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The Effect Addition of Lime and Alum on the Blanket of Screw Piles in the Framework of Increasing Friction on Screw Piles

Asmadi*[1], Zeldi Muhardi[1], Rizal[1]

[1]Civil Enginerring department, Pontianak State Polytechnic, Jenderal Ahmad Yani Street, Indonesia

ABSTRACT

Foundations are an important element in building construction, and errors in their planning can lead to total structural failure. This research aims to improve the friction of screw piles by adding Calcium Hydroxide ($Ca(OH)_2$) and Alum ($Al_2(SO_4)_3$) chemicals, which are believed to improve soil stability. The research was conducted with two models of piles: a model without chemicals and a model with the surface of the pile treated with a mixture of $Ca(OH)_2$ and $Al_2(SO_4)_3$. Both models were staked in clay soil in the yard of Politeknik Negeri Pontianak and loaded after 2 days. The test results showed that the piles with chemicals experienced a maximum settlement of only 2.66 mm which stopped on day 2, compared to 8.19 mm for the piles without chemicals which stopped on day 9. Thus, the use of the chemical was able to reduce the settlement by 5.53 mm or 32.48%, indicating a significant improvement in the bearing capacity of the screw piles.

Keywords: Foundation, Lime, Alum, Adhesion, Piles

1. Introduction

The foundation is the most influential part of the sturdiness of building construction. Therefore, when planning construction, planning the foundation structure is the first thing to get attention. Not all types of foundations or foundation models can be used in every building construction, this must be seen and adjusted to the weight of the building and the type of soil around the building foundation (Sargjoni, 2021).

At this time, various types of deep foundations have been widely used. The use is adjusted to the amount of load, site conditions, and soil layers. The name of the foundation type varies greatly depending on the individual who defines it. The classification of piles based on the method of implementation is the drive pile (minipile), which is a pile installed by making round, square, elongated triangular materials that are staked by pressing into the ground; drilled piles (drilled sheft) poles are installed by drilling the ground first to a certain depth, then steel reinforcement is inserted into the hole, then casted, caisson, which is a box or cylinder shape that has been printed first, then inserted into the ground at a certain depth and then filled with concrete, sometimes kason is also called a drill foundation in the form of a large diameter (Hardianto, 2021)

The term “soil” in the field of soil mechanics is intended to cover all materials from clay to gravel so all natural deposits of civil engineering interest except rocks. Soil is formed by the physical and chemical weathering of rocks. Physical weathering occurs in two types. The first type is destruction caused by continuous wetting and drying or the influence of snow or ice. (Rangan, et al. 2021).

Definition of chalk Chalk is a white and smooth object made of sedimentary rocks, forming rocks composed of calcium minerals. Usually lime is relatively formed in the deep sea with rock conditions containing calcium plates (coccoliths) formed by coccolithophores microorganisms. Types of lime include kapur hohor or kapur sirih. Quicklime or whiting lime, also known as lime oxide (CaO), is the result of burning or heating lime from raw calcium carbonate (CaCO3) at temperatures above 825 degrees Celsius. The reaction equation: CaCO3 (s) <=> CaO (s) + CO2 (g). Apart from being given to agriculture, this chalk is also commonly used by people as a friend to eat betel (betel). This quicklime is very effective for increasing the pH of soil and water (Rangan, et al. 2021).

Aluminum sulfate (Al2(SO4)3), usually called alum, is often used effectively to reduce the level of burning, economical, easy to obtain and easy to store. The use of alum has the advantage that the price is relatively cheap and is widely known. carbonate Alum is in the form of white crystals or powder, soluble in water, insoluble in alcohol If aluminum sulfate (Al2(SO4)3) is added to water in an alkaline atmosphere (the presence of alkalinity), the reaction that occurs is: Al2(SO4)3).18 H2O + 3Ca(OH)2 → 3CaSO4 + 2Al(OH)3 + 18H2O The reactions between aluminum sulfate in water are influenced by many factors. It is therefore difficult to accurately estimate the amount of aluminum sulfate that will react with the amount of alkalinity provided by lime. The solution of aluminum sulfate in water produces: Al2(SO4)3).18 H2O → 2Al3+ 3SO42-+ 18 H2O (Rangan, et al. 2021).

2. Method

This research in the road map is a continuation of previous research where the use of screw piles can increase adhesion significantly when compared to plain or smooth blanket piles. The problem of this research is that the use of screw blanket pile foundation is more effectively used in soft soil where the pile tip does not reach hard soil. Due to the use of foundations that are specialized in soft soil, the strength of the pile bearing capacity which is the main calculation is the strength of friction (friction) on the pile blanket. From previous research to increase the bearing capacity of the pile, namely by adding roughness to the blanket by making threads on the pile blanket. The purpose of this research is to further increase the adhesion of the blanket by adding liquid chemicals, namely Calcium Hydroxide Ca(OH)2 and Alum AI2(SO4)3. In the background of previous research where the use of piles is more devoted to soft soil, the addition of these chemicals is expected to be able to change the soft soil into a harder soil than before so that the adhesion that works on the concrete blanket is stronger and ultimately can increase the bearing capacity of the pile.

The test object to be made consists of 2 models 1) screw piles spaced 10 cm rectangular with a size of 15cmx 15cm 270 cm long and smeared or painted with a chemical mixture of Calcium Hydroxide Ca(OH)2 and Alum AI2(SO4)3 concrete quality K-350 kg/cm2. Model 2) screw piles 10 cm apart are rectangular with a size of 15cmx 15cm 270 cm long and are not smeared or not painted with a chemical mixture of concrete quality K-350 kg/cm2. The purpose of adding this chemical is to physically change the soft soil around the pile blanket into a harder soil, this is obtained from the Journal of Dynamic sainT Journal, that the addition of Calcium Hydroxide Ca(OH)2 and Alum AI2(SO4)3 chemicals can increase soil stability (Parea Rangan, 2021).

This research was conducted by conducting experimental testing in the field. The shape of the test object model was made in 2 models; model 1 concrete minipile piles with screw spacing of 20 cm smeared with a mixture of lime and alum or Calcium Hydroxide Ca(OH)2 and Alum AI2(SO4)3. model 2 concrete minipile piles with screw spacing of 20 cm without surface smearing with lime and alum. The test specimens of model 1 and 2 piles are of the same size. The only difference is that one is smeared with Calcium Hydroxide Ca(OH)2 and Alum AI2(SO4)3. Test specimens of piles with threaded blankets at a distance of 20 cm, the length of the pile is 270 cm with a cross-sectional area of 15cmx15cm. See pigure 1

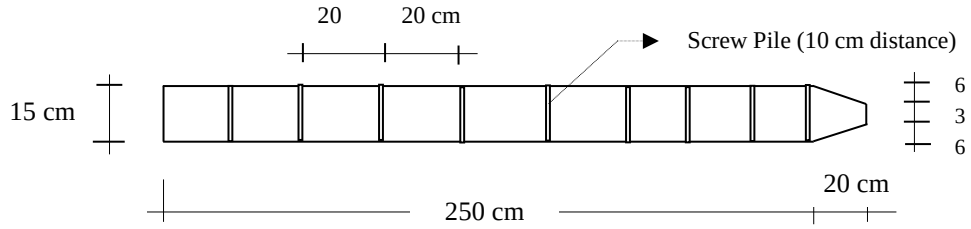

Figure 1. Model of Pile Test Object

Figure 2: Making of Test Objects

Quicklime or liquid lime with the chemical formula Calcium Hydroxide Ca(OH)2 and Alum AI2(SO4)3 are stirred manually. Mengutif from the results of the journal Journal Dynamic sainT by Parea Rusan Rangan et al in the title Stabilization of Soil Using Calcium Hydroxide Ca(OH)2 and Alum AI2(SO4)3, then Calcium hydroxide Ca(OH)2 and Alum Al2(SO4)3 can be as a soil stabilization material, where calcium hydroxide Ca(OH)2 and Alum Al2(SO4)3 mixed with soil can increase the value of CBR. The highest result of the mixing variation in the CBR test is in the soil mixture of 6% alum and 9% calcium hydroxide. This means that the mixing ratio between alum and lime is 6 parts alum: 9 parts lime, or 1 alum: 1.5 lime. The addition of water is seen from the viscosity of the mixture so that the mixture can resemble the viscosity of the paint, so that it is easily satisfied on the screw pile blanket. In making the test objects there are 2 types of piles, where 1 pile is painted/polished with a mixture of lime + alum and the second test object is not polished. After polishing, curing is carried out for 3 days, and after enough time it is ready for piling.

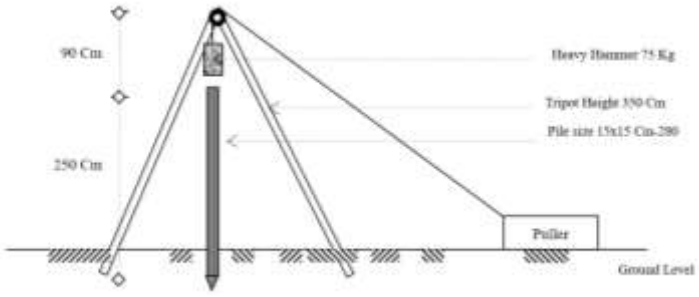

Figure 3. Pile driving

Pile Driving

The piling location was carried out outside the civil engineering laboratory. The piling distance between the piles is 3 meters, this is to maintain that there is no influence of soil crush between the 2 piles. Piling was carried out using wooden tripot legs with a hammer weight of 75 kg. The remaining staked piles were left 50 cm from the ground surface.

Pile Loading

The pile loading is done based on the calculated results of the soil zondir. Calculation of Concrete Block Loading Weight:

Qc Average depth of 2.5 m = 2 Kg / cm2, friction at a depth of 2.5 meters (Fr) = 21 Kg / cm, cross-sectional area of the pile (A) = 15cm x15 cm = 225 cm2, circumference of the pile (Kl) = 15cmx4 = 60 cm, safety numbers 3 and 5. So that the load used is 240 kgx2 = 480 kg.

Figure 4. Pile loading

Testing Process of Test Objects

The stage of testing objects is the most important thing in this research. Testing is done by direct observation of the test object with a loading test on the pile. The process of testing test objects is carried out in the following order: a) the age of the new piles can be used until the concrete reaches 28 days, b) loading test objects, piles are friction then loading experiments and new tests can be carried out at the age of 2 days of piling, it is intended that the soil around the concrete blanket has really been compressed so that the adhesive force of the soil on the blanket of the pile is really perfect. Furthermore, after the concrete age of the pile reaches 28 days, one of the piles is polished with a mixture of lime + alum liquid. After that, curing is carried out for 3 days. After that proceed with pile driving, c) measuring instrument arlogi manometer used has a stalk length of 10 cm with an accuracy of 0.01 cm. Arlogi measure is mounted on the head of the pile, d) loading table is made with a capacity of 480 Kg pikul which is made of steel profile elbow size 60x60x6mm.

The manufacture of test objects as above is made in 2 models, namely a model of threaded piles that are coated with a mixture of lime and alum and a model of piles with threaded covers without lime and alum rubbing materials.

3. Results and Discussions

Results of Observations

This research was conducted for 5 months which was carried out in the civil workshop and laboratory environment of the civil engineering department. From the results of observations of the research on the Effect of the Addition of Lime and Alum on the Blanket of Screw Piles in the Context of Increasing Friction on Screw Piles are as follows;

The length of the pile is 270 cm, rectangular cross section size 15 cmx15 cm, loading weight 480 kg, the location of the piling in the Pontianak State Polytechnic campus environment, the type of soil at the piling location is clay, at the time of piling the weather is good (hot), the loading is carried out

for 3 days from the time of piling, the loading is carried out at 7:00. 00, observation of the decline was carried out at 8.00 to 18.00, the results of observations of the decline in pile loading can be seen in table 1 as follows:

Table 1. Results of Observation of Decrease in Pile loading

Day To Decrease	Decrease			Day To Decrease	Decrease		
	Piles Normal	Screw Piles By Applying Lime	Difference Decrease (mm)		Piles Normal	Screw Piles By Applying Lime	Difference Decrease (mm)
1	3,1	1,8	1,3	2	7,7	2,66	5,04
8 o'clock	4,2	1,9	2,3	3	7,8	2,66	5,14
9 o'clock	4,5	1,95	2,55	4	7,9	2,66	5,15
10 o'clock	4,8	2,05	2,75	5	8,0	2,66	5,34
11 o'clock	4,9	2,10	2,70	6	8,05	2,66	5,39
12 o'clock	5,3	2,18	3,12	7	8,07	2,66	5,41
13 o'clock	5,7	2,19	3,51	8	8,09	2,66	5,43
14 o'clock	5,9	2,27	3,63	9	8,1	2,66	5,44
15 o'clock	6,2	2,35	3,85	10	8,19	2,66	5,53
16 o'clock	6,5	2,41	4,09	11	8,19	2,66	5,53
17 o'clock	6,9	2,55	4,35	12	8,19	2,66	5,53
18 o'clock	7,3	2,61	4,69	13	8,19	2,66	5,53
				14	8,19	2,66	5,53
				15	8,19	2,66	5,53
				16	8,19	2,66	5,53

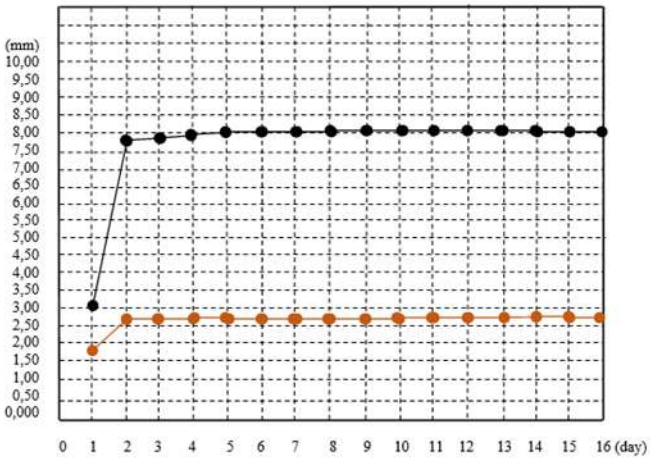

Figure 5. Pile Foundation Settlement

After the piling, the piles were left for 2 days, this was to allow conditioning of the piles against the concrete blanket, where the hollow area of the screw was filled by the surrounding soil. The soil that fills the thread in the form of soft soil can react with Calcium hydroxide Ca(OH)2 (whiting) and Al2(SO4)3 alum to physically change the surrounding soil which in turn can increase the CBR value around the foundation blanket. By increasing the CBR of the surrounding soil, it can increase the frictional strength of the foundation and ultimately the bearing capacity of the pile is getting bigger.

During (loading) with Time at the beginning of the first day of loading, the decrease in the foundation is quite large, namely from the first hour to the 18th hour the decrease reaches 7.3mm for piles without lime spread, while screw piles with lime spread the value of the decrease during 18 hours reaches 2.61 mm so that the difference in decline between piles without lime spread and piles using lime spread is 4.69 difference in decline at hour 18. The largest difference of this decline is 5.53 when the decline stops, namely on day 10 for piles without lime spread and on day two for screw piles with lime spread. On the first day of consolidation loading between the pile blanket and the surrounding soil is not too massive so there is still a gap in the thread that is still not filled, thus reducing the resistance of the pile blanket. While on the second day and so on there is still a decrease (see table) but the time period of the decline is 24 hours, so that the decline on the next day is not too big compared to the beginning of loading, it is possible that the pile blanket has occurred around the passivity of the surrounding soil. To see which of the two pile models is the most favorable in carrying the load can be seen as in table 2.

Table 2. Percentage of pile settlement value

No	**Model Piles**	**Settlement Value (mm)**	**Maximum Settlement Difference (mm)**	**Persentasi Selisih Penurunan (%)**
1	Tiang Pancang Ulir Tanpa Oles kapur	8,19 (hari ke-10)	5,53	32,48%
2	Tiang Pancang Ulir Jarak Dengan Oles Kapur	2,66 (hari ke-2)		

When viewed from the loading results of the two pile models as in the table above, the tighter thread spacing will carry a greater load, meaning that the addition of lime and alum by applying to the entire screw pile can help harden the soil around the piles that enter the screw gap. With the hardening around the soil, the adhesion increases so that it can quickly reduce the decline in the pile foundation. If you look at the results of the loading on the piles of the two pile models, the difference in decline is quite significant, which is 5.53mm with a percentage difference of 32.48%. In addition, the addition of lime and alum to the pile can quickly stop the time of decline in the pile foundation, which is only 2 days has finished the decline, while without applying lime to the pile the decline time is completed on day 10. It can be concluded that the addition of Chemical Calcium Hydroxide Ca(OH)2 and Alum AI2(SO4)3 can stabilize soft soil into hard enough soil due to the reaction of these chemicals so that the decline only takes 2 days, while without using chemicals the decline continues until it reaches 10 days beru stop.

4. Conclusion

From this study, it can be concluded that the results of the decline in piles from loading on the first day were greater, namely 7.3mm, while the screw piles without lime and alum decreased by 2.66 mm. On the second and third days the decline still occurs but not too significant. The difference in the value of the decline of the two models amounted to 32.48%. Stopping the decline in piles without rubbing on day 10 while with chemical rubbing stops

the decline on day 2 this is due to the formation of soft soil into hard soil. With the addition of lime and alum smearing on screw piles, it can increase the bearing capacity of the soil by looking at the decline, but it can also accelerate the decline time.

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