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CLAY SOIL STABILIZATION WITH LIME EFFECT THE VALUE CBR AND SWELLING

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ABSTRACT

Subgrade was a very important part to support all construction loads on it. If the clay subgrade that had unfavorable properties, such as low CBR, the high swelling when applied to the construction of the road subgrade soil would produce a soil that is easily damaged. For that, if used in the construction of CBR value should be towering so that it can withstand a load on it. The swelling would reduce the volume of soil that is stable when it rains the soil is not swollen, otherwise when the dry season does not shrink too high. Ground improvement methods used in this study was stabilization of lime-soil, using a mixture of percentage 5%, 10% and 15% of the lime. Tests performed on the Atterberg limits, Compaction (Standard Proctor Test), C.B.R laboratory, and Swelling. The results of the study about a large percentage of the value of lime plasticity (liquid limit, plasticity index) decreased with the increasing compaction. The average CBR value is increased for the natural soil to percentage 5% and 10% of lime, while the percentage of 15% decreased. For the swelling, the percentage of 15% lime with 24 hours immersion showed 45.28% increase in swelling of the normal soil (i.e. 31.67% to 17.33%) So in general the best for clay soil stabilization is Pakuwon area where the addition of 10% lime CBR values obtained optimum and could reduce swelling value.

Keywords: lime, stabilization, CBR, swelling.

INTRODUCTION

Background

Subgrade is a very important part to support all construction loads on it. If the clay subgrade that has properties that are not profitable, such as CBR (California Bearing Ratio) low and high swelling so that when applied to the construction of a dirt road, the land base will easily damage. For that if used in the construction of CBR value should be towering so that it can withstand a load on it. The swelling will reduce the volume of soil that is stable when it rains he is not swollen, otherwise when the dry season does not shrink too high so that the cracks in the road can be reduced or eliminated [[1], [2], and [3]].

The purpose of soil stabilization is to improve the physical properties, mechanical and increase the carrying capacity of the land that will be taken into account in the planning pavement. Therefore, soil stabilization requires the planning and implementation of an accurate method of soil change for the better.

Lime has been known as one of the good soil stabilization materials, especially for clay stabilization properties that have a large swelling and generally contain high levels of clay, but its swelling properties will be much reduced, even eliminated, if the soil mixed with lime. The presence of Ca2 + cations on the elements of lime can provide bonding between the larger particles that expands on soil properties [[4] and [5]].

From the results conducted by [6], there is an increase in CBR and decrease swelling of the subgrade soil using a method of stability with soil and lime, soil samples from Spring Mulyo and lime from Purwodadi original soil + lime by the percentage of 0%, 5%, 8%, 10%, 12% lime. CBR did not submerged: the percentage of 10% lime, obtained an increase in CBR of 11.8% to 22.1%, but the percentage of 12% lime CBR decreased slightly to 22%. CBR submerged: the percentage of 10% lime, obtained an increase in the CBR from 2.45% to 7.6%, but for 12% the percentage of lime CBR decreased slightly to 7.58%. Swelling decreased with increasing percentage of lime in other words, the more the percentage of lime small swelling that occurs.

Liquid limit and plastic limit do not directly provide the value that can be used in the calculation. Limits used in this experiment are the Atterberg limits the description will represent the properties of the land concerned. High liquid limit soil usually has a poor technical nature, which is a low carrying capacity, towering and difficult compressibility in compaction. For various of soil, Atterberg limits can be linked empirically with other properties, such as shear strength or index compression and so on [[7] and [8]].

Compaction is a process by which the air in the pores of the soil removed by mechanical means to achieve the density requirements. Soil density is usually measured in dry unit weight, not by the number of pores. The dry unit weight great its mean that the number of smaller pores and higher compaction.

Swelling is the process of entry of water into the pores which causes swelling of the soil volume. The amount of swelling is the ratio between height changes after immersion of the original height of the sample is usually presented in the form of percent [[7] and [8]].

C.B.R. was developed as a way to assess the strength of the foundation soil, so that we can know the materials that will be used for the manufacture of pavement. CBR values calculated at the rate of penetration of 0.1 "and 0.2" by dividing each penetration load standards 3000 and 4500 pound load obtained from experiments on a wide crushed stone considered to have a

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CBR 100%. Experiments C.B.R. can be performed on samples of native soil or compacted soil or carried on the spot. Several previous studies [[4], [9] and [10]] only discuss the stability of the soil with lime without waiting time due to chemical reactions. In this research, the waiting times are concerned.

The problem of research

a) The physical and mechanical properties before and after the clay stabilization with lime.
b) Optimum percentage of lime mixed with the soil to get the maximum CBR value.
c) Influence of the addition of lime to the soil to the value of the plasticity and swelling.

The purpose of research

a) Knowing the physical and mechanical properties of clay before and after stabilization.
b) Knowing the value of the optimum percentage of lime in the soil mix to get the maximum CBR value.
c) Knowing the effect of adding lime to the soil, the value of the plasticity and swelling.

The benefits of research.

It is expected that this research can provide an alternative to increase the bearing capacity of the subgrade and determine the effect of lime on the clay against the increasing in the CBR and the decreasing in the swelling value.

RESEARCH METHODOLOGY

Stages of Research

a. Preparations research was conducted on the field observation and taking samples in Pakuwon area.
b) Experiment in the Laboratory.

Experiments were carried out in the Laboratory of Soil Mechanics ITATS. Starting from the making of the original soil and soil-lime mixture of samples with the percentage of 5%, 10%, 15% lime, to stand for 3. Laboratory experiments Atterberg limits, compaction, CBR laboratory and swelling. Then do the grouping data into each group according to the percentage of lime used. Data collection and analysis of the calculation results.

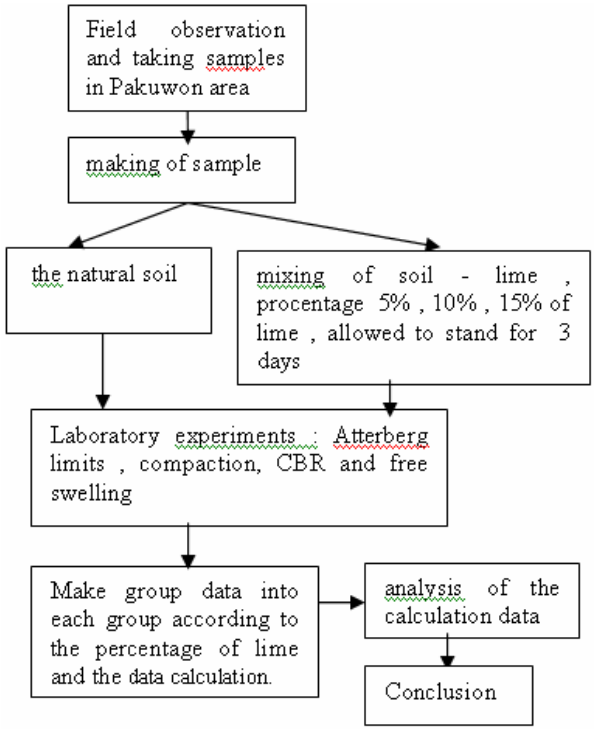

Figure-1. Flowchart of the research.

Mixing lime with the soil base is expected to result in higher soil strength, reduction in swelling potential and increased durability. For this purpose, the mixture allowed to stand for 3 days or a given chemical reaction that produces a mixture with cementation steep and compacted. Cementation in soil - lime system occurs gradually at a certain temperature and is it suitable for use in tropical climates.

RESULTS AND DISCUSSIONS

Test Atterberg Limit

Atterberg limit tests on soil mixture of 5%, 10% and 15% lime with to stand for 3 days. Tests include a liquid limit (LL), plastic limit (PL), and plasticity index (PI), as follows:

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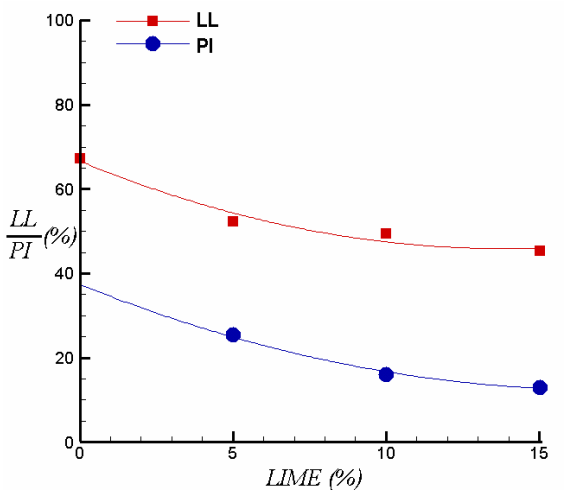

Figure-2. The relationship between LL and PI with the percentage of lime.

Figure-2 shows that the value of liquid limit (LL) and plasticity index (PI) decreased with increasing percentage of lime. By increasing the value of a liquid mixture of lime causes the limit (LL) decreased. Based on the samples with the addition of 15% lime showed the value of the plasticity index is best for low swelling potential.

Compaction Test (Standard Proctor Test)

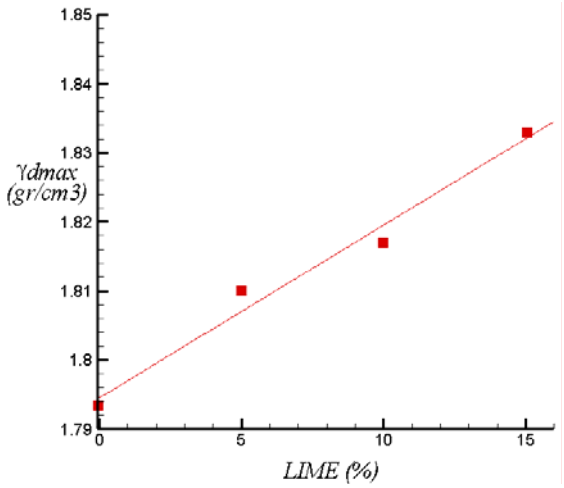

Figure-3. Relationship the dry unit weight (γdmax) with percentage of lime.

In this Figure-3 shows that the dry unit weighs increased with the addition of lime.

C.B.R. laboratory

This study was conducted on soil samples with the optimum moisture content γdmax compaction test. This experiment determines C.B.R. percentage of lime-soil mixtures and natural soils with 5%, 10% and 15% lime.

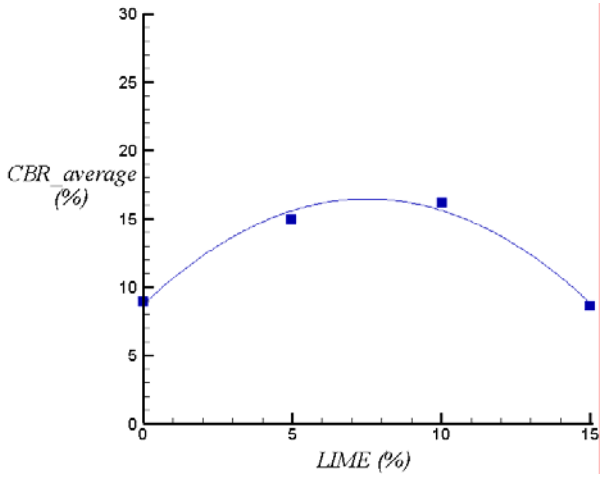

Figure-4. The relationship for CBR average with percentage of lime.

From the Figure-4 shows average CBR value an increased of the natural soil to percentage 5% and 10% of lime, while the percentage to 15% decreased. This shows the suitability of the research conducted by [8] and [9].

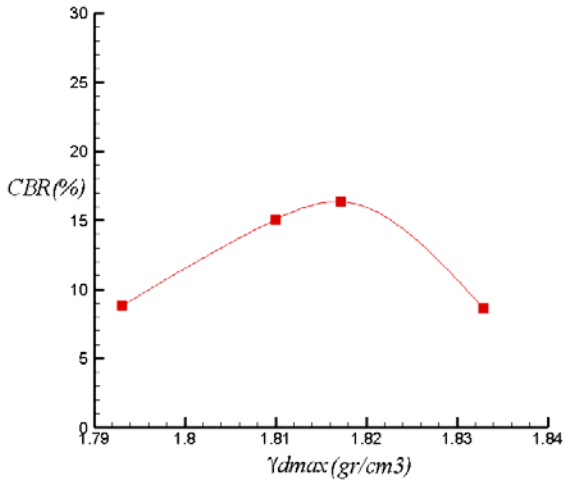

Figure-5. The relationship the dry unit weight with CBR.

Figure-5 shows γdmax 1.817 gr/cm^3 at 10% a mixture of lime, although the largest compaction of 15% of the lime with the value γdmax 1.833 gr/cm^3.

Free Swelling Test

Swelling potential value below the optimum moisture content is taken from the γdmax compaction tests. This study was conducted to determine how much swelling percentage and lime-soil mixtures of natural soil with 5%, 10% and 15% limestone.

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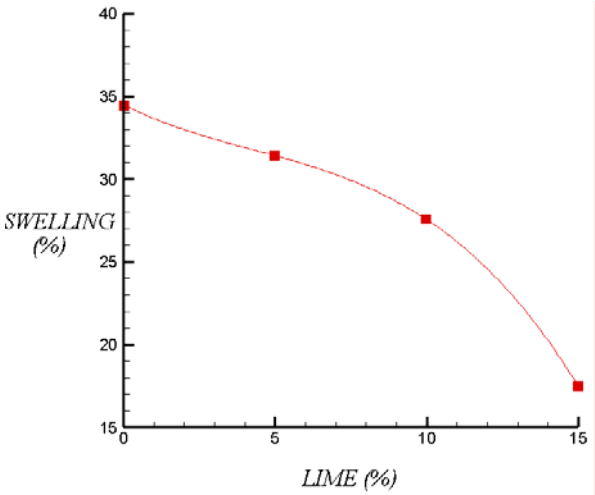

Figure-6. Relation of swelling and the percentage of lime.

In this Figure shows that the possible value of the percentage of swelling decreased with the addition of lime. Greatest swelling potential value decline occurred in the percentage of 15% lime, according to the research of [8] and [10].

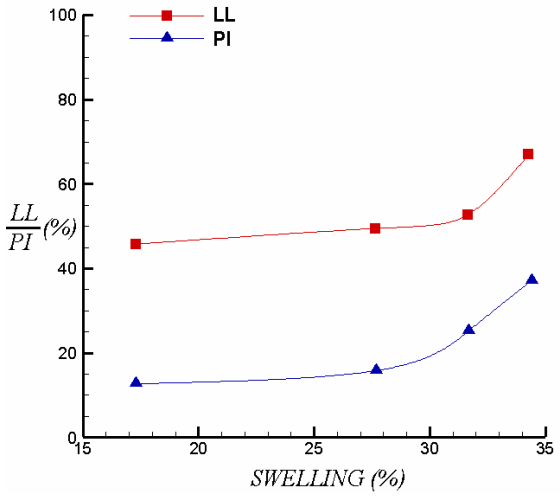

Figure-7. The relationship for Liquid Limit, Plaicity Index with Swelling.

From Figure-7 shows that the value of swelling increased with a liquid limit (LL) and plasticity index (PI) increased. This means that when the liquid limit and plasticity index values rise gain increased potential for land development.

CONCLUSIONS

From the results of experiments and calculations, it can be concluded:

a) Native land value for Liquid Limit (67%), and Plasticity Index (36.96%). As for the soil stabilization mixture of 5%, 10% and 15% with the left for 3 days shows that the value of liquid limit (LL) and plasticity Index (IP) decreased with increasing percentage of lime mixture. Liquid limit values showed a large decrease in the lime mixture 15% from 67% to 45.33%, resulting in the decrease of 32.34% of the original soil. For its plasticity index values decrease most likely in a mixture of 15% i.e. from 33.96% to 12.76%, resulting in the decrease of 65.48% of the normal soil.

b) From the experimental results compacting a mixture of lime 15% with 3 days of omission, can increase the value of γdmax of 1.793% to 1.833% with an increase of 2.23% of the original soil.

c) Results of experiments with a mixture of limes 5% and 10% showed an mean CBR value increased from the original land, whereas the percentage of 15% lime obtained an average CBR decreased.

d) For free swelling experiment, a mixture of lime 15% by soaking with water for 24 hours showed a decrease in the value of a large swelling, the swelling value of 31.67% to 17.33%, or in other words has decreased by 45.27%.

e) So in general the best for clay soil stabilization is Pakuwon area where the addition of 10% lime CBR values obtained optimum.

REFERENCES

[1] Chen F.H. 1975. Foundation on Expansive Soils, Developments in Geotechnical Engineering 12, Else-Vier Scientific Publishing Company, New York.

[2] Kezdi. A. 1979. Stabilized Earth Roads. Elsevier Science Publishing Company, New York.

[3] Hary Christady, Hardiyatmo. 2010. Soil Stabilization for Highway Pavement, Yogyakarta: Gadjah Mada University Press.

[4] Ruckman A. 1980. Summary of Open Discussion, session no. 5. Proceeding of the Fourth International Conference on Expansive Soils. 11: 717-720.

[5] Ingles O.G dan, Metcalf J.B. 1972. Soil Stabilization Principles and Practice. Butterworths Pty. Limited, Melbourne.

[6] Warsiti. 2009. Improving CBR and Decreases Swelling Soil Sub Grade With Soil Stability Methods Using Lime. (Online), 14(1): 38-45. (http://puslit2.petra.ac.id/ejournal/index.php/wahana/article/view/17769, access at 11 February 2013, 6:03 AM).

[7] Bowles J.E. 1984. Physical and Geotechnical Properties of Soils. Second Edition, McGraw-Hill, Singapore.

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[8] Anonim. 2003. Annual Book of ASTM Standards. section 4, Volume 04 08, ASTM International Barr Harbor Drive, West Conshohocken, PA 19428-2959.

[9] Harnaeni Senja. Rum. 2007. CBR Review Clays Stabilized With Lime On Wet Side Compaction. (Online), volume 7(2): 163-169. (http://publikasiilmiah.ums.ac.id/handle/123456789/123, diakses 25 Maret 2013, 1:36 PM).

[10] Wardana I., Gusti. Ngurah. 2009. The behavior of the evolving nature of land with high and low tide on soil stabilization with marble powder material and stabilizing agent. Scientific Journals of Civil Engineering, (Online), volume 13(2):161-172. (http://www.scribd.com/doc/59933050/6-ok-wardana-161-173-, accecc at 14 Maret 2013, 3:16 PM).