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ANALYZED SOIL IMPROVEMENT BASED GYPSUM AND CEMENT IN SOIL CLAY

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Abstract

Land is an important element of the structure underneath a construction, so that the soil must have a good carrying capacity. But the reality on the ground is that many soils have low carrying capacity, so it is necessary to stabilize the soil with gypsum and cement. This study aims to determine the effective percentage of gypsum and cement addition and the effect of the addition of Gypsum and Cement to physical changes in clay soil in terms of the CBR (California Bearing Ratio) value of the curing time. This research was conducted in the laboratory, by testing the physical properties of the soil and the carrying capacity of the soil (CBR) with variations in the addition of gypsum and cement by 1%, 3%, and 5% with a long curing time of 1, 7, and 14 days . Sample testing is carried out with two treatments, namely soil samples are first cured and then compacted and the sample is solidified first and then cured. From the research results obtained the largest CBR (California Bearing Ratio) value occurs in the variation of the addition of Gypsum and Cement 5% with the length of time for soil specimens to be compacted first before curing is equal to 41.54%, this is due to the mixture of soil with gypsum and cement has been manjai solid before the collection can occur, the cavities between soil particles also become solid, so that the strength also increases. From the California Bearing Ratio results, it can be seen that the addition of gypsum and cement to clay soil shows an increase in the value of California Bearing Ratio on clay.

Keywords: CBR; Curing Time; Gypsum and Cement Stabilization.

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1. Introduction

The strength of subgrade is very important, so it is necessary to stabilize the soil with gypsum and cement. This is because the stability of the soil with gypsum and cement is more suitable for a longer time. So, it can be advantageous if there is a longer work delay after mixing and there is no risk of decreasing the strength of the mixture due to compaction.

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The development of human civilization has experienced very significant progress since the last thousand years, including the transportation sector. Human activities in meeting their daily needs must sometimes lead to mobilization, therefore we need facilities that support these mobilization activities.

The road is the main factor that underpins human activities in making the move. The term road has existed since Roman times named Via Sratea, a route consisting of various layered materials (Copsom Malcom, Ancill roy, Kendrick, Peter S, Wignal Artur, Project road theory and practice, p. 2, 2003).

In determining the carrying capacity of the soil, there are several ways to determine the ability of the soil to carry loads, one of which is the California Bearing Ratio test, the California Bearing Ratio, is a test to determine a relative material used as a foundation layer for a standard material (SNI 03- 1738-2011, CBR Field Test Method). Determination of the carrying capacity of the soil with the California Bearing Ratio, is inseparable from other soil parameter tests, but all are interconnected. Therefore, before carrying out the California Bearing Ratio test, other soil tests are needed, one of which is testing the optimum moisture content (Standard Proctor).

CBR is an empirical method for measuring soil density values. This method was first invented by O.J Porter, then developed in California, United States. This method combines attempted loading of penetration in the laboratory or in the field with an empirical plan to determine the thickness of the pavement layer. To get the CBR value it is called the thickness of the pavement layer. To get the CBR score it is called the CBR test. The CBR test was developed around the 1930s at the Laboratory of Materials Research Department of the California Division of Highway, USA, CBR is a comparison between test load and standard load and expressed as a percent. Based on the existing background, the construction of the road construction must first be considered for the subgrade to avoid damage when holding traffic loads that will be received.

Therefore, the research is interested to study more deeply about stabilized clay soil with gypsum and cement. Research on the stabilization of clay has been carried out, among others research Arif Wibawa (2015), Maryati (2016) Analysis of the use of gypsum waste with cement as a material for stabilizing clay soil and Yayuk Apriyanti (2016) Increasing CBR Value of Clay Soils by Using Cement for Stockpiling Street. From the above research it is explained that the addition of addictive substances (lime, rice abusekam, kettle crust) will be able to improve the properties of soil mechanics and increase the carrying capacity of expansive clay. The study is expected to determine the effective percentage of lime addition to changes in physical properties of the soil in terms of the value of the CBR (California Bearing Ratio) to the curing time, so that it is expected to be a good pile or subgrade and high economic value. This is why the authors are interested in conducting scientific research for the final project with the title "Analysis of the Effect of Addition of Gypsum and Cement for Clay Soil Stabilization Against CBR Value.

2. Literature Review

Clay soils consist of very small grains (<0.002 mm) and show the properties of plasticity and cohesion showing the fact that the parts are placed against each other, whereas plasticity is a trait

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that allows the shape of the material to be changed without this change or without returning to its original form and without cracking or fragmentation (LD Wesley, 1977).

Clay particles can be shaped like sheets which have a special surface; therefore, clay soil has the property of being strongly influenced by the general surface forces, there are approximately 15 types of minerals classified as clay minerals. some minerals classified as clay minerals are montmorrillonite, illete, kaolinite, and plygorskite (Hardiyanto, H.C., 2006).

All types of soil in general consist of three materials, namely the soil grain itself, and water and air contained in the space between these grains. This room is called pores (voids) when the soil is completely dry there will be no water at all in its pores, this kind of situation is rarely found in soil that is still in its original state on the ground. Water can only be completely removed from the soil if we take special action for that purpose, for example by heating it in an oven (Wesley, L.D. 1977, Page 1).

The role of this land is very important in the planning or implementation of buildings because the land serves to support the burden on it, therefore the land that will be used to support construction must be prepared in advance before being used as a subgrade.

2.1. Soil Classification System

The classification system provides an easy language to easily explain the general characteristics of soils that vary greatly without detailed explanation. Most soil classification systems that have been developed for engineering purposes are based on simple soil index properties such as grain size distribution and plasticity.

2.2. Unified Classification System

The unified classification system classifies soils into two major groups, namely: coarse-grained soil, which is gravel and sand where less than 50% of the total weight of the soil sample escapes sieve number 200. Symbols of this group begin with the initial letter G or S, G is for gravel or gravel, and S is for sand or sandy soil. Fine-grained soil is a soil where more than 50% of the total weight of a sample of the sieve soil escapes sieve No. 200. The weight of this group starts from the initial letter M for inorganic silt (C) for inorganic clay, and O for organic silt and organic clay. PT Symbol is used for peat muck and other soils with high organic content. Other symbols used for the USCS classification are: W = well graded (soil with good gradation), P = Poorly graded (soil with poor gradation), L = low plasticity (LL50). Coarse grained soils are marked with group symbols such as: GW, GP, GM, GC, SW, SP, SM and SC. For correct classification, the following factors need to be considered: Percentage of granules that pass the sieve No. 200 (this is a fine fraction).

2.3. AASHTO Classification System

This land classification system was developed in 1929 by the public road administration classification system. This system has undergone several improvements to the current version

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proposed by the Committe On Classification Of Materials For Subgrade And Gramular Type Road Of The Highway Research Board in 1945 (ASTM Standard No. D 3282, AASHTO M145 method). In this system the soil is classified into seven major groups namely A-1 to A-7. Land classified as A-1, A-2, and A-3 are grained soils in which 35% or less of the amount of grains escapes sieve No. 200. Land where more than 35% of the grains pass No. 200 sieve are classified into groups A-4, A-5, A-6 and A-7. The grains in groups A-4 to A-7 are mostly silt and clay.

2.4. Percentage of Coarse Fraction That Passed the Sieve No.40

Uniformity coefficient (Cu coefficient) and gradation coefficient (gradation coefficient, cc) for soils where 0-12% pass the sieve No. 200 Liquid limit (LL) and plasticity index (PI) how the soil passes the sieve No. 40 (for land where more than 5% passed sieve No. 200). When the percentage of grains that pass the No. 200 sieve is between 5 to 12% double symbols such as GW-GM, GP-GM, GW-GC, SW-SC, SP-SM, and SP-SC it is necessary to classify fine-grained soil using symbols ML, CL, OL, MH, CH, and OH are obtained by drawing the liquid limit and the plasticity index in question on the plasticity chart (Casgrade, 1948).

2.5. Land Consistency

If fine-grained soil contains lampung minerals, the soil can be remolded without causing cracks. This collective nature is caused by the presence of absorbed water around the surface of the clay particles. In early 1900 a Swedish scientist named atterbarg developed a method to explain the consistency of fine-grained soils at varying water contents when the water content was very high, a mixture of soil and water would become very stable.

2.6. Liquid Limit

The liquid limit is defined as the water content contained in the soil at the boundary between the liquid and plastic phases. Plastic Limits. The plastic limit is defined as the water content in the soil in the phase between plastic and semi-solid. If the water content in the soil decreases, the soil will become harder and have the ability to withstand changes in shape.

2.7. CBR Measurement

CBR measurements include two types, namely: CBR value for penetration pressure at 0.254 cm (0.1) against Standard penetration is 70.37 kg / cm^2 (1000 psi) CBR value = (PI / 70.37) X100% (PI in kg / cm^2) m CBR value for penetration pressure at 0.508 cm (0.2) against Standard penetration of 105.56 kg / cm^2 (1500 psi) CBR Value = (PI / 105.56) X100% (PI in kg / cm^2) From the second CBR the largest value calculation is used.

2.8. CBR Laboratory

Laboratory CBR can be divided into two, namely: CBR Soaked Design CBR Laboratory Unsoaked Design CBR.

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In the implementation of laboratory immersion CBR testing is less because it requires time and relative costs greater than laboratory CBR without immersion, while the results of laboratory CBR testing without immersion so far have always resulted in greater soil carrying capacity compared to the immersion laboratory CBR.

3. Research Methods

Soil samples were taken from the land of PTPN II Kebun Patumbak Deli Serdang, North Sumatra. Before the research was carried out there were several stages to be carried out, namely making proposals, gathering information and studying literature, taking test specimens in the field, preparing stabilization materials, preparing for laboratory, consultations with supervisors. These activities are the initial series of preparatory work.

Field work is carried out by taking soil samples. Soil samples taken include disturbed soils and undistrub soils, but in this study sufficient sampling with disturbed soils (disturbed soils). Soil research was conducted at the Medan State Polytechnic Civil Laboratory (POLMED).

Table 1: Summary Laboraturium

Jenis Pemeriksaan	No.	(mm)	Hasil PTPN II Patumbak	Keterangan
Gradasi (Kumulatif Lolos dalam %)	No. 4	4.750	100.00	Kelompok Tanah dalam Sistem AASHTO : **A-7** **Tanah Berlempung**
	No. 10	2.000	99.09	
	No. 20	0.850	97.18	
	No. 40	0.425	94.27	
	N0. 60	0.250	90.32	
	No. 100	0.150	85.75	
	No. 200	0.075	81.65	
Specific Gravity			2.63	
Atterberg Limit	LL	(%)	41.54	
	PL	(%)	22.63	
	IP	(%)	18.91	
	Activity	(%)	0.936	
Compaction	w opt.	(%)	22.29	
	γd max.	(gr/cm³)	1.45	
CBR 100% MDD	(%)		10.52	

Sumber Laboraturium Politeknik Negeri Medan (POLMED),2018

Tables 2: Control Bearing Ratio (CBR)

Decrease (mm)	Dial Readings (Divisi)	Loads (KN)
0.0000	0	0.000
0.3120	9	0.240
0.6200	12	0.300
12.500	23	0.690

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18.700	38	1.020
25.000	49	1.260
37.500	56	1.620
50.000	70	1.950
75.000	90	2.700
100.000	138	3.300

Tables 3: Value of Data

Unit Weight	Diameter of Mould	15.21	[cm]
	Height of Mould	12.72	[cm]
	Volume of Mould	2.312.119	[cm3]
	Weight of Mould	4480	[gram]
	W Mould + Soil	8580	[gram]
	γ wet of soil	1.773	[gram/cm3]
	γ dry of soil	1.432	[gram/cm3]
	Weight of Cont.	13.80	[gram]
Water Content	Weight of Cont + wet soil	170.60	[gram]
Before Soaking	Weight of Cont + dry soil	140.40	[gram]
	Water Content	23.85	[%]
	Weight of Cont.	13.80	[gram]
Water Content	Weight of Cont + wet soil	134.40	[gram]
After Soaking	Weight of Cont + dry soil	104.00	[gram]
	Water Content	33.70	[%]

1 KN = 224.809 lb CBR 0,1” = $\frac{1.169 \text{ x } 224.809}{3x1000}$ x 100% = 8,76%

CBR 0,2” = $\frac{2.209 \text{ x } 224.809}{3x1500}$ x 100% = 11,03%

4. Effect of Gypsum and Cement Addition on Clay Soils on Subgrade Plasticity

The difference between the liquid limit and the plastic limit is the area where the soil is in a plastic state. The plastic index shows the plasticity of the soil. The greater the clay plasticity, the greater the clay's cohesive nature.

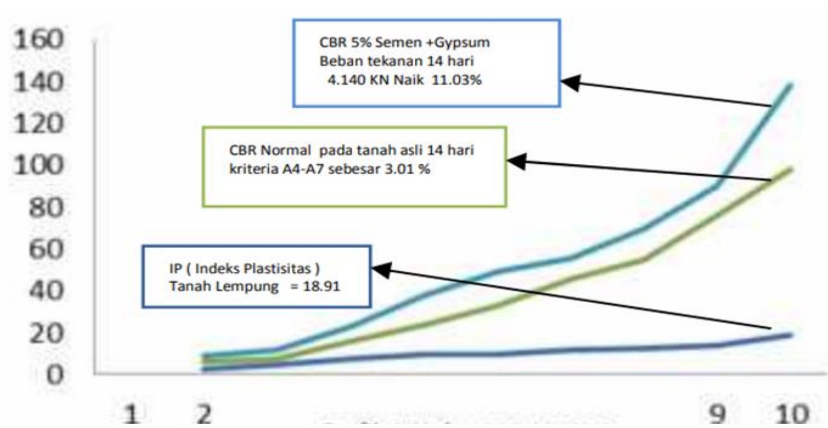

Figure 1: Relationship of Mixed Variation and Plasticity Index

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Plasticity Index (PI) = liquid limit (LL) -lastic limit (PL). this relationship shows that the PI value is highly dependent on the liquid limit value and the plastic limit adding the percentage of gypsum and cement can decrease the liquid limit and increase the plastic limit then the plasticity index will rise, the increase is influenced by the air that has disappeared due to the mixture of Cement and Gypsum and if the decrease occurs because the amount of air and binding particles does not remove air in the clay. Like the theory from Maryati (2016) Analysis of the Use of Gypsum Waste with Cement as a Material of Clay Soil Stabilization and Yayuk Apriyanti (2016) Concerning the Increased Value of Clay Soil CBR by Using Cement for Piles of Road. The increase in IP can be seen in the picture above due to the addition of gypsum and cement. An increase in the plastic limit was 22.63% and the liquid limit was 41.54% so that the plastic index obtained was 18.91% with the addition of 5% curing period of 14 days.

From the results of experiments that have been carried out there is a change in classification based on the plasticity index, namely the nature of the soil from high plasticity to medium plasticity. Identification of soils with high plasticity is generally associated with clarification of the level of soil overlay. Holts and gibs as cited in Nelson and the 1992 military (a model of quality control of earthworks, road geotechnical centers 2009) classifies the potential for developing a land based on its liquid limit and its plasticity index the following table is a test index with the level of development.

5. Conclusions

So, in this conclusion we can give conclusions:

1) On the addition of a mixture of gypsum and cement with a 5% content an increase in the CBR value in clay soil. Increase in CBR value is 224,809 lb.
2) This increase increased by 101,971 kg / m compared to the original land. This increase occurs because gypsum and cement contain calcium which binds organic soil to clay. Gypsum and cement also absorb more water so that making a mixture of gypsum and cement to soil samples will become harder and stronger.
3) The ripening carried out with 7 days and 14 days affects the increase in the compressive strength of the CBR value to the sample becoming harder and stronger. The increase in the maximum value of shear strength occurred during curing for 14 days, namely 4,140 KN or equivalent to 422.16 kg / m. This increase is predicted to occur because the water content in the sample changes slightly during ripening so that the sample becomes harder, and also the bond between soil paticles and gypsum and cement gets stronger.
4) Based on the test results above, it is concluded that the tested clay soil belongs to the CH group (according to USCS) and A-7-6 (19) (according to AASHTO), which is non-organic clay with high plasticity.

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