SOIL STABILITY USING CEMENT PCC IN LUBUK MINTURUN PADANG, INDONESIA

Yocky Syaida Adha Putra[1], Tengku Ahmad Fauzan Syah[1]
Dr. Azwar Inra,M.Pd[2], Totoh Hadayono,ST.,MT[2]
[2]Faculty Of Engineering, Universitas Negeri Padang, Indonesia

ABSTRACT: This study was intended to determine the required semen content to be stable and optimum. Research is an experimental study. From the results At the test well yield the groundwater face is at a depth of 0.57 meters. In Hand Boring The rising of USCS soil type C. From Sieve Analysis known type of graded sandy gristle is not good. From Gs Analysis. Gs 2.61. At Water Content Test was 39,62%. From weighing test the contents of heavy data Content of Wet Wetlands average of 1.59 and data Average Dry Land Content weighted by 1.08. From Atterberg Limit testing obtained Liquid limit value = 45,81%, Plastic limit value = 38,34%, Plasticity index value = 7,47%. From Compression Test Result Obtained γd and air content: At 0% addition of PCC cement compaction result of 1.12 with moisture content 35%, At 4% addition of PCC cement compaction result of 1.19 with moisture content 37%, At 7% velocity PCC cement compaction resulted at 1.24 with moisture content of 35%. In 10% of PCC cement semen obtained compaction of 1.28 with 35% air content.

Keywords: Soil Stability, Soil Investigation, Stability Using Cement PCC, Lubuk Minturun Land

1. INTRODUCTION

Based on the Padang City Planning Agency's plan for the development of Padang City in 2008-2028 at point 3 "Encouraging the development of settlement areas to the north, east and south of the city (Koto Tangah District, Kuranji District, Pauh District, Lubuk Kilangan District and Bungus Teluk Kabung District)".

To realize the plan of Bappeda Padang City, Padang City government must establish supporting infrastructure or facilities and infrastructures such as road construction, irrigation and channel and supporting buildings for community needs. The development plan of Bappeda will also attract the community to establish housing towards the development plan of the city of Padang. All the buildings will be erected on the ground, so the land as a cross section of the building must be ensured in a stable state.

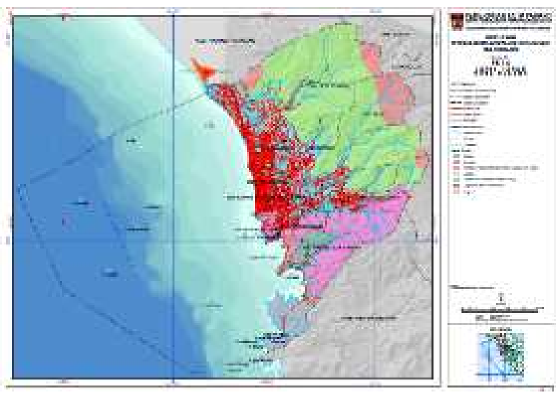

Fig.1 Figure is Map of Padang Land Section

Land is a land parameter that determines the occurrence of landslides, shifts, and collapse. Type of land in the city of Padang based on the map of Padang city land (Fig.1), scale 1: 210.000 then the type of land area that will be used as research (Padang City) is generally dominated by reddish yellow latosol complex and pink yellowish complex. there is also a type of soil andosol, alluvial gray association, dark gray alluvial, and brown regosol. The location that will be the focus of research is Cold Water Area kenagarian Lubuk Minturun dominated reddish yellow latosol land identified Expansive clay.

The properties of clay (Hardiyatmo, 1999) are as follows:

a. Fine grain size, less than 0.002 mm
b. Permeability is low
c. Capillary water rise is high
d. Very cohesive
e. High shrinkage levels
f. The consolidation process is slow.

The direct development of the land can cause physical damage to buildings, especially the road building as a means and infrastructure of road access, therefore efforts are needed to reduce the rate of infrastructure damage by the land.

The depth of the soil solum of the research area is generally between 30cm-100cm which is classified as shallow, depending on the slope conditions that make up the land, the texture is generally sandy clay, and the permeability value is generally rather fast and very fast. This indicates that the research location is generally quite critical and has experienced high degradation of soil physics.

Especially in areas with a slope of> 20% (Hermon, 2009).

The soil classification system is made essentially to provide information about the characteristics and physical properties of the soil. Due to the varied nature and behavior of soils, the classification system generally classifies the soil into a common category where soils have similar physical properties. The classification system is not an identification system for determining the mechanical and geotechnical properties of the soil. Therefore, land classification is not the only way used as a basis for planning and design construction.

Most soil types consist of many mixtures or more than one particle size. Clay is not necessarily composed of clay particles, but can be mixed with grains of silt and sand and there may also be organic material mixtures. In order to support the study and research on "Soil Stability With the addition of Portland PCC Cement Type", it requires good knowledge and understanding of soil properties based on existing theory consisting of physical properties (Index Properties) and engineering properties these two traits are very important to know as the basis for taking a decision related to foundation engineering (roads, bridges, dams and others).

One effort to obtain soil properties that meet certain technical requirements is by soil stabilization methods. Soil stabilization methods can be divided into 2 main classifications based on their technical nature and based on their objectives, where several variations can be used. From its technical nature, the stabilization can be divided into 3 types namely: mechanical stabilization, physical stabilization and chemical stabilization. (Ingles and Metcalf, 1972).

soil stabilization is to increase the soil's carrying capacity and increase in strength to be calculated on the pavement thickness design process. Therefore, soil stabilization requires more rigorous design and implementation methods than land modification. Many soil materials in the field can not be used as a base material in construction work. The condition of this unqualified soil material can be improved on its technical properties so that its strength increases. Improving the soil properties can be done by means of compaction (technically), mixing with other soil, mixing with cement, lime or sulfur (chemically), heating with high temperature, and so forth. Soil stabilization efforts have long been conducted both traditional and technological research and implementation.

Expansive ground stability is cheap and effective is to add certain chemicals, with the addition of chemicals can bind clay minerals into solid, thereby reducing expansive clay soil expansion (Ingles and Metcalf, 1972).

The physical properties and properties of soil engineering are more determined by the type of soil classification itself. Soil classification is intended to facilitate the grouping of various soil types into soil groups according to their engineering properties and characteristics. Grounding places soil in 3 groups, coarse grained soil, fine grained soil and organic soil. Based on USCS the coarse grained soils are those that have percentage of pass filter 200 <50%, and fine-grained soil (clay / loam) if more than 50% passes filter 200. The soil is divided into 2 groups: gravel and gravel and sand and soil sandstone. The fine-grained soil is divided into Lanau (M), Clay (C) based on the liquid limit and the plasticity index.

Organic soils are also included in fine grained clusters. The consistency of clay soils and other cohesive soils is strongly influenced by moisture content. Plasticity index and liquid limit can be used to determine the development characteristics. Characteristics of development can only be estimated using the plasticity index, (Holtz and Gibbs, 1962). Since the plastic properties of a soil are caused by water absorbed around the surface of the clay particles, it can be expected that the type and amount of clay minerals contained in a soil will affect the plastic limit and the corresponding liquid water limit.

According to Ingels and Metcalf (1972), the properties of improved soil with stabilization may include: volume stability, strength/carrying capacity, permeability, and conservation /durability And lime stabilization can convert soil into particle clumps. The amount of lime used ranges from 5-10%, which results in a greater concentration of calcium ions than is actually needed.

In soil matter it is important to know the influence of water content on soil mechanical properties, eg mixing water to a fine grained soil sample (silt, clay or mud clay) to reach the liquid state. When the mixture is dried bit by bit so the sample of the soil will go through certain circumstances from liquid until it is frozen (solid).

In addition, SNI 15-0302-2004 regarding portland pozolan cement (PPC-Portland pozzoland cement). Portland pozolan cement is a cement made from a homogeneous mixture of portland cement together with materials having pozolan properties. Concrete and mortar mixtures using PPC have easy working properties, but there will be extended binding times.

The compressive strength of concrete with pozolan cement at early age is lower but in old age will be higher because there is still reaction between pozolan active silica with Ca (OH) 2 to form CSH compound. Other types of cement are arranged in SNI 15-7064-2004 concerning composite portland cement (PCC-Portland Composite Cement) which is cement made from grinding slags of portland cement and casts with inorganic materials. The mixed inorganic material may be more than one kind eg high kiln slag, pozolan, silicate compound, limestone and so on. There is also masonry cement arranged in SNI 15-3758-2004. Masonry cement is defined as a mixture of portland cement or cement hydraulic mixture with additive (such as limestone, hydrated lime or hydraulic lime) along with other materials used to enhance one or more properties such as time setting, workability, water retention, and durability.

The term modification is used to describe a stabilization process that is only intended for the improvement of soil properties, but is not intended to increase the strength or durability of the soil. The purpose of modifying the soil is to create a working platform for the machine, regardless of the effect of the modified soil on the pavement design count. Although the actual modification of the soil also shows a stabilization process, the main objective is to improve the technical properties of the soil, such as reducing plasticity, enhancing ease of use and reducing development potential.

The clay particles have a negative electric charge. In an ideal crystal, the negative and positive charges are balanced. However, due to the isomorphic substitution and the continuity of the split, there is a negative charge on the surface of the clay particles. To compensate for such a negative charge the clay attracts a positive charge ion (cation) from the salt present in the pore water. This is called ion exchange. The cations may be arranged in order of strength of attraction, as follows:
$Al^{3+} > Ca^{2+} > Mg^{2+} > NH^{4+} > K^{+} > Na^{+} > Li^{+}$

The sequence gives the meaning that Al^{3+} ions can replace Ca^{2+}, Ca^{2+} can replace Na^{+} and so on. This process is called cation exchange. The bonds between soil particles composed by clay minerals will be greatly influenced by the magnitude of the network of negative charges on minerals, types, concentrations and distribution of cations that serve to weigh the load.

Several methods have been proposed in the selection of added ingredients. Some of the proposed methods depend on the experience of the organization of the country of origin. The following will be studied, some pointers from how the material-added selection for soil stabilization has been used. Here are some additional material selection methods:

a. Alaska Department of Transportation and Public Facilities Research & Technology Transfer
b. Ingles and Metcalf (1972)
c. Department of The Army and The Air Forces
d. Indiana Department of Transportations
e. Another method to consider in the addition of cement

After the type of added material is determined from the preliminary test in the laboratory, other factors to consider in selecting the type of add-on materials for stabilization are:

a. Climate
b. Laboratory Test
c. Availability of Costs, Tools, Personnel and Materials
d. Soil Contains Organic Material
e. Soil Containing Sulphate
f. Water
g. Time of Bonding

The test well is a ground investigation by making a hole dug with a certain depth. Test wells can be excavated using a backhoe or fronted loader, but these have limited depth and require a large enough space and are quite expensive.

The test well is best suited for the source of the material for development because the many samples can be seen directly. The test well can be used to obtain "Undisturbed samples" samples taken neatly and thoroughly for laboratory testing. In addition, the test well can be used as a testing ground-usually a load test using a flat metal plate. The plates are laid on the ground and gradually loaded to simulate a foundation. This is called "plate-load test", and the largest plate load capacity is associated with recommended permit soil pressure to planners for foundation design.

Original soil samples can be taken with sample tubes or cone barrels. This sampling can be done in various ways such as Hand Borring, SPT, and others. This example is taken using sample tubes. This tool is a thin walled cylinder connected with drill handlebar with a device called sample tubes holding device, used for soft to medium clay. How to use that is by inserting the sample tube to the bottom of the drill hole then beaten into the original soil to be taken for example. The commonly used sample tube has a diameter of 6 - 7 cm.

The grain size analysis of a soil is the determination of the variation of the particles present in the soil. The variation is expressed in the percentage of total dry weight, the variation of the grain size of the soil and the proportion may support the load present therein, for example, if the soil consists of various grain sizes, the soil will be denser and stable than the soil composed of granules -

uniform grains. Since the soil that contains of various grain sizes has good properties, this soil is called well graded. On the contrary, the soil consisting of slight granular variations, poorly supporting the load, the soil is called poorly graded soil, which is generally very difficult to solidify, especially when dry. Sea sand is generally gradually poor and can not be solidified properly, so it can not support large loads.

The soil type of soil is the ratio between the weight of the soil and the weight of the water present in the soil at a certain temperature. The result of determination of the soil type of soil from most of the soil shows that the BJ (specific gravity) of the soil usually ranges from 2.4 to 2.8. Berta type of soil is determined by the quartz content of the soil. The higher the quartz content of the soil, the higher the density.

Soil density is required to calculate the soil properties index (eg pore rate, soil content weight, degree of saturation) and other important soil properties. In addition, the weight of the soil type can also be determined by soil characteristics in general, such as organic soils have a small density, whereas the presence of other heavy mineral content (eg. iron) is indicated by heavy soil type.

The water content is the ratio of the percentage of the water weight and the dry weight of the soil. Water content is one of the important parameters to determine the correlation between soil behavior with soil physical properties, which is done routinely in the implementation of soil testing laboratory. Water content testing is a laboratory test to determine atterberg boundaries, compaction testing and shear strength testing. When testing the moisture content of drilled soil, moisture content or moisture content from the drilled soil will be obtained. Natural moisture can help us in predicting decline or collapse. The relationship of aiar content and depth of drill soil can be used to detect capillary rise of the groundwater, or the location of the water source, if all related factors are taken into account.

Usefulness of Atterberg Boundaries: The liquid limit and plastic limit do not directly give usable figures in the design. What we get from this Atterberg Boundary experiment is an outline of the properties of the soil. Soils with high liquid borders usually have poor technical properties, ie low strength, "compressibility" is high, and difficult to solidify for example for road construction. For certain kinds of land Atterberg boundaries can be linked empirically with other properties, for example with shear strength or "compression index", and so on. Plastic index is usually used as one of the requirements for materials to be used for road construction.

Compaction is an attempt to increase the density of the soil by the use of mechanical energy to produce compression of particles. The soil compaction energy in the field can be obtained from the roller machine, vibration compaction devices, and from heavy objects dropped. In collaboration, the test samples for obtaining quality control are compressed using the collision (or dynamic), pressure-suppressing, or static pressure using pistons and press machines.

Soil can be worked initially by drying, adding water, aggregates (grains), or with stability materials such as cement, limestone, coal ash, or other materials. Other additional work can be done by tearing, plowing, or using a mixing machine, all of which can be done depending on the circumstances of the soil.

The purpose of compaction is to improve the soil's technical properties. Some of the advantages of this compact are:

a. Reduced subsidence, ie vertical movement within the soil itself due to reduced pore number.
b. Increased soil strength.
c. Reduced depreciation due to reduced volume due to reduced moisture content of benchmark values during drying.

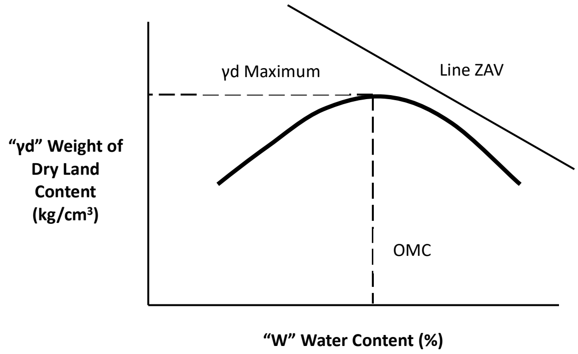

Fig.2 Chart of Relation Weight Dry Content (γd) and Water Content (W)

In figure (Fig.2) there is a line called "Zero Air Void's line (ZAV)" or a 100% saturation degree line. This line is the theoretical relationship between the weight of the dry content and the moisture content when the degree of saturation is 100%, if the soil pore does not contain the air of the line it can be calculated by the formula:

$$ZAV = \frac{Gs \,.\, ¥w}{1 + w \,.\, Gs} \quad (1)$$

Eq. (1) Determined Zero Air Void (ZAV).

The relevant research in this research is: Sutikno dan Budi Damianto (2009) : "Stabilisasi Tanah

Ekspansif Dengan Penambahan Kapur (*Lime*) : Aplikasi Pada Pekerjaan Timbunan" dan Andreas Dharmawan Hur,dkk (2009) : " Stabilisasi Tanah Dengan *Fly Ash* dan Semen Untuk Badan Jalan PLTU Asam-Asam"

This study aims to determine the maximum density before and after the addition of PCC cement on Stabilized soil.

2. RESEARCH METHOD

This study was designed to see how much soil stabilization with the addition of PCC cement on the sample soil. The implementation of this research was conducted in collaboration with soil mechanical engineering. Based on the research implementation, it is known that this research type is experimental research.

The sample in this research is the ground with a depth of 40 - 100 cm which is in Cold Water Lubuk Minturun Padang City with disturbed and uninterrupted condition and Cement Type PCC that can be obtained from the building store. Taking the test data is done by testing as follows:

a. Soil Sampling: Disturbed Sample's (Undisturbed soil samples) and Undisturbed Sample's (eg undisturbed soil)
b. Testing Filter Analysis
c. Specific Gravity Test (Gs)
d. Water Moisture Test
e. Consistency Limit Tests (Atterberg Limit): Liquid Limit (Limit Liquid) and Plastic Limit (Plastic Limit)
f. Standard Proctor Test (Compaction)

3. DISCUSSION/RESULTS OF RESEARCH

3.1 Sampling

a. Disturbed Sample (Disturbed Sample), In the disturbed soil sampling obtained at the Ground Water Level at 0.57 meters by making the test well.
b. Undisturbed Sample, In undisturbed soil sampling using Hand Boring with a depth of 2.5 meters.

3.2 Sieve Analysis Test

Based on the test that has been done, then obtained data as follows: Cc = 1.4 and Cu = 2.3.

3.3 Atterberg Limit Test

a. Liquidity limit, Based on the test that has been done, then the value of water content to reach the liquid limit (at 30-40 beats) is 45,81%.
b. Plasticity limit, Based on the test that has been done to obtain plastic limit at average water content = 38,34%
c. Value of Plastic Index, Based on testing that has been done, the value of plastic index is: 7,47%

3.4 Specific Gravity Test

Based on the tests that have been done in the laboratory, the data Specific Gravity test average of: 2.61

3.5 Water Content Test

Based on testing of water content that has been done in the laboratory, then the data as follows: 39.62%

3.6 Content Weight Test

Based on the test of content (unit weight) that has been done dilaboratorium, then obtained data as follows:

a. Weight of wet soil content = 1.55 gr/cm^3
b. Weight of dry soil content = 1.07 gr/cm^3

3.7 Compaction Testing with PCC Cement Enhancers

3.7.1 Method of Material Selection of Stabilization Mixture

In standard compacting the proctor will be done by modifying the PCC Cement on the ground to be stabilized clay soil to be tested. Before melakukkan addition of PCC cement in clay so it is necessary to fulfill the criteria of mixed materials as follows:

a. Based on the initial guidance table for the selection of stabilization methods (Hicks, 2002) obtained from test data Filter Section no.200 of 11.57% <25% with PI 7.47% <10% known from the table that the soil to be modified suitable to be added with PCC cement.
b. Based on the table of application of suitable soil stabilization (Ingles and Metcalf, 1972) it is known that coarse clay soil with stabilization plan using PCC cement obtained is effective stabilization but quality control is difficult.
c. Soil classification according to unified system (MIL-STD 619B), LL and PI constraints according to method 103 in MIL-STD-62 Given value of PI (Plasticity Index) of
   - 7,47%. *PI* < {20+ ¼ x (50% lolos saringan no. 200)}
   - 7,47% < {20+ ¼ x (0.5 x 11,57)}
   - 7,47% < 21,44% … (Worthy addition of PCC Cement for stabilization)
d. Based on the Department of Army and the Air Force (1994) it is known from the comparison graph between percent fine pass filter no.200 to percent sand, the material passes filter no.4 and

stay filtered no. 200 land was found in the area of 1C and the soil was feasible for stabilization with PCC cement.

e. Based on the Indiana Department of Tranportations (INDOT, 2002) decent soil mixed with cement, the soil has a PI ≤ 10 and percent pass filter no.200 <20%. So based on the results of soil testing is feasible to do the addition of cement with the amount of additional cement 3-10%.
f. Based on Portland cement association (1979) the soil tested has entered predetermined criteria. Once the soil meets the feasibility criteria for the addition of cement then dilakukkan compaction on the land to be stabilized.

3.7.2 Calculation of Compaction Research Data

a. Determination of Water Content
In the determination of water content dilakukkan mixing water as much as 18%, 21%, 24%, 27%, 30%, 33%.
b. Determination of Density
Compaction was performed by the addition of PCC cement 0%, 4%, 7% and 10%.

3.7.3 From Compression Test Result Obtained γd and moisture content of:

a. At 0% addition of PCC cement obtained compaction of 1.12 with moisture content of 35%
b. At 4% addition of PCC cement obtained compaction of 1.19 with moisture content of 37%
c. At 7% addition of PCC cement obtained compaction of 1.24 with moisture content of 35%
d. At 10% increase of PCC cement obtained compaction of 1.28 with moisture content of 35%

4. CONCLUSION

a. At the test well obtained groundwater face is at a depth of 0.57 meters.
b. In Hand Boring obtained classification of USCS type C1 soil
c. From Filter Analysis known graded sandy clay is not good.
d. From Analysis Gs obtained Gs 2.61
e. At Water Content Test obtained 39.62%
f. From the weight weighing test, we found that the average weight of Wet Land Content was 1.59 and the average dry matter contents of soil was 1.08.
g. From Atterberg Limit testing obtained Liquid limit value = 45,81%, plastic limit value = 38,34%, Plasticity index value = 7,47%
h. From Compression Test Result Obtained γd and moisture content of:
   - At 0% addition of PCC cement obtained compaction of 1.12 with moisture content of 35%
   - At 4% addition of PCC cement obtained compaction of 1.19 with moisture content of 37%
   - At 7% addition of PCC cement obtained compaction of 1.24 with moisture content of 35%
   - At 10% addition of PCC cement obtained compaction of 1.28 with moisture content of 35%

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