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EFFECT OF SOAKING TIME ON THE BEARING CAPACITY AND SWELLING POTENTIAL OF EXPANSIVE SOIL WITH THE MIXING DOLOMITE PLUS BOTTOM ASH

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ABSTRACT

Soil properties are poor and less profitable when used as the basis of a building or construction, among others, high plasticity, low shear strength and great congestion that can cause harm, especially in the structure of lightweight construction and road highway. Expansive soil is soil that has a high sensitivity that can cause damage to the buildings standing on it. Tests were conducted preliminary testing to obtain the physical properties and the California Bearing Ratio (CBR) value of the original soil as well as follow-up testing is done to stabilize 0%, 3%, 6%, 9%, 12% and 15% dolomit and bottom ash. Tests were carried out, namely the Atterberg limits, sieve analysis, hydrometer, specific gravity, compaction and CBR (soaked) using the optimum moisture content obtained from the native soil compaction testing to get the value of swelling potential with soaking time 0, 1, 4, 7 and 14 days. Results of tests performed by dolomit and bottom ash on expansive soil (Bentonite) can improve the physical properties, increase the bearing capacity unsoaked and lower the swelling potential value of the soil base.

Keywords: expansive soil, soaking, California bearing eatio, swelling potential.

1. BACKGROUND

Expansive soil generally has less favourable properties for civil construction because of its very high water content, low carrying capacity and high shrinkage properties. It is necessary to make an effort to repair the soil to improve the soil properties. Expansive soil has a high degree of sensitivity and has the nature and expansion of shrinkage that can cause damage to buildings standing thereon, this soil also has the competence to expand and contract very highly due to changes in moisture content in the soil. Inflate the value of soil has a low bearing capacity that needs to be improved so that the ground swells to get a more stable soil.

2. INTRODUCTION

According to (Bowles, 1984), Bentonite is a deposit having particles of 0.002 mm or smaller than that in amounts greater than 50%. According to Mitcheel (1976), Bentonite is defined as soil particles measuring <0.002 mm, while ASTM provides a limitation that physically the size of Bentonite is escaped from filter No. 200.

Low soil bearing capacity is unfavourable when used as a subgrade to support a building. Many of the losses would be caused, among other damage to the soil and building construction purposes itself. Although the damage is not caused by sudden and immediate but caused material losses will be large enough, there should be efforts to increase the bearing capacity of the expansive soil. The selection of stabilization materials also needs to be considered, as the availability of existing materials at construction sites and the contribution of stabilizing materials in improving soil properties expands.

Stabilization of infested soils has been widely practiced using cement, Dolomite, chemicals by Desiani A., (2003), Anagnostopoulos C.A. and Chatziangelou M, (2008), coal ash by Mallikarjuna K and Rama Subba G.V, (2008). Bottom ash is one of the wastes of palm processing expected to have the potential to improve the soil properties expands.

3. LITERATURE REVIEW

According to Craig (1997), soil is the accumulation of mineral particles that have no bonding or weak bonds between particles formed by weathering rocks. The weakening of such bonds is the influence of carbonates or oxidation or the influence of organic content. According to Karl Tarzaghi (1987), soil is an aggregate of natural mineral granules commonly separated by a mechanical means of aggregate including stirring in water. Braja M. Das (1988) defines soil as a material consisting of aggregates (granules) of unregenerated (chemically-bonded) solid minerals with each other and from decayed organic materials (solid particles) with liquids and the gas that fills the empty spaces between the solid particles.

According to Sukoto (1984) explains that bentonite is a microscopic particles derived from weathering rocks. The expandsive soil of Bentonite is plastic at moderate moisture content and in dry state Bentonite is very hard and is not easily exfoliated with fingers. In higher water conditions the bentonite is very soft and cohesive and has a high shrinkage properties.

Bentonite determination is insufficient only in terms of grain size, but also known minerals contained in it.

Bentonite that has high development properties is very much in nature, the swlling of Bentonite occurs when the water content increases from its reference value, and

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depreciation occurs when the water content is below the reference value to the shrinking limit.

Usually a Bentonite clay can is expansive to have a large content change (expand), if the Plasticity Index ≥ 20 (Soedarmo & Poernomo, 1997).

According Q. Wiqoyah 2009 level of soil plasticity is divided into 4 levels based on plasticity index values that exist in the interval between 0% and 17%. Limits on plasticity index, properties, kinds of soil, can be seen in Table-1.

Table-1. Value and plasticity index of soils.

PI	Various	Soil Properties
0	Non plastis	Sand
< 7	Low plasticity	Silt
7 – 17	Medium plasticity	Silt clay
> 17	High plasticity	Clay

Source: Atterberg, 1911, in Qunik Wiqoyah 2006

According to Chen (1988), soil with IP > 35, SL > 11, and LL > 63 is a clay that has swelling potential was high. Of relationship plasticity index of the swelling potential given Chen (1975) can be stated the greater a mineral soil plasticity index, the greater swelling potential (see Table-2).

Table-2. Relationship swelling potential with plasticity index .

Swelling the potential	Plasticity index (IP)
low	0 - 15
medium	10 - 35
high	20 - 55
very high	> 55

Source: Chen 1975

According Panjaitan, SRN (2014), conducting a study entitled The Effect of Limestone on the Bearing Capacity of Expansive Clay and Swelling. CBR soak test results with the addition of lime 0%, 2%, 4%, 6%, 8% and 10% with soaking time of 1, 4, 7 and 14 days. It is known that the longer the time of immersion is carried out, the further the CBR soak value is compressed with 56 strokes. This happens because the longer the immersion occurs, the more the soil expands and the amount of water that enters the mold soaked more and more, then when the penetration value is obtained, it will decrease. The addition of 4% lime shows that the CBR value meets the carrying capacity requirements of the soil according to ASSHTO, because the CBR value is > 9% at the time of soaking 1-14 days. An increase in CBR values is higher with the addition of lime between 4 - 6%. From the results of this study can be seen in Figure-1.

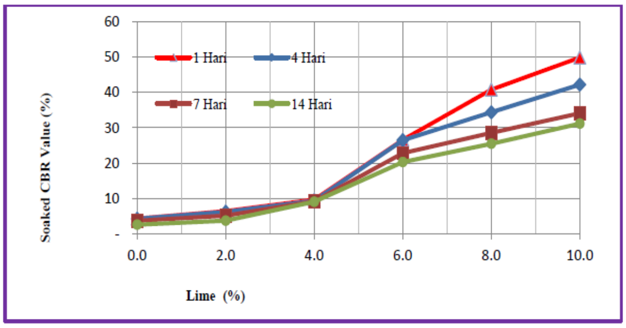

Figure-1. Mixing lime To CBR with soaking time.

4. RESEARCH METHODS

The study was conducted using clay (Bentonite) samples from North Sumatra. Bottom ash and Dolomit is material stabilisers.

Tests were performed on the preliminary research stage include:

- Atterberg limit
- Spesific gravity
- Seive analysis
- Compaction test

Further testing is done by mixing 0%, 3%, 6%, 9%, 12%, and 15% with dolomit plus bottom ash on clay and California Bearing Ratio (CBR) testing is done soaked and unsoaked to determine the bearing capacity and swelling potential of soil policy.

5. RESULTS AND DISCUSSIONS

The soil used in testing is bentonite, and is classified as inorganic clay with high plasticity (CH) in the AASHTO soil classification: A-7-6 namely clay with high plasticity index, thus classified as clay soil with high plasticity because Plastis Index ≥ 17% (Atterberg, 1911, in Qunik Wiqoyah, 2006), to variations dolomit and bottom ash 2%, 4%, 6%, 8% and 10%, including the group ML - OL namely inorganic clay with plastic low up to now, according to a unified classification. Whereas according to the AASHTO classification: A-7-5. The physical properties of the original clay are shown in Table-3.

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Table-3. Physical properties of original clay.

No	Nature of soil	Unit	The original clay
1	Specific Gravity (Gs)	-	2.68
2	Plastic Limit (PL)	%	43,52
3	Shrinkage Limit (SL)	%	38,85
4	Liquid Limit(LL)	%	99,63
5	Plastic Index (PI)	%	56,11
6	Sieve Analysis	%	79,60
7	Dry weight contents (γd max)	gr/cm³	1,39
8	Optimum Moisture Content (Wopt)	%	42,67

5.1 Physical Properties of Original Soil, Stabilized with Dolomit and bottom ash

The effect of mixing with dolomit plus bottom ash on soil physical properties of clay (the original) is dependent on the percentage mix of dolomit plus bottom ash used. Variations such as a percentage addition of dolomit plus bottom ash stabilization on clay soils can alter his physical attributes.

5.2 Atterberg Limits

Test results atterberg limits on boundary clay stabilized with dolomit plus bottom ash can be seen in Figure-2.

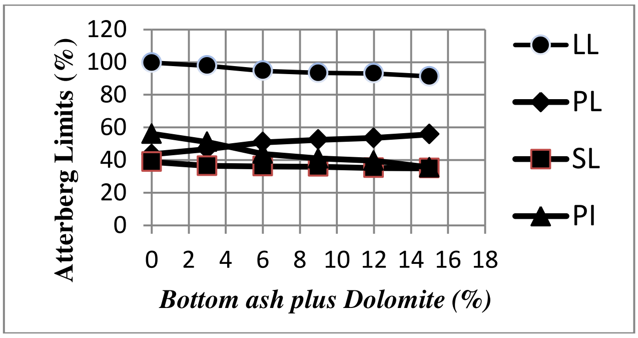

Figure-2. Results of Atterberg limit testing soil clay mixing Dolomit plus bottom ash (%).

Bentonite test results obtained a liquid limit 99.63% and a plastic index 56.11%. According to AASHTO, the land belongs to the A-7 group and is a type of clay that is not feasible to use. While according to the Unified System classification, with a liquid limit of 99.63% and plastic index of 56.11%. It can be concluded that bentonite belongs to the CH group which is inorganic clay with high plasticity, expansive clay / expanded.

Figure-2 shows the percentage of the addition of dolomit plus bottom ash to 2% value of plastic limit increased, but for liquid limit, shrinkage limit and plastic index decline the value of Atterberg limits testing clay without dolomit and bottom ash mixture (native soil). With the addition of dolomit plus bottom ash percentage is 4%, 6%, 8% and 10%, the plastic limit value is increasing and the liquid limit, shrinkage limit and plastic index decrease. In addition, the percentage of 4% of the value of the IP is below 17%, i.e. 16.64%, but the percentage of dolomit plus bottom ash addition of 10% value of its IP is that low of 10.67% Atterberg limit test results for an increase in the value of the plastic limit.

The result of the plastic index show decrease due to the mixing of dolomit plus bottom ash, a decrease in the optimal occurred on the addition of dolomit and bottom ash. This decrease causes the value of the swelling potential of soil clay. Plastic index values obtained from the experiment results according to Atterberg 1911 in Qunik Wiqoyah 2006 classified the nature of high plasticity and according to Chen in 1975 on high swell potential. According to OG Ingles and Metcalf, 1972, the addition of dolomit and bottom ash is good for stabisasi material clay with dolomit and bottom ash.

5.2 Specific Gravity

Specific gravity test results on clay stabilized with dolomit plus bottom ash can be seen in figure 3 shows the result of this test influence the addition of dolomit plus bottom ash clay soil, clay soil density decreased with the increasing percentage of the addition of dolomit plus bottom ash. Based on the results of tests performed in Figure-3, about the physical properties of the original soil. That the specific gravity of the soil decreases, this is due to lower specific gravity than the dolomit plus bottom ash heavy soil types tested, so the specific gravity of the mixture of soil with dolomit plus bottom ash, the resulting decline in shrinking pores and soil particles more glue.

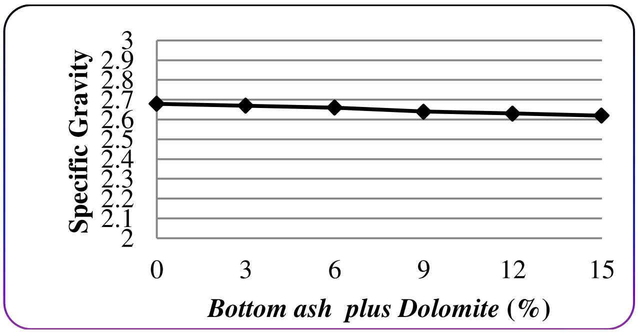

Figure-3. Relationship the mixing among Dolomit plus bottom ash to the specific gravity.

5.3 Sieve Analysis

The results of the sieve analysis mixed with bottom ash and dolomite can be seen in Figure-4. From the results of the test analysis of the filter by increasing the bottom ash mixture, it causes a change in the composition of the soil fraction i.e. the percentage of Sieve Analysis No. 200 escapes decreases.

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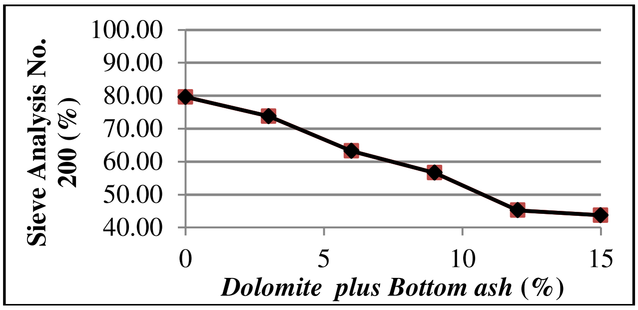

Figure-4. Relationship the mixing among dolomite plus bottom ash to the sieve analysis.

5.4 Compaction Test

Soil compaction results will be obtained with optimum water content and maximum dry unit weight. Soil compaction testing laboratory using the Standard Proctor compaction, compacted with 25 blows with a standard proctor. The results of testing the original clay soil compaction can be seen in figure 5 and clay stabilized with dolomit and bottom ash can be shown in Table-4.

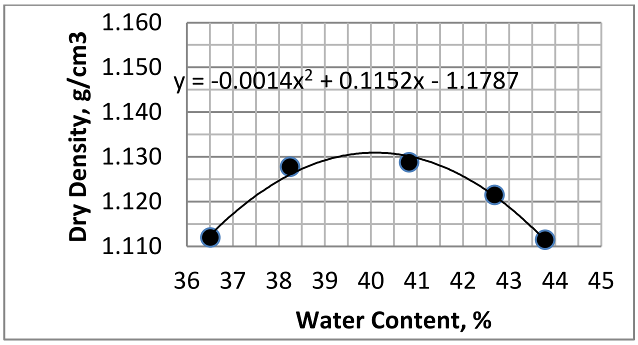

Figure-5. Results of testing Standard Proctor compaction is stabilized with dolomit and bottom ash.

Table-4. Results of Standard Proctor compaction is stabilized with dolomit and bottom ash.

No	Bottom ash plus Dolomit (%)	Dry Content Weight (gr/cm^3)	Optimum of Water Content (%)
1	0	1,390	42,67
2	3	1,133	41,20
3	6	1,131	40,20
4	9	1,130	40,00
5	12	1,127	38,70
6	15	1,200	37.30

It can be influenced by the chemical composition of dolomit and bottom ash contained in alumina and silica active especially if mixed with CaO derived from dolomit and bottom ash stone that forms a strong bond when added to water, the chemical reactions that occur due to events that meet the hydration of CaO with active silica (Lea, F, M, 1970). Because dolomit and bottom ash are heated, the water in the clay decreases. So it can be concluded that each additional dolomit and bottom ash can reduce the water content and increase the weight of the optimal cleaning up will be more compact, and the pores of the soil will be getting smaller.

5.5 CBR with Soaking Time

Results of testing CBR with the addition of bottom ash plus dolomite 0 %, 3 %, 6 %, 9 %, 12 % and 15 %. CBR test results can be seen in Figures 6 and 7.

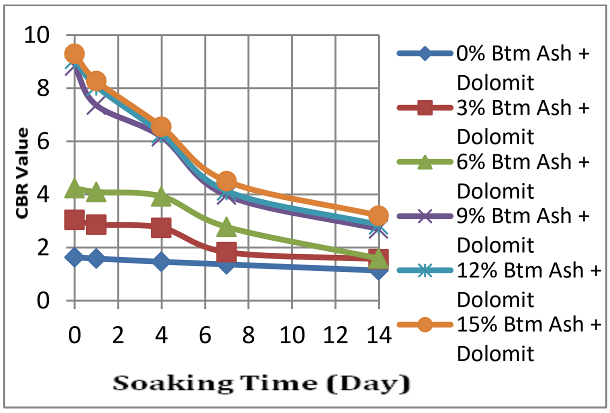

Figure-6. Relationship value of bearing capacity among bottom ash and Dolomite with soaking time.

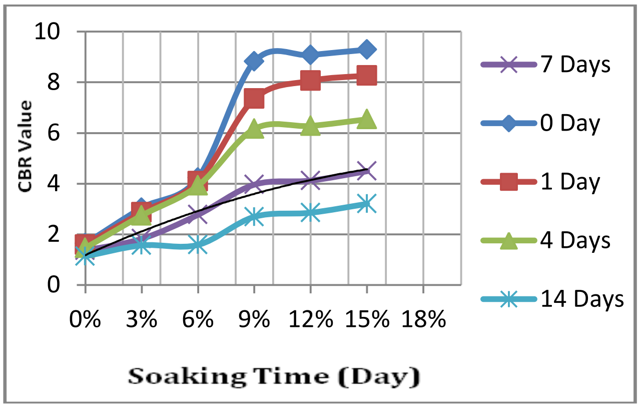

Figure-7. Relationship Value of B among bottom ash and Dolomite with soaking time.

Based on Figures 6 and 7 that the results of the immersion value decreased when compared to the CBR value without soaking. Where bentonite has very high water absorption, the longer the immersion is carried out, the lower the CBR soaking value. It happens because the longer the immersion occurs, the more bentonite expands, and the amount of water that enters the mole, the more the penetration of the CBR decreases.

5.6 Swelling Potential

Figures 8 and 9, the largest swelling value occurs in 14 days bentonite soaking time of 14.45%, according to seed *et al* (1962) swelling value of 14.45% is between 5-25% then the bentonite is considered high expansion potential. Where the value of swelling with the addition of bottom ash 15% with 1 day to curing time has reached < 1.5% then it is classified as having low expansive degree according to seed *et al* (1962).

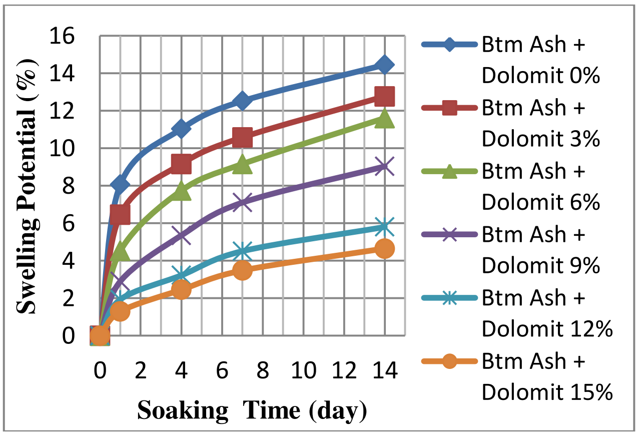

Figure-8. Graphs the relationship the soaking time with swelling.

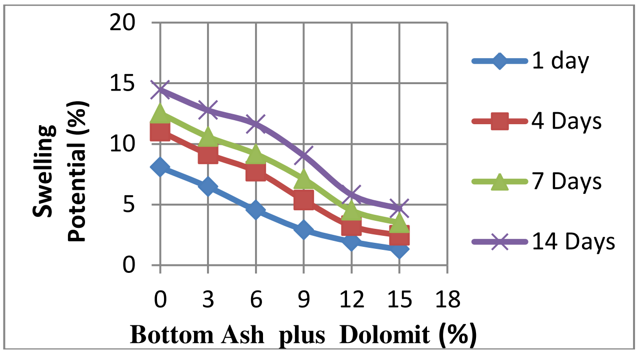

Figure-9. Graphs the relationship the bottom ash plus dolomit with swelling.

6. CONCLUSIONS

Based on the Unified classification, bentonite (expansive clay soil) belongs to the CH group of inorganic clay soils with high plasticity. While according to the classification AASHTO, bentonite is included in class A-7-6 and is not good soil used as a base ground.

Atterberg test result with the addition of bottom ash 15% can decrease plasticity index with a difference of 20, 66%. Result of the compaction test with modified proctor obtained by weight of bentonite dry content 1,390 gr / cm3 and optimum water content equal to 42,67%. The mixing of bottom ash 3%, 6%, 9%, 12%, and 15% can increase the dry fill weight and decrease the optimum water content.

The value of California Bearing Ratio (CBR) bentonite (expansive soil) was 1.63% and there was a significant increase of CBR value in the 12% ash bottom mixture of 9.08 and 15% by 9.29%. On the mixing of bottom ash, 12% and 15% have met the requirements of good soil-bearing capacity according to AASHTO because the value of CBR > 9%. After soaking the CBR value decreases with each addition of dolomite plus bottom ash in accordance with the soaking time.

The greatest swelling value occurs in 14 days bentonite of soaking time of 14.45%, then the bentonite is classified as a high swelling potential. Where the value of swelling with the addition of bottom ash 15% with 1 day soaking time has reached < 1.5% then it is classified as having a low expansive degree.

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