

The Influence of Slack Lime to Clay Towards Optimum Moisture Content (OMC) and Maximum Dry Density (MDD)

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Abstrak

Peningkatan populasi di Indonesia khususnya pada wilayah Jawa barat telah mengakibatkan perubahan yang cukup signifikan pada bidang tata guna lahan. Area vegetasi yang hijau telah berubah menjadi area-area perumahan, gunung kapur telah ditambang dan hal-hal tersebut mengakibatkan bencana seperti banjir dan longsor pada area yang curam. Penyebab terjadinya longsor adalah dikarenakan berat tanah lebih berat dari tahanan tanah itu sendiri. Salah satu penyebab hal tersebut adalah tingginya limpasan yang terjadi pada daerah hulu DAS dan kemampuan tanah untuk menyerap air. Tanah pada lahan yang digunakan untuk perumahan atau pun pada area yang curam haruslah dipersiapkan pada kondisi *maximum dry density (MDD)* dan *Optimum Moisture Content (OMC)* agar bisa menghasilkan kuat geser yang optimum dan dapat menghindari potensi terjadinya longsor. Kondisi tanah pada area hulu umumnya terdiri dari kondisi lempung yang berasal dari pelapukan batuan dan partikel lainnya. Lempung memiliki pori-pori yang cukup kecil dan cenderung tidak lulus air hingga dapat dijadikan inti bendungan. Hal tersebut mengakibatkan perlunya analisa untuk membuat campuran komponen yang dapat dikerjakan dan juga dapat membantu lempung untuk meningkatkan pori-pori tanahnya juga mengurangi berat tanah tersebut. Penelitian ini terdiri dari serangkaian pengujian yang terdiri dari beberapa persentase lempung (CL) dan kapur padam (SL), persentasinya adalah 95% CL – 5% SL, 80% CL – 20% SL, 65% CL – 35% SL dan 55% CL – 45% SL. Pengujian ini menghasilkan kesimpulan bahwa semakin tinggi Kapur Padam maka Kepadatan semakin menurun dan semakin menurun kepadatan maka kadar air semakin tinggi.

Kata kunci:

Kapur Padam, Lempung, OMC, MDD

Abstract

An increase of population in Indonesia, especially in West Java make big changes in land use. Green area had been changed to housing, lime hills were mined and it makes several disaster like flood was happened in a high land and landslide happened in a steep area. A reason of landslide happened is the burden of weight soil is higher than its strength to hold overall burden. A reason of flood is a huge runoff capacity in upper area and one of its factor is soil capability to absorb the water. The soil works for housing or even for steep area have to be prepared in a maximum dry density (MDD) and at Optimum Moisture Content (OMC) to get the optimum strength of soil and prevent it from landslide. The soil in upper area usually in a form of clay, where it used to be came from the weathering of stone and another particles. Clay pores are so small and it make clay become so impermeable and used to as a core clay of earth dam. There are a necessity to research a mixing component that workable and can help clay increase its pore so the weight of soil can reduce, meanwhile the bigger pore of soil can help its capacity to absorb rainfall and decrease the runoff. The research is conducted with a tests in several percentage of clay (CL) and slake lime (SL), the percentages are CL 95% SL 5%, CL 80% SL 20%, CL 65% SL 35% and CL 55% and SL 45%. The results show that the higher SL so the MDD is lower and the lower of MDD is make a higher OMC.

Keywords:

Slake Lime, Clay, OMC, MDD

I. INTRODUCTION

The increase of population in Indonesia makes a big changes in land use. Several area with designation of forests had been changed to farming area and housing. Several of them are in a steep area like in the slope of mountain. There had to be a good research to examine whether there are a cheap, eco-friendly and easy to use thing to keep the steep area in a safe position. Steep area in the slope of mountain is risky because of its soil composition. The soil in steep area of Bandung West Java commonly in the form of clay. Clay is a soil which have a specific mineral particle that make a plastic properties to soil if it mixed with water (Grim, 1953 in Risman 2008)¹. Its particle size is smaller than 2 micron and to determine soil as clay it doesn't just from its size but also we have to determine mineral in the soil. ASTM D-653 gives a boundary in size such as between 0.002 mm to 0.005 mm. Another properties of clays that stated by Hardiyatmo (1999) in Qunik Wiqoyah (2006)² are : (1) Fine granular, smaller than 0.002 mm, (2) Low permeability, (3) Slow Concolidation.

Slake lime or Calcium Hidrokside is a fine dry powder that gained from the burnout of Calcium Oxide. Slake lime's water content around 80 to 200%. Lime is a very effective materials to help fertilize soil, and it need another research to prove its effectiveness in help soil stability. Soil stability is based on cohesion and soil weight, another important component is moisture content. A lighter soil weight will decrease its dead load and help the soil stability whether a higher moisture content increase the water component of soil particles. This research will examine the influences of slake lime towards the optimum moisture content and maximum dry density.

II. METHOD

Research method that used in this research is experimental method. Experimental method is a trial method which is used to learn an effect of one variable to another variable in a custom condition (Fathoni 2006:99)³. This research take a soil sample from a high land in West Java, the slake lime was bought in a chemical. Tools that used in this research was one set compaction tools. The composition of clay and slake lime is shown in tabel below.

Tabel 1 Percentage of Clay and Slake Lime

No	Clay Percentage	Slake Lime Percentage
1	95%	5%
2	80%	20%
3	65%	35%
4	55%	45%

III. STANDARD OF TESTS

To determine the properties and mechanism value of soil and the value of OMC-MDD from the samples therea are several standard of tests that have to be held.

1. ASTM C-29⁴

This test method is often used to determine bulk density values that are necessary for use for many methods of selecting proportions for concrete mixtures. The bulk density also may be used for determining mass/volume relationships for conversions in purchase agreements. However, the relationship between degree of compaction of aggregates in a hauling unit or stockpile and that achieved in this test method is unknown. Further, aggregates in hauling units and stockpiles usually contain absorbed and surface moisture (the latter affecting bulking), while this test method determines the bulk density on a dry basis. A procedure is included for computing the percentage of voids between the aggregate particles based on the bulk density determined by this test method.

2. ASTM D2216-98⁵

This test method covers the laboratory determination of the water (moisture) content by mass of soil, rock, and similar materials where the reduction in mass by drying is due to loss of water

3. ASTM D854-02⁶

These test methods cover the determination of the specific gravity of soil solids that pass the 4.75-mm (No. 4) sieve, by means of a water pycnometer. When the soil contains particles larger than the 4.75-mm sieve, Test Method C 127 shall be used for the soil solids retained on the 4.75-mm sieve and these test methods shall be used for the soil solids passing the 4.75-mm sieve. Soil solids for these test methods do

not include solids which can be altered by these methods, contaminated with a substance that prohibits the use of these methods, or are highly organic soil solids, such as fibrous matter which floats in water.

4. ASTM D4318-00⁷

These test methods cover the determination of the liquid limit, plastic limit, and the plasticity index of soils. The liquid and plastic limits of many soils that have been allowed to dry before testing may be considerably different from values obtained on non-dried samples. If the liquid and plastic limits of soils are used to correlate or estimate the engineering behavior of soils in their natural moist state, samples should not be permitted to dry before testing unless data on dried samples are specifically desired. The multipoint liquid limit method is generally more precise than the one-point method. It is recommended that the multipoint method be used in cases where test results may be subject to dispute, or where greater precision is required. The correlation on which the calculations of the one-point method are based may not be valid for certain soils, such as organic soils or soils from a marine environment. It is strongly recommended that the liquid limit of these soils be determined by the multipoint method. The liquid limit and plastic limit of soils (along with the shrinkage limit) are often collectively referred to as the Atterberg limits. These limits distinguished the boundaries of the several consistency states of plastic soils.

5. ASTM D698⁸

Soil placed as engineering fill (embankments, foundation pads, road bases) is compacted to a dense state to obtain satisfactory engineering properties such as, shear strength, compressibility, or permeability. In addition, foundation soils are often compacted to improve their engineering properties. Laboratory compaction tests provide the basis for determining the percent compaction and molding water content needed to achieve the required engineering properties, and for controlling construction to assure that the required compaction and water contents are achieved. During design of an engineered fill, shear, consolidation, permeability, or other tests require preparation of test specimens by compacting at some molding water content to some unit weight. It is common practice to first determine the optimum water content (w_{opt}) and maximum dry unit weight

($\gamma_{d,max}$) by means of a compaction test. Test specimens are compacted at a selected molding water content (w), either wet or dry of optimum (w_{opt}) or at optimum (w_{opt}), and at a selected dry unit weight related to a percentage of maximum dry unit weight ($\gamma_{d,max}$). The selection of molding water content (w), either wet or dry of optimum (w_{opt}) or at optimum (w_{opt}) and the dry unit weight ($\gamma_{d,max}$) may be based on past experience, or a range of values may be investigated to determine the necessary percent of compaction.

6. ASTM D1557⁹

Soil placed as engineering fill (embankments, foundation pads, road bases) is compacted to a dense state to obtain satisfactory engineering properties such as shear strength, compressibility, or permeability. In addition, foundation soils are often compacted to improve their engineering properties. Laboratory compaction tests provide the basis for determining the percent compaction and molding water content needed to achieve the required engineering properties, and for controlling construction to assure that the required compaction and water contents are achieved. The degree of soil compaction required to achieve the desired engineering properties is often specified as a percentage of the modified maximum dry unit weight as determined using this test method. If the required degree of compaction is substantially less than the modified maximum dry unit weight using this test method, it may be practicable for testing to be performed using Test Method D698 and to specify the degree of compaction as a percentage of the standard maximum dry unit weight. Since more energy is applied for compaction using this test method, the soil particles are more closely packed than when D698 is used. The general overall result is a higher maximum dry unit weight, lower optimum moisture content, greater shear strength, greater stiffness, lower compressibility, lower air voids, and decreased permeability. However, for highly compacted fine-grained soils, absorption of water may result in swelling, with reduced shear strength and increased compressibility, reducing the benefits of the increased effort used for compaction (2). Use of D698, on the other hand, allows compaction using less effort and generally at a higher optimum moisture content. The compacted soil may be less brittle, more flexible, more permeable, and less subject to effects of swelling and shrinking. In many applications,

building or construction codes may direct which test method, D698 or this one, should be used when specifying the comparison of laboratory test results to the degree of compaction of the in-place soil in the field. During design of an engineered fill, testing performed to determine shear, consolidation, permeability, or other properties requires test specimens to be prepared by compacting the soil at a prescribed molding water content to obtain a predetermined unit weight. It is common practice to first determine the optimum water content (w_{opt}) and maximum dry unit weight (γ_{dmax}) by means of a compaction test. Test specimens are compacted at a selected molding water content (w), either wet or dry of optimum (w_{opt}) or at optimum (w_{opt}), and at a selected dry unit weight related to a percentage of maximum dry unit weight (γ_{dmax}). The selection of molding water content (w), either wet or dry of optimum (w_{opt}) or at optimum (w_{opt}) and the dry unit weight (γ_{dmax}) may be based on past experience, or a range of values may be investigated to determine the necessary percent of compaction.

IV. ANALYSIS

Index Properties of Clay

To make sure the soil that we used is clay, we have to examine it's component thorough several tests. The test is used to determine a kind of soil and what kind of soil exactly it is. There are two big group of soil tests in soil mechanic, first is index properties tests and the second is mechanical tests. In index properties tests that conducted for this research, several of them show an amount of points in spesific units and several of them show a graphic that exactly determine type of soil. One of part from index properties test is Atterberg Limits tests.

Atterberg Tests

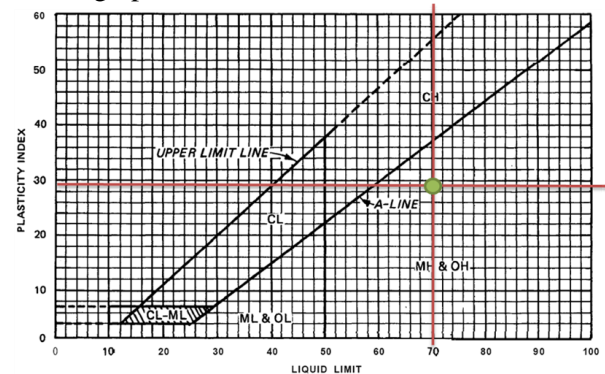
Atterberg tests stand of two kind of tests, such as liquid limit and plastic limit test. From both of them acquired plasticity index that can determine soil type. The first one is liquid limit tests, it show the difference of behavior form plastic condition to liquid condition. The second test is plastic limit test, it show the lowest water content where the soil start to plastic. In this condition

the plasticity determined with a scrolled soil in a palm, where it start to crack after 1/8 inch. The results from Atterbeg tests shown in tabel below.

Tabel 2 Atterberg test results

No	Type of Test	Result
1	Liquid Limit	70.00%
2	Plastic Limit	40.5%
3	Plasticity Index	29.5%

Based on Tabel 2 we determine the type of soil in graphic below.



Graphic 1 Atterberg Result

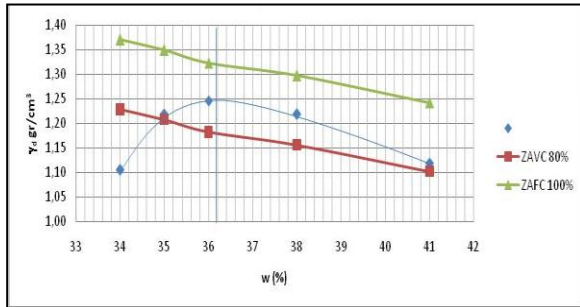
Based on graphic above we can see that the soil is in MH OH group. MH is an organic clay with low until high plasticity. It confirm the type of soil where the soil is taken from high land of West Java which have a high degree of fertility. A degree of fertility can be seen by it's kind of plants which live in the area.

Mechanical Test

There are several type of mechanical types with different output, one of them that used in this research is soil compaction tests.

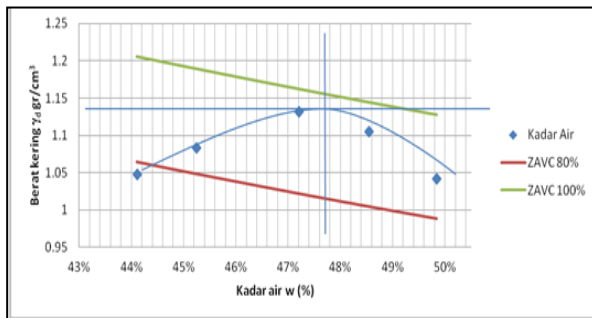
Compaction is a process to eject an air in soil pores with mechanical ways. In compaction every density that is gained based on an amount of water content. For example if the soil is too stiff to be compacted with a small percentage of water content, it needs more water to make it easier to be compacted. In higher water content the water density will down because soil pore was filled with water that can't be extracted

through the compaction. From this test we can gain maximum dry density and optimum moisture content. Maximum Dry Density (MDD) is a highest weight that gained at compaction test in certain energy. Optimum moisture content is a water content at Maximum Dry Density. The result of this tests is used to determine a terms that have to be fulfilled in compaction process. The Graphics results from every compaction tests are shown below.



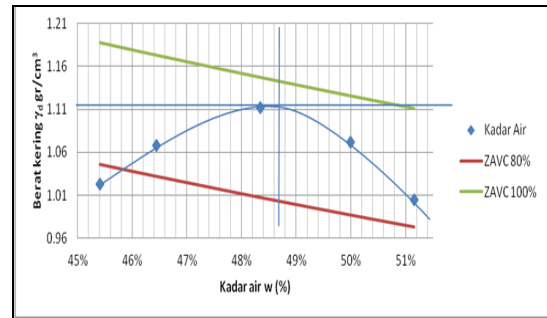
Graphic 2 Compaction Graphic of 100% Clay

This graphic shows MDD 1.25 gr/cm³ and OMC 36.2%



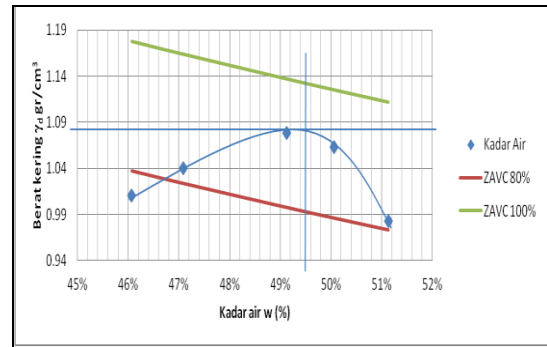
Graphic 3 Compaction Graphic of 95% Clay and 5% Slake Lime

This graphic shows MDD 1.13 gr/cm³ and OMC 47.5%



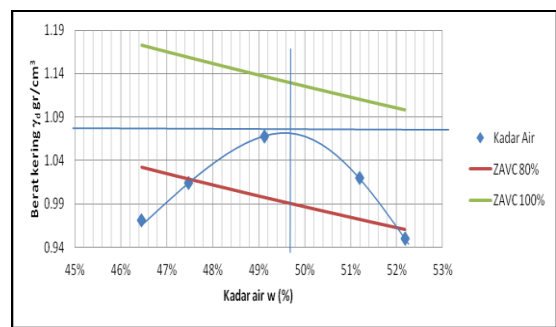
Graphic 4 Compaction Graphic of 80% Clay and 20% Slake Lime

This graphic shows MDD 1.14 gr/cm³ and OMC 48.5 %



Graphic 4 Compaction Graphic of 65% Clay and 35% Slake Lime

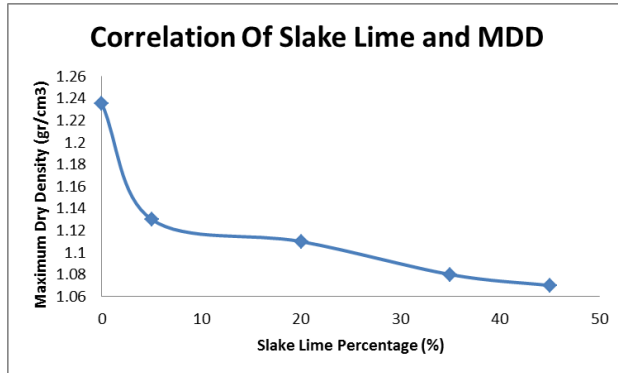
This graphic shows MDD 1.08 gr/cm³ and OMC 49.5 %



Graphic 4 Compaction Graphic of 55% Clay and 45% Slake Lime

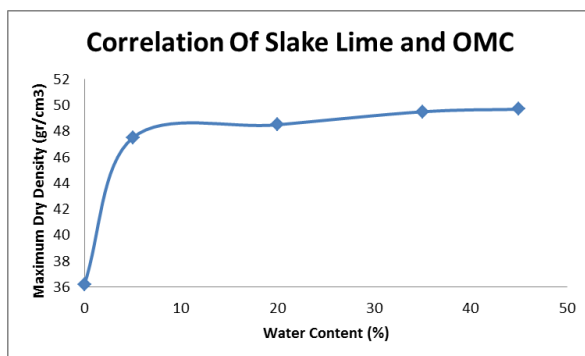
This graphic shows MDD 1.07 gr/cm³ and OMC 49.5 %

From the figure above it possible to create graphics that show the corelatin between lime concentrate with MDD and lime concentrate with OMC.



Graphic 5 Correlation of Slake Lime and MDD

Based on graphic above we can see that consistent with an increase of slake lime percentage it decrease the maximum dry density. The decrease of maximum density is caused by the increase of pores in soil while the volume is remain. The pores is filled with water and after it is removed from the oven the water is evaporate and leave a pores filled by air. It can be seen from the chart that the higher an amount of lime, it will be lighter because of more pores are formed.



Graphic 6 Correlation of Slake Lime and OMC

Based on graphic above we can see that consistent with an increase of slake lime percentage it increase the optimum moisture content. The increase of moisture content is caused by an increase of pores in soil while the volume is remain. The pores is filled with water and after it is removed from the oven the water is evaporate and leave a pores filled by air. It can be seen from the chart that the higher an amount of lime, it will be lighter because of more pores are formed and water that filled had been evaporated.

V. CONCLUSION

Based on research results and discussion above, the conclusion of this research are :

- a. The reaction between slake lime and clay increase the pores of soil, it can makes the soil lighter and decrease the burden of soil in stability calculation.
- b. The increase of pores also increase the ability of soil to absorb the water, it can help to reduce run off in upper area to prevent the flood happened in downstream area.

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