EFFECT OF THE DISTANCE BETWEEN VERTICAL DRAINAGE COLUMN IN CLAY SOIL AGAINST SETTLEMENT DUE TO DISTRIBUTED LOAD

Submitted as partial for filling the requirement for bachelor degree of

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ENDORSEMENT PAGE

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Has been retained in front of the board of Examiners
Engineering Faculty Civil Engineering Study Program
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On Friday, October 13rd, 2017

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Abstract

In Java region there's type of clay that can be found in several areas in Central Java, such as Blora, Purwodadi, Solo, Sragen, Klaten. In this study the land used as sample from Troketon Pedan Klaten village which has a PI value of 50.20%, so making it less beneficial for contruction. In this study the property of the soil is improved by vertical drainage reinforcement. The aim of this research is to determine the value of soil settlement that is influenced by the distance between columns 100 cm and 50 cm due to the distributed load on it. In this research put sand 5 cm, then put the soil into box which has been paired column mold as much as 3 layers, each layer is given a blow 25 times, then it's saturated with water for four days, then the water removed through the valves and then being kept for 24 hours, then column mold filled with sand, lime, mixture of sand and lime, sand over lime, lime over sand, put the sand 5 cm, then three dials paired and given a distributed load on it. The results showed that smallest soil settlement value was found on soil using lime with spacing between column 50 cm 2.11mm, while the biggest settlement value occurred on soil using sand column with distance of coloumn 50 cm is 5.31 mm, near the lime column distance the smaller the decrease value. While on the variation of sand and lime combination as the reinforcement of soil obtained the least value of the settlement occurred on the variation of lime columns above the sand with a distance between columns 100 cm of 3.05 mm.

Keywords: Distance variation, Soil settlement, Vertical drainage.

Abstrak

Di wilayah Jawa memiliki jenis lempung yang bisa ditemukan di beberapa daerah di Jawa Tengah antara lain Blora, Purwodadi, Solo, Sragen, Klaten. Dalam penelitian ini tanah yang digunakan sampel dari desa Troketon Pedan Klaten yang memiliki nilai PI 50,20%, sehingga kurang menguntungkan bagi kontruksi. Dalam penelitian tanah diperbaiki dengan perkuatan drainase vertikal. Penelitian ini bertujuan untuk mengetahui nilai penurunan tanah yang dipengaruhi jarak antar kolom 100 cm dan 50 cm akibat beban merata di atasnya. Pada penelitian ini pengujian dilakukan dengan memasukkan pasir 5 cm, kemudian masukkan tanah ke dalam box yang sudah dipasang cetakan kolom sebanyak 3 lapis, setiap lapis diberi pukulan 25 kali, lalu dijenuhkan dengan air selama empat hari, kemudian air dikeluarkan melalui kran dan ditunngu selama 24 jam, setelah itu kolom drainase diisi material pasir, kapur, campuran pasir dan kapur, pasir di atas kapur, kapur di atas pasir, kemudian masukkan pasir 5cm, pasang tiga dial dan diberi beban merata di atasnya. Hasil pengujian menunjukkan bahwa nilai penurunan tanah terkecil terdapat pada tanah menggunakan kolom kapur dengan jarak antar kolom 50 cm yaitu 2,11mm, sedangkan nilai penurunan paling besar, terjadi pada tanah menggunakan kolom pasir dengan jarak antara kolom 50 cm yaitu 5,31 mm, semakin dekat jarak kolom kapur semakin kecil nilai penurunanya. Sedangkan pada variasi penggabungan pasir dan kapur sebagai perkuatan tanah diperoleh nilai penurunan paling kecil, terjadi pada variasi kolom kapur di atas pasir dengan jarak antara kolom 100 cm yaitu 3,05 mm.

Kata kunci: Drainase Vertikal, Penurunan tanah, Variasi jarak.

1. INTRODUCTION

At first the clay is not noticed in the development or construction, due to population growth and development of the building, this is reason people to build buildings or construction on clay area. In Java has a region that has a soil characteristic is clay that can be found in several area in Central Java, such us Purwodadi, Solo, Sragen, Klaten, whereas in Java experience the development of the building or construction is rapid.

One of the cases that have soil is a research in Troketon Village area, District Pedan, Klaten regency with PI value of land amounting to 50.20% of the study conducted by Merdhiyanto, P (2015). The high value of PI indicates that the soil has less properties for contruction. The land require soil stabilization or repair soil that is more stable.

One method to improve soil properties is by using vertical drain, vertical drain methods is generally used in soil improvement with the carrying capacity of the land to inadequate usually clay and organic soil, as the soil has the same characteristics: moisture extremes, high compressibility, and permeability coefficient small.

This study tried to determine the value of settlement as a result from the influence of variations in the distance between the columns with sand and lime for clay with distributed load on it, so in this study combines sand and lime as a column with the method of vertical drains, water pores in the clay will come out through the columns of sand and reinforced by lime, which has researched has been beneficial to reduce water content thus increasing the permeability of the soil and as improved soil.

2. RESEARCH METHOD

Implementation of research:

2.1 Determining the Location

Soil samples from the Troketon, Pedan, Klaten with undisturbed conditions (disturbed), acquisition of land is done at a depth of approximately 40 cm. Bring soil sample to civil engineering laboratory of the Universitas Muhammadiyah Surakarta.

2.2 Preparing Test tools.

Prepare the necessary tools as box with dimension 100 cm x 40 cm x 40 cm, dial gauge, case of vertical drainage, plywood, distributed load around 60 kg.

2.3 Making Sample.

Including the sand in bottom of box with a height is 5 cm and pair case of vertical drainage column then fill the clay into mold box, with a height of clay is 30 cm solid ground. Each layer was given a blow by 25 strokes, after this saturated with water for four days, and water is removed through

the valve and then being kept for 24 hours. On the box first column filled with sand, the second box columns are filled with lime, three box columns are filled with a mixture of sand and lime, the fourth columns filled with sand on lime, the fifth box columns are filled with lime on sand. Next including sand on clay in mold box with a height is 5 cm. For distance between column 100 cm, the stages same with 50 cm.

2.4 Soil Settlement Test.

Paired the plywood on the clay, then paired three dials in the right, left side, and the middle and zero setting of the dials. Put the distributed load with weighing 60 kg, with a three paired dial to find the value of settlement and average how much settlement after the clay given reinforcement using variations of sand and lime columns. Then every morning and night check the settlement with seen dial gauge has paired, when the result of settlement in morning same with settlement in night, the settlement is stop.

3. ANALYSIS AND DISCUSSION

3.1 Soil Settlement Test with Distance between Column 100 cm.

The result of settlement tested on clay reinforced by using vertical drainage with variations material at distance between columns 100 cm can be showed the result in Table 1.

Table 1. Result of Settlement Soil with Distance between Columns 100 cm.

Type of Reinforcement	Settlement (mm)			Average (mm)
	Dial 1	Dial 2	Dial 3	
Without Reinforcement	3,85	2,54	2,23	2,87
Sand Reinforcement	4,91	4,97	5,56	5,15
Lime Reinforcement	1,12	1,72	4,54	2,46
Mixture Sand and Lime Reinforcement	1,72	3,68	3,87	3,09
Sand Over Lime Reinforcement	3,46	2,93	2,77	3,05
Lime Over Sand Reinforcement	4,67	2,92	1,90	3,16

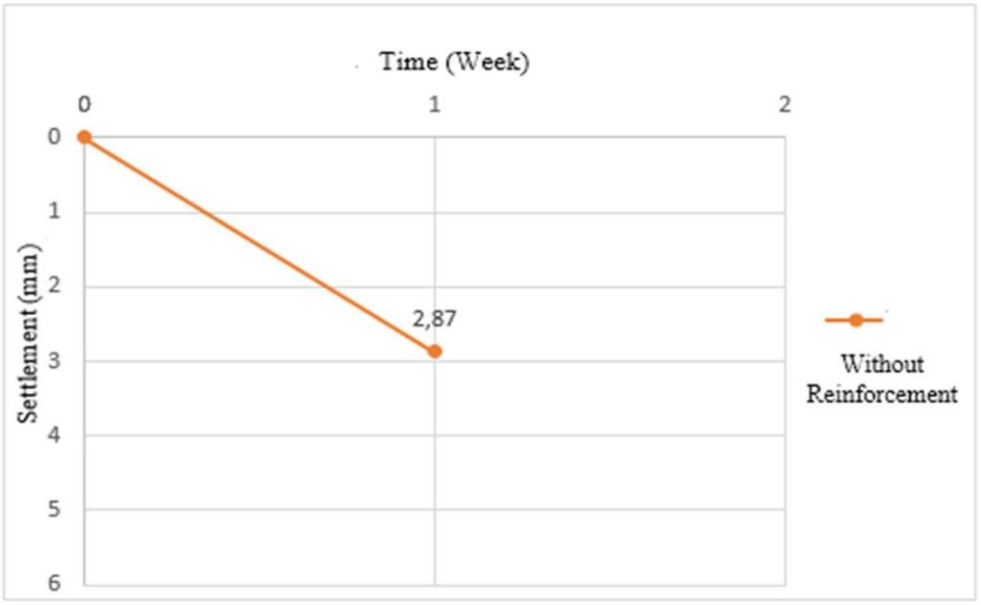

Figure 1. Graph of Settlement without Vertical Drainage Reinforcement.

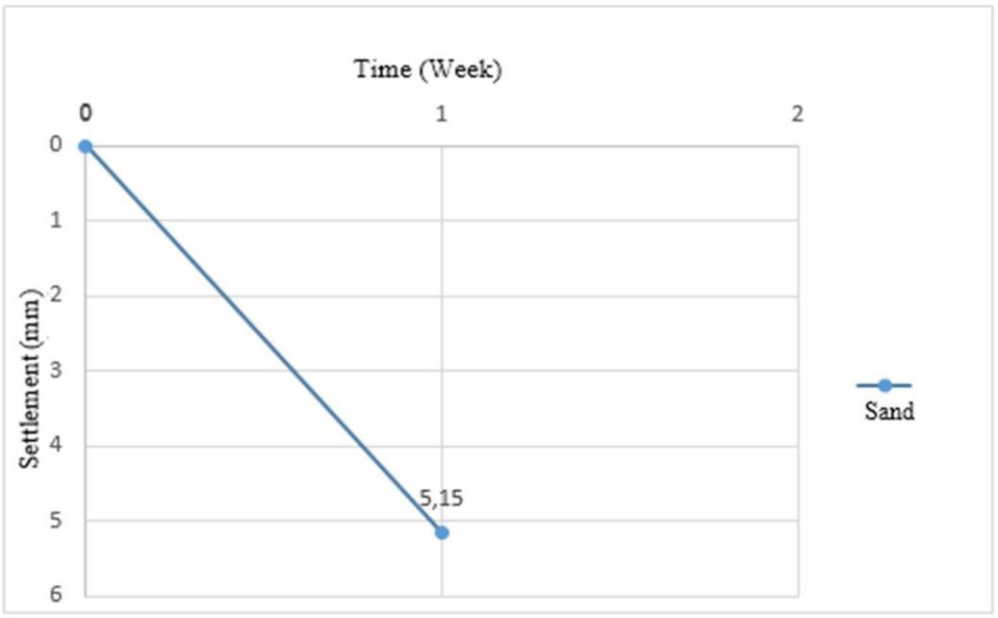

Figure 2. Graph of Settlement Using Sand Reinforcement as Filler Material Vertical Drainage with Distance between Column 100 cm.

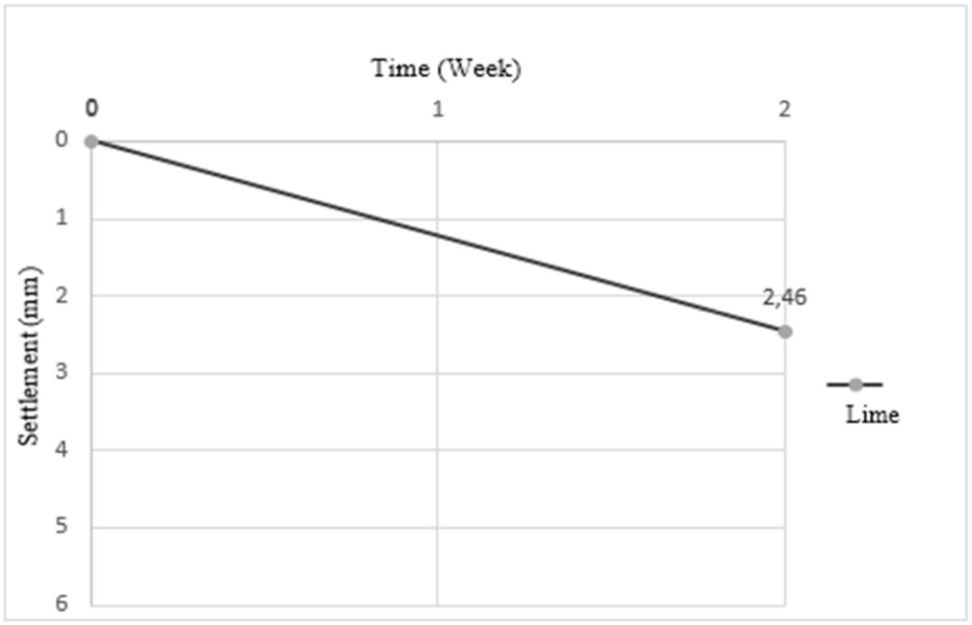

Figure 3. Graph of Settlement Using lime Reinforcement as Filler Material Vertical Drainage with Distance between Column 100 cm.

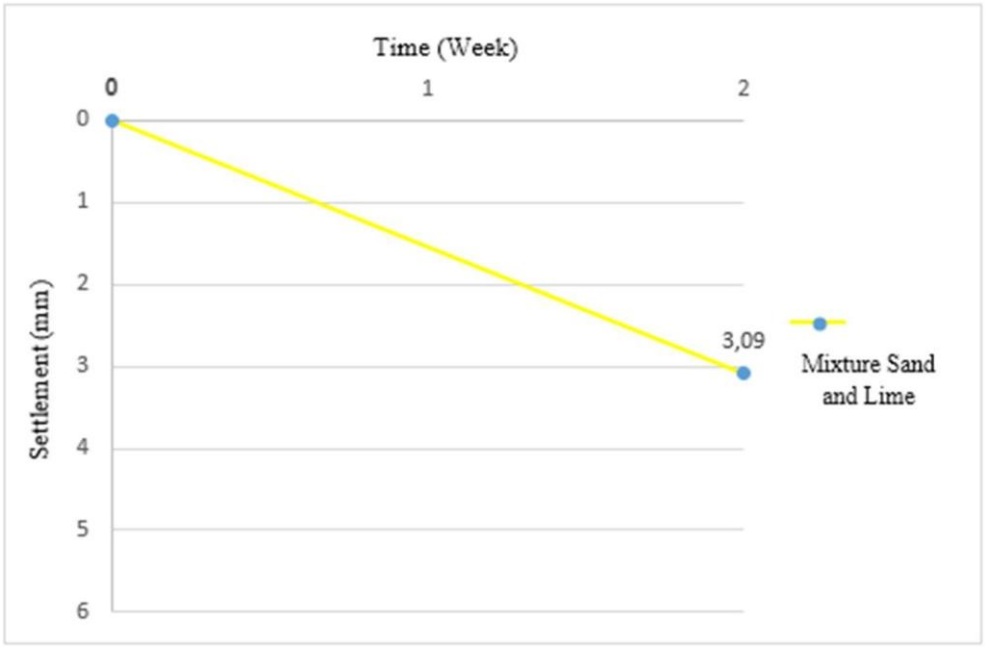

Figure 4. Graph of Settlement Using Mixture Sand and Lime Reinforcement as Filler Material Vertical Drainage with Distance between Column 100 cm.

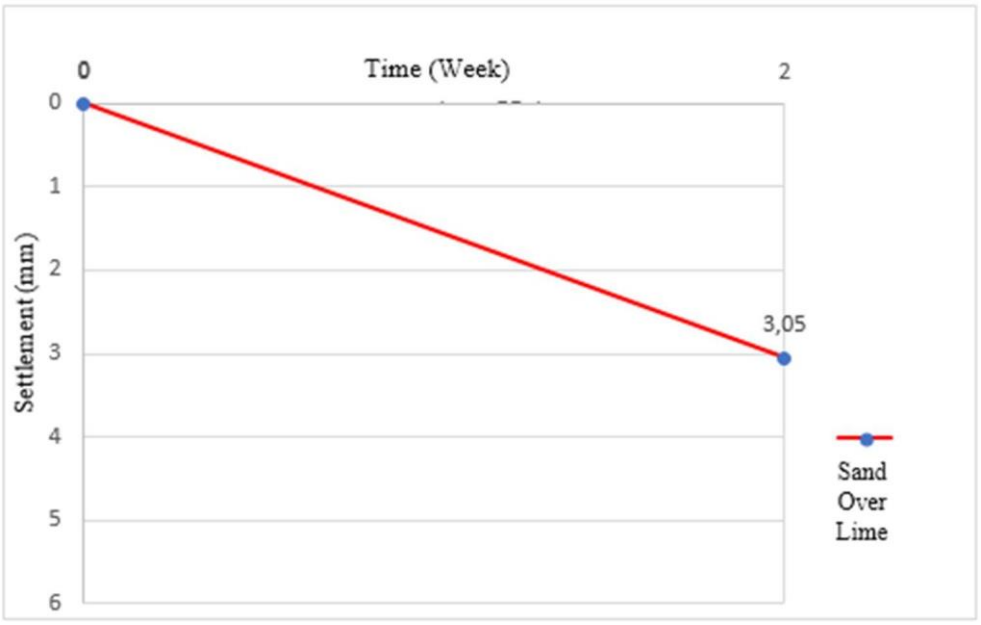

Figure 5. Graph of Settlement Using Sand Over Lime Reinforcement as Filler Material Vertical Drainage with Distance between Column 100 cm.

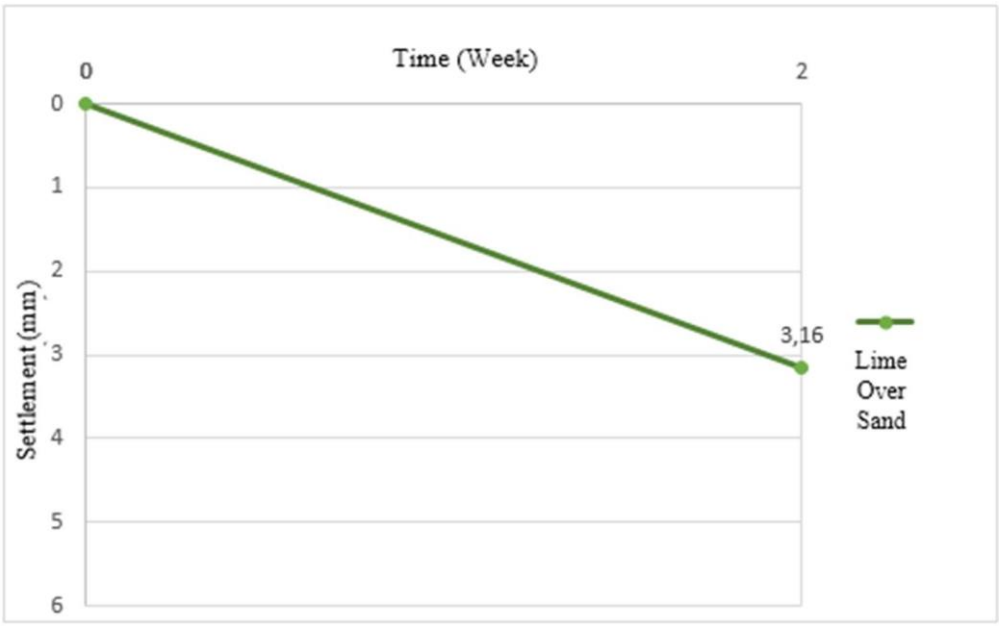

Figure 6. Graph of Settlement Using Lime Over Sand Reinforcement as Filler Material Vertical Drainage with Distance between Column 100 cm

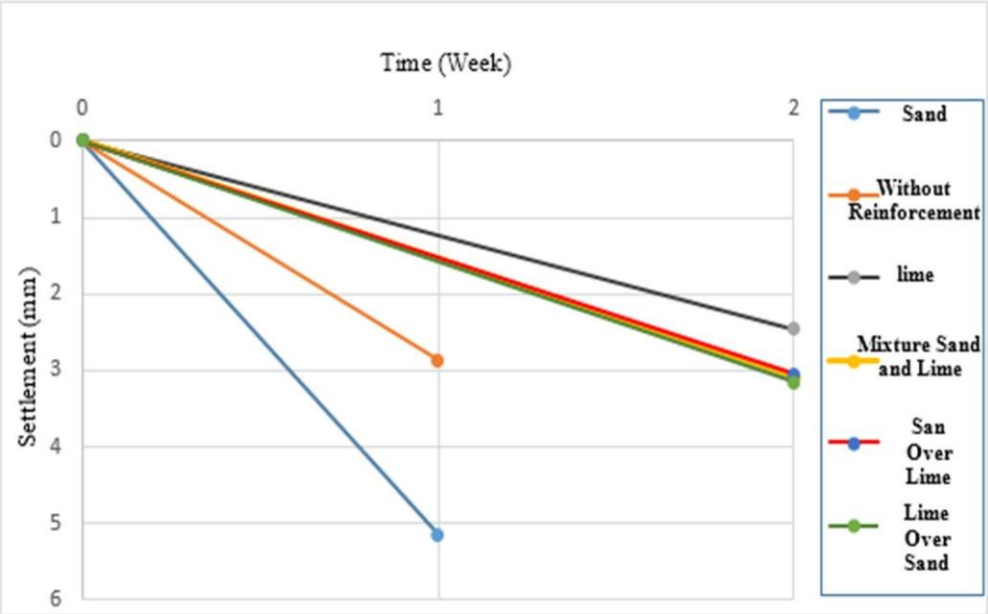

Figure 7. Graph of Comparison of Settlement in Clay Using Reinforcement Variations of Vertical Drainage Fillers and Without Reinforcement with Distance between Columns 100 cm.

Figure V.7. Indicate the result of settlement in clay occurred at the distance between columns 100 cm, the greatest settlement is in the clay containing sand column the value of settlement is 5.15 mm, because the sand has a high permeability base and the sand also has a grain of large particles so that can be draining water on the clay.

While the smallest settlement is in clay containing lime column, the value of settlement is 2.46 mm, because the lime column make it impossible to drain water effectively, and due to the lime has cement properties that is hardened if reacted with water.

In the settlement of clay using vertical drainage reinforcement with fill material of sand and lime variation, the smallest result of settlement is using sand over lime the value is of 3.05 mm, while the most result of settlement is using lime over sand with obtained result is 3,16 mm.

3.2 Soil Settlement Test with Distance between Column 50 cm.

The result of settlement test on clay reinforced by using vertical drainage with variations material at distance between columns 50 cm can be showed the result in Table 2.

Table 2. Result of Settlement Soil with Distance between Columns 50 cm.

Type Reinforcement	Settlement			Average (mm)
	Dial 1	Dial 2	Dial 3	
Sand Reinforcement	5,15	5,24	5,53	5,31
Lime Reinforcement	2,23	2,07	2,03	2,11
Mixture Sand and Lime Reinforcement	3,37	3,45	3,59	3,47
Sand Over Lime Reinforcement	3,55	3,84	3,92	3,77
Lime Over Sand Reinforcement	4,02	3,91	3,76	3,90

Table 2. Shows the result of settlement in clay using vertical drainage with a distance of 50 cm, obtained the result of settlement soil is stable can be showed in three dial pairs. The result of settlement between one dial and the other is not different large gap.

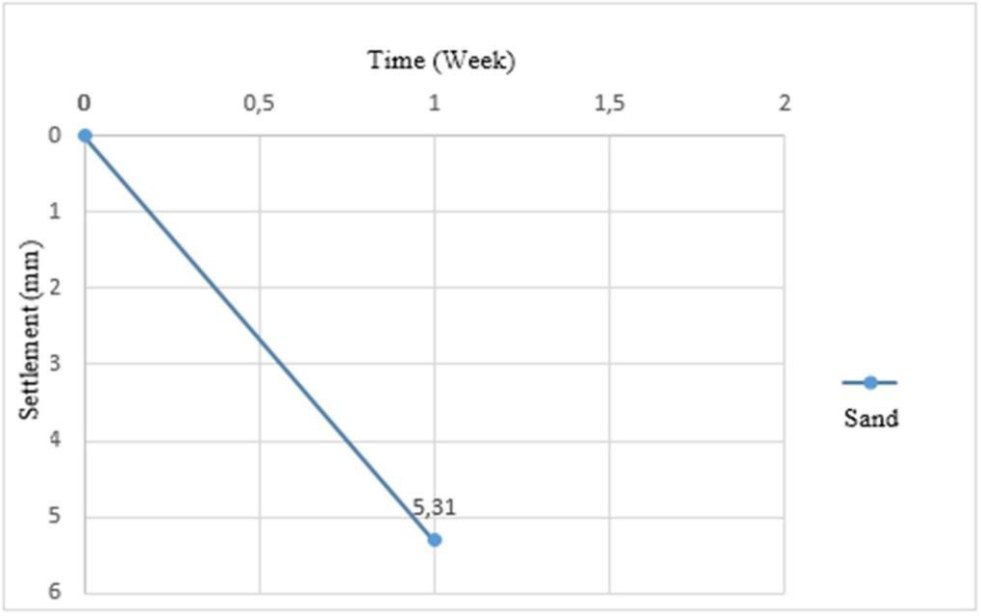

Figure V.8. Graph of Settlement Using Sand Reinforcement as Filler Material Vertical Drainage with Distance between Column 50 cm.

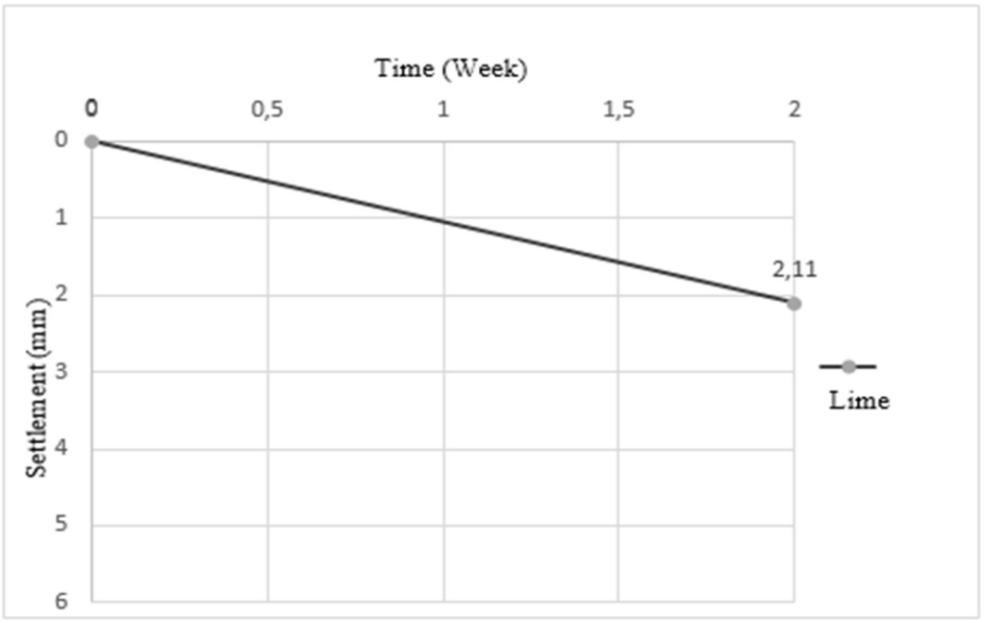

Figure V.9. Graph of Settlement Using Lime Reinforcement as Filler Material Vertical Drainage with Distance between Column 50 cm.

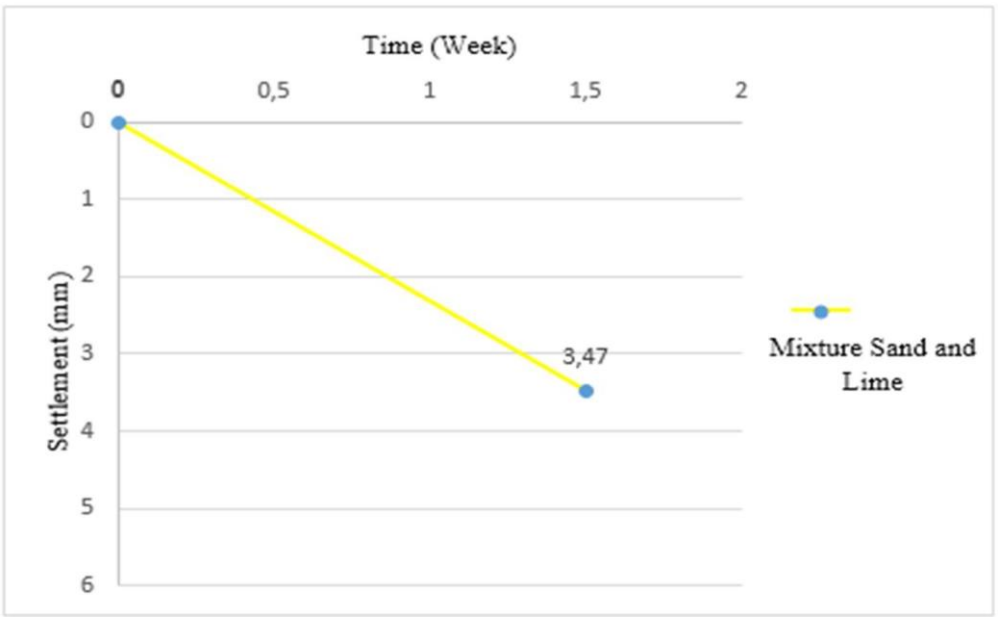

Figure V.10. Graph of Settlement Using Mixture Sand and Lime Reinforcement as Filler Material Vertical Drainage with Distance between Column 50 cm.

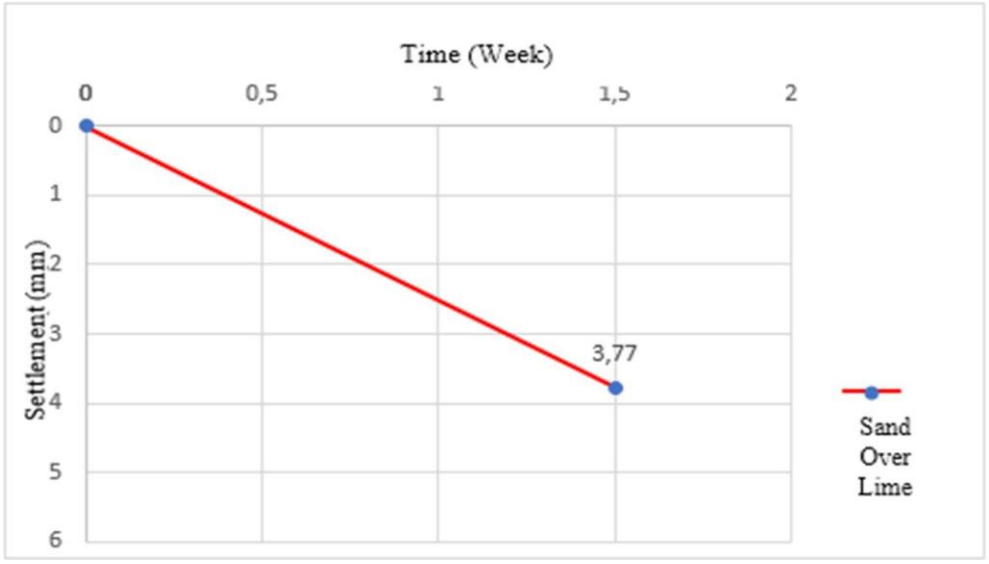

Figure V.11. Graph of Settlement Using Sand Over Lime Reinforcement as Filler Material Vertical Drainage with Distance between Column 50 cm.

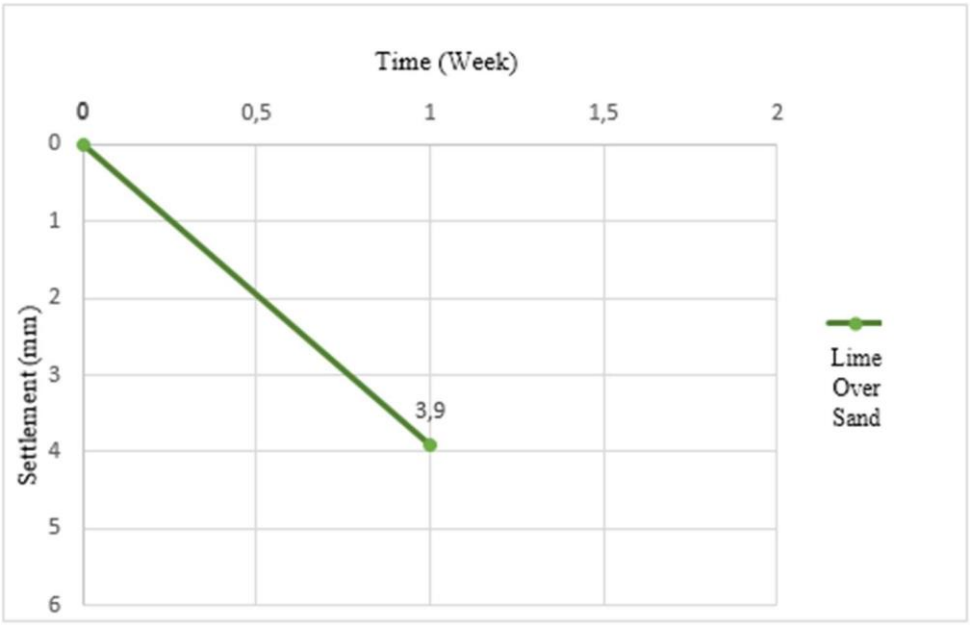

Figure V.12. Graph of Settlement Using Lime Over Sand Reinforcement as Filler Material Vertical Drainage with Distance between Column 50 cm.

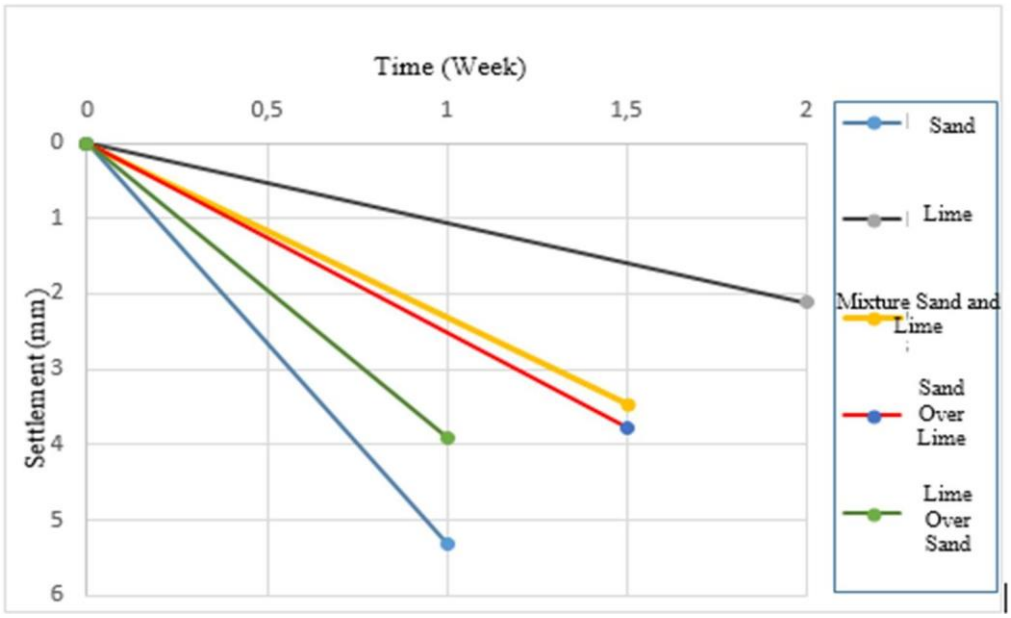

Figure 13. Graph of Comparison of Settlement in Clay Using Reinforcement Variations of Vertical Drainage Fillers with Distance between Columns 50 cm.

Figure 13. Indicates the greatest settlement occurs in the soil containing sand columns. The value of settlement is almost equal to the settlement of sand column at the distance between the columns of 100 cm, the settlement is 5.15 mm, while the value of settlement in the sand column at a distance of 50 cm is 5.31 mm.

The smallest settlement occurs on the soil containing lime columns. The value of settlement is almost same as the value in soil containing lime columns at the distance between columns 100 cm,

the settlement is 2.46 mm, whereas the value of settlement of lime column at the distance between columns 50 cm is 2.11 mm. Because the column with lime as filler material in vertical drainage can be reduce the settlement well, than the closer lime columns distance the value of settlement is smallest, because the lime has cementation properties.

In the clay using vertical drainage reinforcing with sand and lime variation as filler material at distance between column 50 cm, the smallest value of settlement is using mixed sand and lime with the value is 3.47 mm, while the greatest settlement value is using lime over sand as filler material the settlement is 3.90 mm.

In this research is still consolidation process not reinforcement, because the clay contained vertical drainage has large settlement, but in distance column 50 cm can be observed from the three dial paired the settlement is more stable because the settlement value between one and another dial is not different much gap value. Except in the clay containing a vertical drainage using lime material as filler the value of settlement is smallest, that comparison with the settlement value containing the other material. The closer the lime column is, smaller settlement.

4. CONCLUSION AND SUGGESTION

4.1. CONCLUSION

Based on the test has been done in the laboratory, data analysis and can be concluded as follows:

4.1.1 The greatest settlement value occurs on soil with sand column reinforcement due to distributed load on it, at the distance between column 100 cm is 5.15 mm, while at the distance between columns 50 cm is 5.31 mm. Because the sand column with much of amount will be more help the water flow out to valve in the besides test box, so the value obtained large settlement. Getting closer the distance between sand column, the settlement value is larger.

4.1.2 The smallest settlement value occurs on soil with lime column reinforcement due to distributed load on it, at the distance between columns 100 cm is 2.46 mm, while at the distance between columns 50 cm is 2.11 mm. Because the lime has similar characteristic with cement properties, getting closer the distance between lime column, the settlement value is smaller.

4.1.3 The soil containing reinforcement of the column with the variations of sand and lime, obtained the smallest settlement value occurs on the soil contained sand on lime column at a distance of 100 cm. Because lime under sand can be reduce the settlement, because lime has cementation properties.

4.1.4 The smallest settlement from all the data in this research value occurs on soil with lime column reinforcement distance between column 50 cm.

4.1.5 Observe in three dials paired the value of the settlement in the distance between columns 50 cm more stable than in the distance between columns 100 cm.

4.2. SUGGESTION

Based on testing conducted, so for the next testing has suggested as follows:

4.2.1 Further research on soil strengthening is required using vertical drainage method, with more complex materials and more varied diameters

4.2.2 Need to be repaired and maintenance of civil engineering laboratory equipment of Universitas Muhammadiyah Surakarta especially on dial gauge to get maximum result.

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