Repairs Of Expansive Land For Sub Grade Roads

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Abstract- Subgrade is the most important part in laying the building structure, especially for road construction. The improvement of the quality of road facilities is carried out with initial planning on good pavement layers and should consider the type and strength of subgrade. Road conditions are often damaged in the structure of the road surface layer because it is caused because the structure of the soil in the area often experience shrinkage causing the road becomes cracked and even waving.

It is therefore necessary to experiment to stabilize the soil by improving the gradation of mixing the original soil with a larger graded material of rice husk ash, in several experiments with several samples and aggregate mixture to find out the free press value on soil tested both before and after stabilized.

The test results showed free press value of comparison between mixing using inorganic salts and lime has increased soil bearing capacity. From the results of this study can be concluded that the addition of the right stabilizer material on expansive soil is good enough to be used to improve the physical and mechanical properties of expansive soil.
Keywords: Subgrade, expansive soil, soil stabilization, stabilizer material, soil bearing capacity

1. Introduction

Soil as the basis for laying a structural building must have good nature and carrying capacity, since the strength of the building structure will be directly affected by the basic soil's ability to receive and pass on the work load. In some locations often found soil that does not have the nature and carrying capacity is good (Ninik, 2011). The subgrade is the most important part in laying the structure of the building, especially for road construction, the quality improvement of the highway facilities is carried out with the initial planning on the pavement layer and should pay attention to the type and strength of the subgrade.

Road conditions that are above expansive soil often experience damage to the surface layer structure of the road. To overcome this problem one of the ways or methods to be used is to improve the quality of the original soil (stabilization) in order to be used as a subgrade for the highway (Hardiyatmo, 2010).

Stabilization of soil is generally associated with soil conditions that have low carrying capacity mixed with auxiliary materials or coarse grained material to increase the carrying capacity of the soil (Aschuri, 2004).

In the process of soil stabilization on the road will be done by mixing a larger graded aggregate as a stabilizer material which is expected to be able to alert the carrying capacity of the soil. Mixing process is done in the laboratory by taking samples of land on the highway that is above expansive soil and then mixed with the stabilizer material that has been provided. After the mixing process is complete, the curing is done for 3 days to remove the water contained in the soil, after which a free press test on the soil will be tested both before and after stabilization.

2. Objectives and Benefits of Research

The objectives and benefits of this subgrade research, among others:

a. Know the physical and mechanical properties of fine grain type of expansive soil containing area, and to know the effect of mixing the stabilizer material to the expansive soil, so as to know the value of free press test before and after stabilization.
b. Provide solutions to expansive soil handling in order to have stable land carrying capacity to be used as road subgrade.
c. Knowing the right materials to overcome the problem of road damage caused by the low soil carrying capacity to be used as a subgrade of the road, and in terms of academic can be used as a material for further research studies.

3. Research Methods

Soil mixed with stabilizer and ready to be compacted by modified proctor method, after which will be curing for 3 days and soaked for 1 day and dipam for 3 days without soaked. The grinding is done inside the CBR mold, tightly closed and fastened and stored properly, so that the soil samples in the CBR mold are not affected by the surrounding environment. Implementation of tests conducted in the laboratory, is testing the physical and mechanical properties of soil and chemical elements contained in ash husk. Soil testing was conducted on two conditions, ie soil test in original condition before stabilization and soil testing mixed with stabilizer.

4. Flowchart Of Research

The steps taken in the implementation of this research can be explained in the chart or figure 1. below:

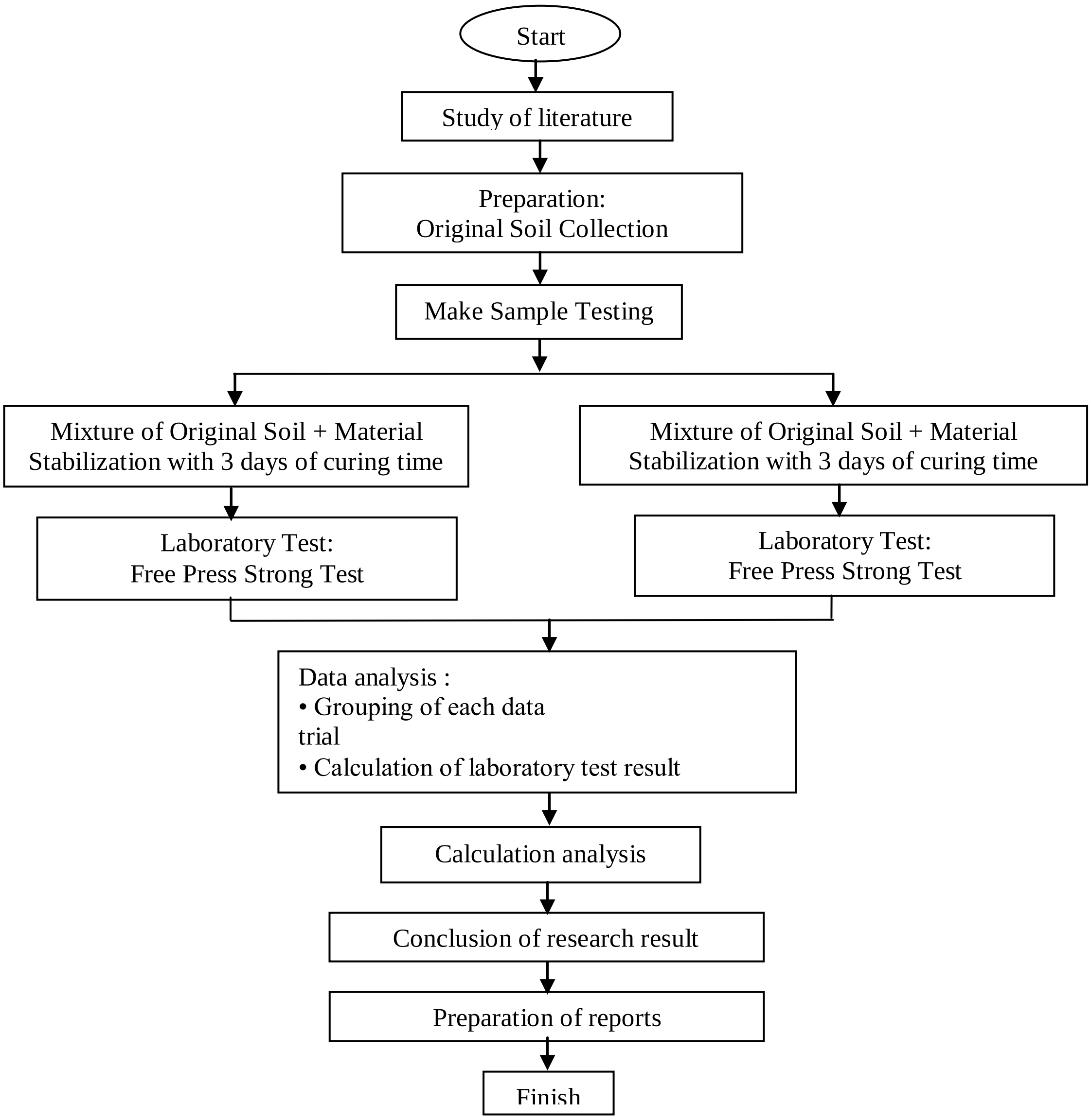

Figure 1. Implementation Step Research

5. Literature Review

Expansive soil is a soil that has great potential for flowering and shrinkage. If the rainy season and the increase in water content, the soil will expand along with increased pore water pressure and the emergence of development pressure and vice versa if the dry season, then the water content will decrease shrinkage.

Some of the minerals commonly found on expansive soils are montmorilonite, kaolinite, and illite. From the results of previous research has provided information that the biggest problems that occur in expansive soil with high content of montmorilonite as shown in table 1. below:

Table 1. Soil Mineral Relations with Activity

Mineral	Aktifity
Kaolinite	0.33 – 0.46
Illite	0.9
Montmorillonite (Ca)	1.5
Montmorillonite (Na)	7.2

Source : FH. Chen : "Foundation on Expansive Soil"

The physical properties of the soil affecting the development of expansive soil include (CHEN, 1975): Kada Air; Dry Density and Index Properties. There is a good correlation to show the expansive land properties based on the percentage of clay soil, the liquid limit and the decreasing resistance in the field as seen in Table 2.

Table 2. Relationship % Passed Screen no. 200 against Development Potential

Laboratory and Field Data			Possible Development of% total Volume Change	Developmental Pressure (ksf)	Development Potential
% Escaped no. 200	Liquid Limit %	Standard Decrease Prevention (blow / ft)			
>95	>60	>30	>10	>20	Very high
60-95	40-60	20-30	3-10	5-20	High
30-60	30-40	10-20	1-5	3-5	Medium
<30	<30	<10	<1	1	Low

Source : Chen, FH. "Foundation on Expansive Soil"

Table 2 above is used to predict the possibility of volume changes in expansive soils.

Table 3. Relation of Plasticity Index with Development Level

% Koloid	IP	Shelf Limit	Possible Development (%) Volume Changes	Development Level
>28	>35	>11	>39	Very high
20-31	25-41	7-12	39-50	High
13-23	15-28	10-16	50-63	Medium
<15	<18	<15	<63	Low

Source : Chen, FH. "Foundation on Expansive Soil"

There are several ways to find out whether the land belongs to an expansionary land category and how much potential the development is between (CHEN, 1975):
The expansive soil can be identified based on the plasticity index value as shown in Table 4. below:

Table 4. Relationship between Plasticity Index against Development Potential

Indeks Plastisitas (%)	Potensial
0-15	Very high
15-35	High
20-55	Medium

Source: FH. Chen "Foundation on Expansive Soil"

Measurement of expansive land development in a straightforward manner can be done using one dimensional consolidation. to know the percentage rate of development. To know the development level of an expansive soil can be seen in Table 5.

Table 5. Percentage of Development Relation to Development Level

Presentase Pengembangan	Tingkat Pengembangan
>100%	Kritis
50%-100%	Batas
>50%	Aman

Source : FH. Chen "Foundation on Expansive Soil"

a. Soil Stabilization with Inorganic Salt

Salt is a substance that results from neutralization reaction in the form of reaction between acidic and basic compounds. Its characteristics, that the salt has ionic bonds, is generally heat resistant (decomposed at high temperatures), may become electrical conductors when dissolved in water, and in solid form having a crystal structure. Based on the formation process, the salt can be organic salt and inorganic salt Organic salt is a salt produced by living organisms, while inorganic salts are produced from inanimate objects such as from the earth or air.
Based on the characteristic of the salt having the crystal structure and its bonding in the form of ionic bonds, the fine grained soil with weak van der waals bonds can be converted into ionic bonds to obtain the crystalline structure on the soil. In this case, inorganic salts are used as stabilization solutions because the reaction occurs faster than organic salt. Inorganic salt solution used is a mixture of two compounds namely Water glass / sodium silicate (Na^2SiO^3) and Sodium bicarbonate ($NaHCO^3$). Types of Tests Conducted were free press tests performed on original soils that had been stabilized with variations of inorganic salts and treatment periods of 1, 7, 14 and 28 days.

b. Stabilization of Soil with Lime

Lime is produced from the burning of Calcium Carbonate ($CaCO^3$) or natural limestone by heating ± 980 ° C carbon dioxide is released so that only chalk remains (CaO). Calcium oxide obtained from the combustion process is known as quick lime. Lime from this combustion when added water will expand and crack. The amount of heat released during this process will produce calcium hydroxide ($Ca(OH)^2$). This process is called slaking as the result is called slaked lime or hydrated lime.

When calcium hydroxide is mixed with water will be obtained mortar lime. Lime carrots in the open air absorb carbon dioxide (CO2), by chemical processes will produce a hard and insoluble CaCO3 in water. In this hydration reaction will be produced free lime or lime out (Ca (OH) 2). This chalk when reacted / added silicates or aluminate will form a gel as a binder. Calcium hydroxide (slaked lime) is most widely used as a soil stabilizer and is recommended to be a powder. This is very important to reduce the problems that arise from avoiding skin irritation for construction workers.

6. Results and DiscussionHasil dan Pembahasan

a. Soil Stabilization with Inorganic Salt

The results of free press testing were performed on the original soil that had been stabilized with variations of inorganic salt addition and treatment periods of 1, 7, 14 and 28 days can be seen in Figure 2 s.d. 7.

1) Effect of Inorganic Salt on Value of qu

The relationship between the inorganic salt content to the value of qu with the variation of treatment period can be seen in Figure 2 s.d 4.

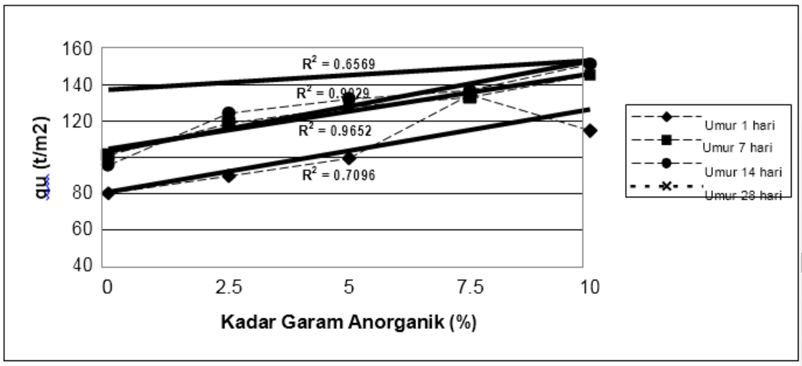

Figure 2 Graph of the relationship between inorganic salt content and soil stress (qu) on dry side conditions.

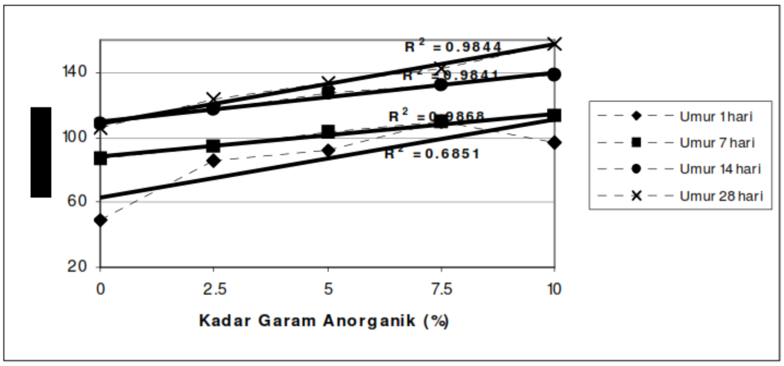

Figure 3. Graph of the relationship between inorganic salt level and soil stress (qu) under optimum conditions.

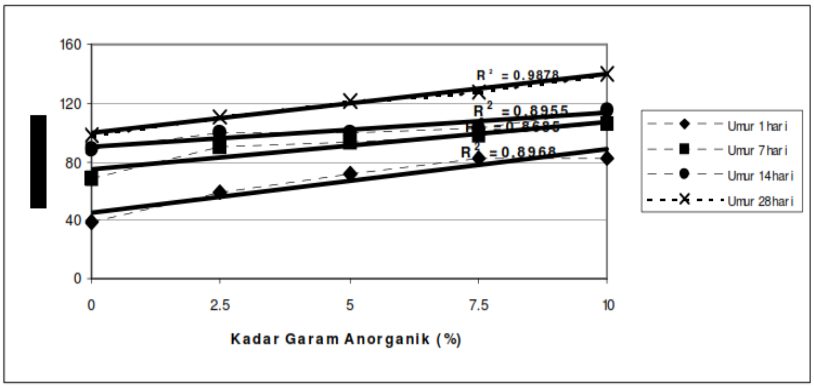

Figure 4. Graph of the relationship between inorganic salt level and soil stress (qu) on wet side conditions.

Resulting increase of qu value equal to 10,39% on dry side condition, 49,76% at optimum condition, 42,34% on wet side condition from qu value of original soil.

2) Influence of Period of Care to Value qu

The relationship between the treatment period of the value of qu with the variation of inorganic salt content can be seen in Figure 5 s.d 7.

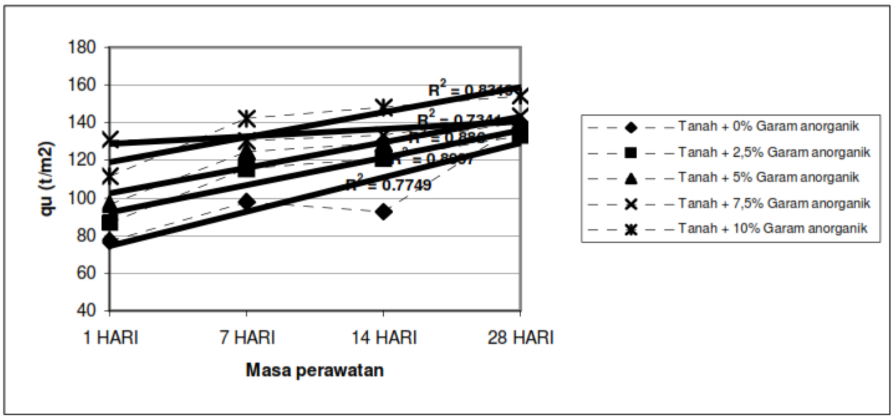

Figure 5. Graph of the relationship between treatment period and soil stress (qu) on dry side conditions.

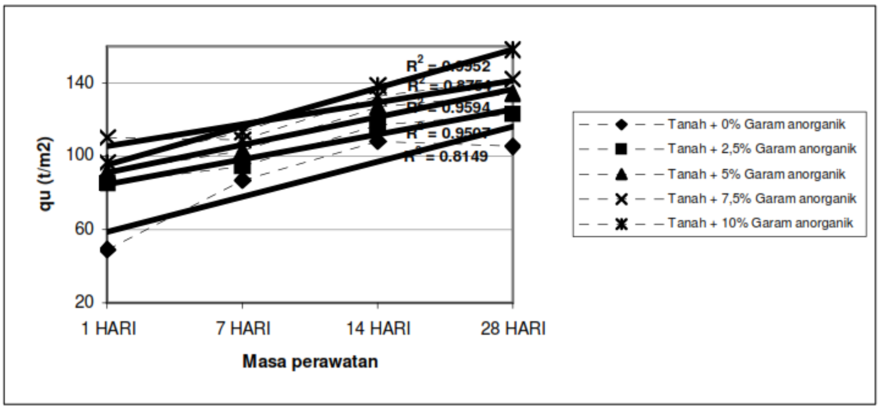

Figure 6. Graph of the relationship between treatment period and soil stress (qu) under optimum conditions.

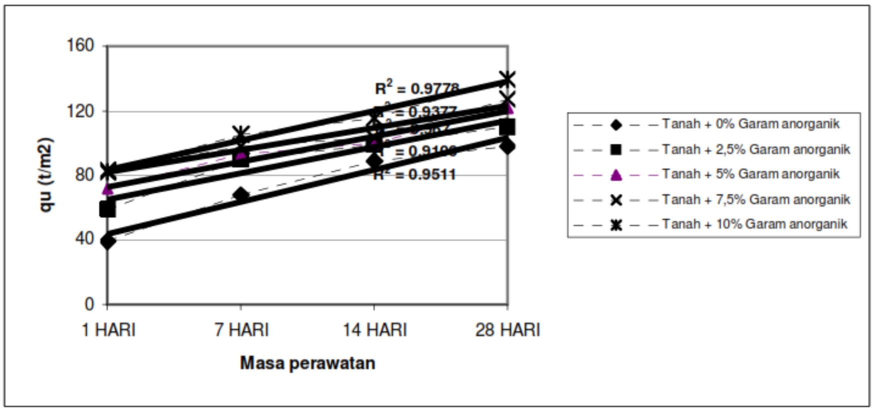

Figure 7. Graph of the relationship between treatment period and soil stress (qu) on wet side conditions.

Figures 5 to 7 show that the longer the treatment period, the greater the quantity of the inorganic salt, the addition of inorganic salts, the maintenance period has an effect on the increase of the qu value and with the addition of 10% inorganic salt and the duration of 28 days maintenance, 100% on dry side conditions, 222.22% under optimum conditions, and 257.69% on wet side conditions to native soil with 1 day maintenance period.

b. Stabilization of Soil with Lime

From the result of free compressive strength test on each percentage of lime addition and variation of curing time plotted curve relationship between curing time with qu of each specimen as shown in Figure 9. below

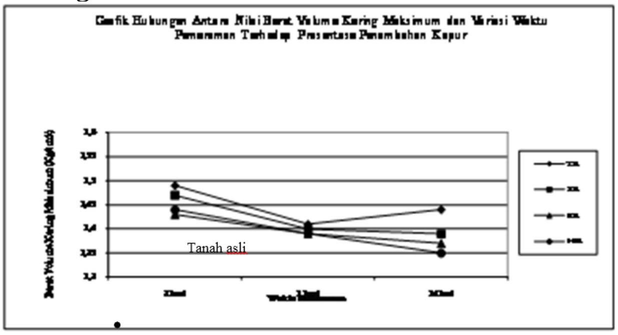

Figure 9. The relationship between the maximum dry volume weight (γd max) of soil and the variation of curing time on the percentage of lime addition.

Table 6. Strongest Free Press Test Results

Grounding	Mixed	qu (kN/m^2)
0 hari	Original Soil	0,585
2 hari	Soil + 2% Lime Soil + 5% Lime Soil + 8% Lime Soil + 10 % Lime	0,343 0,302 0,274

Grounding	Mixed	qu (kN/m²)
0 hari	Original Soil	0,585
7 hari	Soil + 2% Lime	0,384
	Soil + 5% Lime	
	Soil + 8% Lime	0,246
	Soil + 10% Lime	0,217
14 hari	Soil + 2% Lime	0,287
	Soil + 5% Lime	
	Soil + 8% Lime	0,312
	Soil + 10% Lime	0,232

From the results of free compressive strength test on each percentage of lime addition and variation of curing time plotted curve relationship between curing time with qu of each specimen as shown in Figure 10 below.

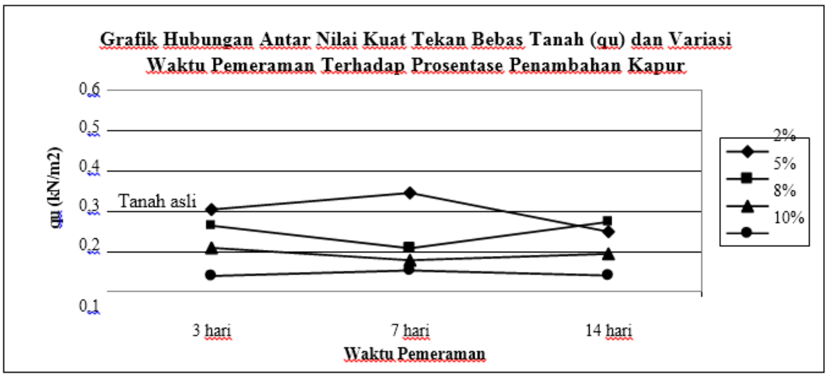

Figure 10. The relationship between the free compressive strength value (qu) of soil and the variation of curing time against the percentage of lime addition.

From the above test results note that the addition of inorganic salts and lime tends to decrease the value of Specific Gravity (Gs) soil, this is due to the mixing of two materials with different specific gravity. In addition, the cementation process on the soil with inorganic salts or lime causes the agglomeration that glue between particles. Partially existing pore cavities will be surrounded by a harder, harder water cementation material. The insulated pore cavity by the impermeable ementation layer will be measured as the granular volume thus increasing the grain volume and further decreasing the Gs.

The addition of inorganic salts or lime with the length of time of curing causes the value of the liquid limit and soil plasticity index tends to decrease. Original soil plasticity index value of 30.80% decreased to 4.55% for 3 days curing, 4.83% at 7 days curing and 2.87% at 14 days curing for a 10% increase in lime addition. The tendency to decrease the soil plasticity index by the addition of lime due to the cementation process between the soil and lime is happening. With the decline in the plasticity index value may cause a decrease in the potential value of soil development and soil properties will be better to use as a foundation ground for the foundation placement.

In the soil free compression test with the addition of inorganic salts and lime in general showed a tendency to decrease the value of compressive strength of soil free (qu). On the original soil the qu value of 0.585 kN / m2 falls into the soft loam consistency category. Figure 2 s.d 10 m3 indicates that the more additive additions decreases the value of the soil and the length of time the curing does not affect the value of qu. The addition of lime to the soil reduces the attachment between the grains of soil and water, so the soil becomes easily broken when pressed vertically. The decrease of attachment between grains of soil by lime causes the occurrence of friction in the soil which allows optical frictional (□) friction on the ground.

7. Conclusion And Suggestion

Based on the results of the research, it can be concluded:

1. free compressive strength test by mixing inorganic salts produced, the resulting soil strength increases with the addition of inorganic salts and length of treatment. With an inorganic salt addition of 10% and length of treatment for 28 days will result in an increase of free compression test value of 10.39% on dry side conditions, 49.76% under optimum conditions, 42.34% on wet side conditions of value qu the original soil.
2. The addition of lime to the clay soil does not necessarily increase the free compressive strength of the soil (qu). In the free compression strength test of expansive clay soil with the addition of lime tends to decrease the value of free compressive strength. The original soil free press test obtained qu value of 0.585 kN / m2 decreased the value of qu to between 0.302 kN / m on the addition of lime 2% curing time 3 days to 0.178 kN / m2 on the addition of lime 10% curing time 14 days. In this test the addition of lime and length of curing time does not affect the increase of the qu qu value.
3. Lime turns down the attachment between soil grains so that the soil will break easily when given a vertical pressure, but the possibility of friction occurs on the ground or the incidence of internal friction angle (□) on the ground.
4. In the soil free strength test it is preferable to use more than one sample soil at each percentage of lime addition in order to obtain a more perfect average value.

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