be used as a separator or separator, drainage, filter or filtering, and reinforcement as reinforcement. In addition, geotextiles are also used as filtration or filtering which serves to limit the migration of other particles in fine soil from a soil mass but remain permeable to water movement, and as a reinforcement i.e. stabilization of soil mass by providing tensile strength to the soil system and geotextile fabric.

According to [11] the inclusion of reinforcing geotextile materials in soils improves the CBR and therefore the strength of soils. It implies that geotextile-reinforced soils in unpaved roads will perform better than unreinforced ones and increase load carrying capacity of soils. According to [2] Geotextiles
are effective materials for reinforcing soft subgrade ballasted railways. Numerical simulation using finite element analysis provides a potentially useful design method in the construction of reinforced soft subgrade ballasted railways.

Several papers explain the testing of interface friction soils – geotextiles have been shown [1, 4, 6, 9].

The purpose of this study is to review the ratio ($\delta/\phi$) of the interface friction between the laterite-geotextile soil surfaces. Also, this research is a reference material in research and planning in the field of civil building construction on laterite land that applies geotextiles as reinforcement material.

2. Research methods

Research methods used is to use laboratory-scale experimental methods. The research design as shown in figure 1. This research was conducted with the condition of the soil sample not submerged in water (unsaturated). The tests included original laterite soils, non-woven laterite-geotextile soils, and woven laterite-geotextile soils. The whole test scheme in a condition not submerged in water (unsaturated water).

3. Tools and materials

A tool used in soil sampling is using a hand drill, while the equipment used in this study is a shear test tool. Geotextile materials used are for woven geotextile (HRX250) and non-woven geotextile (TS600).

4. Theory of soil shear strength

Soil shear strength is the ability of the soil against shear stresses that occur when burdened. Ground shear collapse occurs not because of the destruction of soil grains but because of the relative motion between these soil grains. The shear strength possessed by soil is caused by several factors, namely

a. In fine-grained (cohesive) soils such as clay, the shear strength of a soil is caused by cohesion or attachment between soil grains.

b. In coarse-grained (non-cohesive) soil, shear strength is caused by friction between grains of soil so it is often called the friction angle in the

c. Soil which is a mixture of fine soil and coarse soil ($c$ and $\phi$).
Shear strength due to the attachment (cohesion) and friction between grains of land (due to $\phi$). Where $\tau$ is the shear strength of the soil, $c$ is the soil cohesion, $c_a$ is the geotextile adhesion to the soil, $\sigma$ is the total stress, and $\delta$ is the friction angle of the soil-geotextile interface.

5. Data analysis
Test pieces shaped as many as 3 pieces. The specimens are placed in two rings arranged top and bottom while for geotextile material is placed right in the middle between the lower part of the holder and the laterite soil specimens. Geotextile is glued to the holder, the holder can be made of wood/plywood, and then at the top it is given a normal load (N) of 0.5 kg, 1 kg, and 2 kg. Soil samples are shifted by force (T) whose magnitude is gradually increased. When the ground shifts, the value (T) is recorded and then repeated for the 2nd, 3rd, and so on on specimens each using N2, N3, and so on. Calculate $\tau_2$, $\sigma_2$, $\tau_3$, $\sigma_3$ and so on. Values $\phi$ and $c$ are searched graphically (test result data) based on the Coulomb formula.

The soil shear strength is expressed by the formula:

$$\tau = c + \sigma \tan \phi \quad \text{(original land)} \quad (1)$$
$$\tau = c_a + \sigma \tan \delta \quad \text{(soil-geotextile)} \quad (2)$$

6. Results and discussion
Based on the results of tests conducted in the laboratory, it can be seen the properties of laterite soils.

6.1. Physical original soils physical
Properties of laterite soils from the results of laboratory tests are shown in Table 1.

| No. | Parameter      | Results   |
|-----|----------------|-----------|
| 1   | water content(w) | 29.61%    |
| 2   | soil volume weight($\gamma_b$) | 1.62 t/m³ |
| 3   | Plasticity Index | 26.25%    |

In the Table 1 of laterite soil physical properties above, it can be seen that the laterite soil has a water content of 29.61%, a volume weight of 1.62 t/m³, and a Soil Plasticity Index of 26.25%. From the results of the laboratory test, it can be seen that the soil is classified as high clay soil with high plasticity, according to USCS is A-7-5, whereas according to AASHTO it is classified as A-7 soil.

6.2. Mechanical of laterite soil
Properties of original soil Mechanical properties of original soil from the results of laboratory tests can be seen in Table 2.

| No. | Parameter   | Results   |
|-----|-------------|-----------|
| 1   | Cohesion ($c$) | 0.356 kg/cm² |
| 2   | Shear angle ($\phi$) | 22.52° |

A Table 2 of mechanical properties above can be seen that the cohesion value ($c$) of laterite soil is 0.356 kg/cm², while the value of the shear angle of the laterite soil is 22.52°

6.3. Interface ($\delta$) non-water-geotextile non-water-saturated.
From the results of tests in the laboratory, laterite-geotextile soil in unsaturated water conditions can be seen the value of cohesion ($c$) and interface friction ($\delta$) can be seen in Table 3.
Table 3. Cohesion and interface unsaturated water non-woven geotextile water (TS600)

| No. | Parameter               | Results          |
|-----|-------------------------|------------------|
| 1   | Cohesion (c)            | 0.325 kg / cm²   |
| 2   | Interface Swipe (δ)     | 19.45°           |

In the table above it can be seen that the cohesion value of laterite soils with the use of non-woven geotextiles for water unsaturated conditions has a value at 0.325 kg / cm². As for the friction value of the interface of laterite soil with non-woven geotextile is 19.45°.

6.4. Interfaces (δ) laterite-geotextile woven not water-saturated.
From the results of tests in the laboratory, laterite-geotextile soils in unsaturated water conditions can be seen the value of cohesion (c) and interface friction (δ) can be seen in Table 4.

Table 4. Cohesion and Interface Conditions Unsaturated Water Woven Geotextile (HRX250)

| No. | Parameter               | Results          |
|-----|-------------------------|------------------|
| 1   | Cohesion (c)            | 0.268 kg / cm²   |
| 2   | Friction Interfaces (δ) | 20.16°           |

In Table 4 it can be seen that the value of laterite soil cohesion with the use of woven geotextiles has a value of 0.268 kg/cm². As for the value of the interface friction of laterite soils with woven geotextiles is 20.16°.

Table 3 and Table 4 show that the soil laterite-geotextile after testing in the laboratory has a cohesion value (c) of 0.325 for non-woven type geotextiles, while the cohesion value (c) of 0.268 for Woven type geotextiles, seeing that both values have differences in cohesion values, This is due to the contact surface of laterite-geotextile is influenced by the attachment caused by high levels of clay in the soil. Besides, the friction angle of the laterite-geotextile (δ) has varying values, this is due to the contact between the soil grains and the geotextile surface. Of the two types of Non-Woven and Woven geotextiles, there is a difference in the value of the interface friction angle which is not much different.

6.5. Interfaced angular interface (δ) laterite-geotextile
From the results of testing in the laboratory, it can be seen the shear angle, sliding interface of laterite soil with geotextile. Table 5 shows the relationship between the ratio of the shear angle (ϕ) of the laterite soil to the value of the interface friction (δ) with the use of nonwoven and woven geotextiles. From this table, it can be seen that the ratio (δ/ϕ) for laterite-nonwoven geotextile (TS600) has a value of 0.86. Whereas for laterite - woven geotextile (HRX250) soils, the ratio increased by 0.89.

Table 5. Ratio (δ/ϕ)

| No. | Test Scheme                  | Laboratory Results Testing | ratio(δ/ϕ) |
|-----|------------------------------|-----------------------------|-----------|
| 1   | Laterite soil                | Shear Angle(ϕ) 22.52°       |          |
| 2   | Laterite-geotextile nonwoven (TS600) | Swipe interface(δ) 19.45° | 0.86     |
| 3   | Laterite-woven geotextile (HRX250) |               | 0.89     |

7. Conclusions
From the results of research in the laboratory and data analysis that has been done, it can be concluded that laterite soils originating in the Tanah Laut Regency, South Kalimantan are classified into laterite soils that have high levels of clay with high plasticity. From the test results it can be seen that the interface shear strength that occurs is not only influenced by the type of geotextile, but the grain content in the soil also influences the shear angle value of the laterite-geotextile soil interface. The ratio (δ/ϕ) of woven laterite soil (HRX250) has a ratio of 0.89 and the non-woven geotextile (TS600) has a ratio of 0.86.
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