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CHARACTERISTIC OF EXPANSIVE CLAY SOIL (Case research at Bugel Village, Godong Subdistrict, Purwodadi Regency, Central Java Province)

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Abstract- Almost all civil constructions were built on the ground. However, not all soil types can be used for construction due to the load supporting capacity of the soil and the soil deformation that occurs for each different soil type. One type of soil that has many problems on its supporting capacity is expansive clay soil. It is a type of soil that has a mineral content that easily absorbs water in wet conditions and also release water easily in dry conditions so that is soil can swell and shrink in a relatively short time. The purpose of this research is to know expansive soil characteristic in Bugel Village, Godong District, Purwodadi Regency, Central Java Province covering physical and mechanical properties. Based on laboratory tests, the soil in Bugel Village has Waverage = 60.90%. From result of atterberg limit test obtained result LL = 90,75%; PL = 24.138%; SL = 23.759%; And PI = 66.612%. According to Raman with a PI of 66.612% already shows the soil is expansive ground. For Gravity Specific the results is 2,782, indicating the soil contains Montmorillonite minerals that have high passivity properties. The AASTHO classification of soil is incorporated into groups A-7-6 whereas for USCS classification is incorporated into CH zones and for English classification is entered into the zone between CV and CE. Of the three classifications can be drawn the clay soil area has a high plasticity value. For standard compaction test result, the characteristic value for maximum γunsat = 1,389 gr / cm2, γsat maximum = 1.78 gr / cm2, Woptimum = 31,46%, and n = 58,92%. And for soil swelling test can be seen the percentage of swelling is very high that is about 274%.

Keywords: *Soil Charactreristic, Expansive Clay Soil, Montmorillonite, Bugel Village.*

1. Introduction

Almost all civil constructions are built on the ground. However, not all soil types can be used for construction due to the soaring carrying capacity of the soil and the soil deformation that occurs for each different soil type.

One type of soil that has many problems on its carrying capacity is expansive clay soil. Expansive clay soil is a type of soil that has a mineral content that easily absorbs water in wet conditions and also release water easily in dry conditions so that this soil can expand and shrink in a relatively short time. This soil has a large destructive force in civil

infrastructure such as foundation decline, hair cracking to large cracks in walls, bumpy roads and others. Factors that influence the extent of exspansive soil shrinkage is the amount of rainfall, the surrounding climate, and the height of the water table.

To recognize the type of expansive clay soil in the Godong area, Purwodadi District then it is necessary to investigate the soil by conducting various tests in the laboratory by taking soil samples in the area.

1) Research Problem

Based on the description of the problems above the problems that arise is how the characteristics of expansive soil in the Village Bugel, Godong District, Purwodadi District, Central Java Province.

2) Research Purposes

The purpose of this paper is to know the characteristics of expansive soil in Bugel Village, Godong District, Purwodadi District, Central Java Province.

3) Limitation Problems

Given the wide scope of the problem and the limitations of time and ability, problem limitation is made:

a. The soil under study is soil taken from Bugel Village, Godong District, Purwodadi District, Central Java Province. The soil in detail is the ground with a depth of 1 m in that location.
b. Research conducted in the laboratory is Water Content (Water Content), Gs (Specific Gravity), Sieve Analysis, Standard Proctor, Atterberg Limit, and Consolidation Test.

2. Literature Review

1) The Definition of Expansive Soil

Expansive soil is a soil that has large shrunken characteristics due to capillary events or changes in its water content (Muntohar, 2006). Expansive clay soils are highly flooded soils. Types of swelling movement on expansionary soil there are two that is movement of swelling of lateral and vertical direction (Hardiyatmo, 2014). The amount of swelling or shrinkage is not evenly distributed from one point to another so as to cause a difference in the decrease in the soil surface. Seed et al. (1962) mentioned factors influencing the extent of expansive soil expansion, among others, species and amount of clay, soil structure, density, changes in water content, compaction method, electrolyte concentration in water and pressure on the surface pressure (surcharge pressure).

2) Swelling

Factors affecting soil shrinkage by Nelson and Miller (1992) can be divided into three distinct groups:

a. Soil characteristics that affect the nature of the internal force field.
b. Environmental factors that affect the changing of internal style systems.
c. Position of voltage.

1) Swelling and Correlation With Properties of Soil Index

The soil potential for attracting and releasing water depends on the initial moisture content of the soil and moisture content relative to the moisture content of consistency limits, such as plastic limit, liquid limit and shrinkage limit (Hardiyatmo, 2014).

a. Correlation with Atterberg Boundaries

Through Atterberg Limit test it can be seen that plasticity index value (IP), according to Chen (1988) has a relationship with swelling potential. Shown in the table below:

Table 1. The relationship of swelling potential and PI

Indeks plastisitas (PI)	Potensi pengembangan
> 35	Sangat tinggi
20 - 55	Tinggi
10 - 35	Sedang
0 - 15	Rendah

b. Correlation swelling with Activity

In 1953, Skempton defined the activity of expansive clay (A) by the formula:

$$A = PI / C \quad (1)$$

Where:

A = activity
PI = plasticity index
C = percent clay size fraction (granular diameter <0.002 mm)

Here is a table of typical values of some clay particles and their activity.

Table 2. Clay mineral activity

Mineral	Aktivitas (A)
Na-montmorillonite	04-Jul
Ca-montmorillonite	1,5
Illite	0,5 - 1,3
Kaolinite	0,3 - 0,5
Hallyosite (*dehydrated*)	0,5
Hallyosite (*hydrated*)	0,1
Attapulgite	0,5 - 1,2
Allophane	0,5 - 1,2
Mica (*muscovite*)	0,2
Calcite	0,2
Quartz	0

2) Consolidation Swell Test

Consolidation swelling test can be done by oedometer test. The test with the oedometer shall take into account the sequence of loading and wetting, the burden of the test object and the stiffness of the tool so it is important to immerse the specimen at the beginning of the test. As it expands gradually, the test object increases its water content and the degree of saturation increases. After vertical swelling has been constant or stopped, the specimen is saturated, so loading after maximum swelling is achieved.

3. Research Methodology

1) Research Sites

The research was conducted at Soil Mechanics Laboratory of Civil Engineering Department of Sultan Agung Islamic University.

2) Materials Research

The research material is soil taken in Bugel Village, Godong Subdistrict, Purwodadi Regency, Central Java Province. The soil sample is taken at depth (-1 m).

3) Research Tools

a. Sampling tools
b. A set of moisture test kits
c. A set of specific gravity test kits (Gravity Specific)
d. A set of limitations of consistency testing tools (Atterberg)
e. A set of standard filter tools for gradation test (Grain Size)
f. A set of standard compaction test equipment
g. A set of consolidated test kits

4) Research Stages

The stages performed in this study are as follows:

a. Phase sampling of soil.
b. Soil Test testing phase to determine the water content and soil type of soil.
c. The test phase limits the consistency to know the liquid limit, plastic limit, and shrinkage limit.
d. Sieve Analysis testing stage to find out grain grain on the soil sample.
e. The soil compaction testing stage with Standard Proctor to determine the optimum moisture content required for soil compaction (Wopt), optimum wet soil weight (wet), and optimum dry weight of the soil volume.
f. Consolidation testing stage to know Swelling Index value (Cs).

4. Research Result and Discussion

1) Grain of Soil Analysis

To know the soil type based on the grain of soil, so sample of soil coming from Bugel Village was done some testing in laboratory. In obtaining the results of sieve analysis test for percentage that pass filter no. 200 equal to 98,7%, and atterberg test with PI value = 66,612%, LL = 90,75%, SL = 23,759. The results obtained are then inserted into the Unified grain classification graph as seen below.

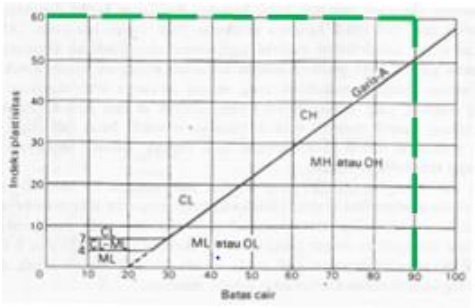

Fig. 1. Classification of Soil Based on Unified

From the above graph shows the green line is above the A line, which occupies the CH zone. Where CH is an inorganic clay type clay with high plasticity, fat clays (fat clays). While according to AASHTO classification based on IP value> 11% and PL <30% then the soil is classified into group A-7-6. When plotted into the graph then it can be seen in the picture below.

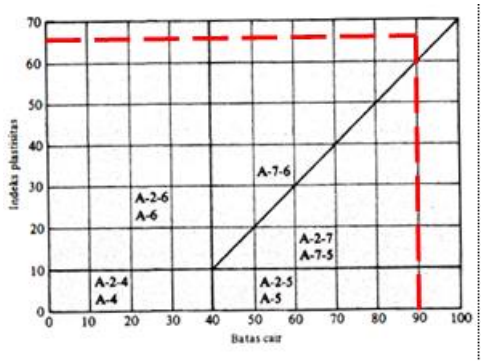

Fig. 2. Classification of Soil Based on AASHTO

In the graph above shows the red line into the group A-7 (A-7-5 and A-7-6) is a clay soil that is plastic and has the properties of large volume changes. Lastly according to the classification of English where the percentage of minerals more subtle than 0.06 mm is between 65% - 100%, and the exposure of test results in the above discussion then obtained the graph results as below.

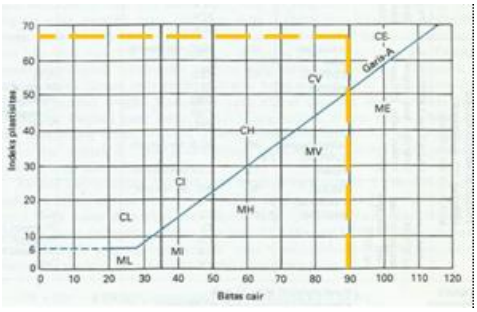

Fig. 3. Classification of Soil Based on the British System

From the graph above shows the orange line is above the A line, which occupies the zone between **CV and CE**. It is known that CV and CE are both soil types that have a very high palsticity value, but for CE has a value of plasticity is more extreme than the CV. So the soil samples include clay soils that have extreme levels of plasticity.

So from the above 3 classification system, it can be concluded the sample soil in Bugel Village, Godong Subdistrict, Purwodadi Regency, Central Java Province is a clay soil that has high plasticity value.

2) Mineralogy Analysis

To find out the type of minerals contained in the soil in Bugel Village, Godong District, Purwodadi District, Central Java Province is done by finding the weight of the soil type obtained from the laboratory. In the test using piknometer got value Gs =

2,782. The results are then incorporated into the mineral criteria according to Braja M. Das as below.

Table 3. Mineral Specific Weights
Specific Weight Minerals (Gs)

Mineral	BeratSpesifik (Gs)
Kaolinite	2,6
Illite	2,8
Montmorillonite	2,65 – 2,8

Based on the above table it can be concluded the mineral composing the soil is ***Montmorillonite***. These minerals belong to a type of mineral that has a high rate of shrinkage with the risk of damage caused very large.

3) Correlation Atterberg Limit

To predict the potential for soil swelling in the Bugel Village, Godong Subdistrict, Purwodadi Regency, Central Java Province requires data of test results that have been done in soil mechanics laboratory using Atterberg boundary analysis. From the test results in the laboratory showed the sample of soil in the test has a value of liquid limit (liqiud limit) = 90.75%, plastic limit = 24.138%, shringkage limit = 23.759%, and plasticity index (IP) = 65.862%. The results are then incorporated into the swelling potential criteria according to Chen, and some experts like below.

Table 4. Relation of Swelling Potential and PI (Chen, 1988)

Indeks Pengembangan (PI)	Potensi Pengembangan
> 35	Sangat tinggi
20 – 55	Tinggi
10 – 35	Sedang
0 – 15	Rendah

Based on laboratory test results, the soil in the area has a swelling index value (PI) of more than 35 with very high swelling potential. Unlike the case according to some experts like the picture below.

Table 5. Classification of Swelling Degrees Based on Boundaries - Atterberg Limits According to Some Researchers.

Derajat pengembangan	Indeks plastisitas	Indeks susut	Indeks susut	Batas cair (LL)
Rendah	< 12	< 15	< 20	20 - 35
Sedang	12 - 23	15 - 30	20 - 30	35 – 50
Tinggi	23 - 32	30 - 60	30 - 60	50 – 70
Sangat Tinggi	> 32	> 60	> 60	70 - 90
Ekstra Tinggi				> 90
Referensi	Raman (1967)		Ranganatam dan Satyanarayana (1965)	Ladd dan Lambe (1961)

Based on the above classification, obtained some statements are:

a. If according to Raman (1967) the sample soil in the area has a high degree of swelling that is in moderate to very high condition with criteria of plastic index> 32%, and shrinkage index 15% - 30%.
b. If according to Ranganatam and Satyanarayana (1965) the sample soils in the area have a moderate degree of swelling with a shrink index value of between 20% - 30%.
c. If according to Ladd and Lambe (1961) the sample soil in the area has a very high degree of swelling with the liquid limit criteria of between 70% - 90%.

From some of the above statement, it can be concluded that for the soil in Bugel Village, Godong Subdistrict, Purwodadi Regency based on data of soil plasticity in the area has high swelling potential.

4) Soil Compaction Analysis

To determine the volume of water content of a soil condition with dry weight, a soil compaction process is adjusted to the conditions in the original field. In this experiment in can graph as shown below.

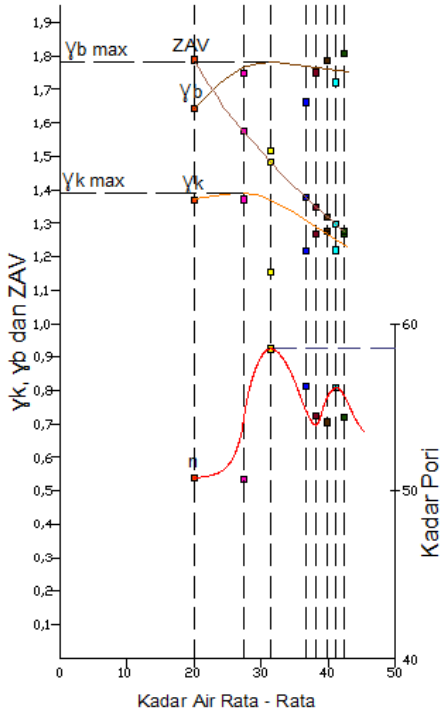

Fig. 4. Standard Proctor Chart

Based on the results of the graph above, for the soil sample in Bugel Village, Godong Subdistrict, Purwodadi Regency has a characteristic value for γkringmaksimum = 1,389 gr / cm^2, γbasahmaksimum = 1,78 gr / cm^2, Woptimum = 31,46%, and n = 58.92%.

5) Soil Swelling Analysis

To see the size of the swelling of a soil condition, a consolidation testing process with consolidometer tool is performed. This test is performed on the soil test results proktor with different water content conditions - different. The results of this experiment obtained graphs as seen below.

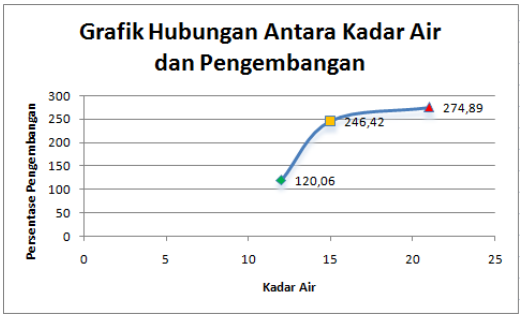

Fig. 5. Graph of Relation Between Water Content And Swelling

From the graph above it can be seen the amount of swelling that occurred on the soil sample is proportional. Where the increasing amount of water contained then the percentage of swelling will be greater. Compared to swelling on normal soils, expansive soil types have large swelling so the damage is also high.

5. Conclusions and Suggestions

Conclusion

From the results of this study can be concluded as follows:

From the results of laboratory tests obtained the original water content of the soil from Bugel Village of 60.90%. As for the consistency limit test, the limit of liquid (LL) is 90.75%, plastic limit (PL) is 24.138%, the shrinkage limit (SL) is 23.759% and the plasticity index (IP) is 65.862%. For AASTHO classification the soil is fed into groups A-7-6 whereas for USCS classification is entered into CH zone and for English classification is entered into the zone between CV and CE. Of the three classifications can be drawn the clay soil area has a high plasticity value. For soil type soil tests it was found that sample soils from Bugel Village were included in the criteria of expansive clay soil containing montmorillonite mineral content in accordance with expert opinion. From the result of standard proctor compaction test, the characteristic value for γkeng maximum = 1,389 gr / cm^2, γbasah maximum = 1,78 gr / cm^2, Woptimum = 31,46%, and n = 58,92%. And to test the swelling of soil can be seen the percentage of swelling is very high that is about 274%.

Suggestion

Can perform the test procedures in the laboratory in accordance with the rules for data in getting more valid.

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