BEARING CAPACITY OF SKIRTED SQUARE FOOTING ON CLAY UPPER SAND

Submitted to complete the requirements of achieving degree of bachelor of engineering in civil engineering

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APPROVAL SHEET

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Final Project

Submitted and defended in Final Examination of
Final Project in front of the board of examiner
on 2018

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Surakarta,2018

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Surakarta, 7 February 2018

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BEARING CAPACITY OF SKIRTED SQUARE FOOTING ON CLAY UPPER SAND

ABSTRACT

The foundation is element of the building structure which connects the structure to the ground, and transfers loads from the structure to the ground. Skirts are used to improve the bearing capacity of shallow footings on clay upper sand soil by constraining the soil beneath and containing the plastic flow of soil. They are used as an alternative to deep foundations in soils with low strength at the surface, the bearing capacity formulation is used in the analysis of failure. The research are performing nine laboratory experiments on square steel footings of different widths footing made of steel width 75 mm, 100 mm and 150 mm with length of skirt 100 mm and 150 mm on clay upper sand by keeping the similar water content and compaction method,The results from the laboratory show that the skirt is effectively to reduce the foundation settlement on clay upper sand which is observed on similar load 1 kN. The observations on L/B ratio on similar width show that the higher L/B ratio the smaller settlement. The load generally increase, when it is observed on settlement 3 mm with similar width, it shows that when increase the length of skirt increase the load valueon the footing.

Keywords:*bearing capacity,foundation, square footing, settlement, skirt.*

Pondasi adalah elemen struktur bangunan yang menghubungkan struktur ke tanah, dan memindahkan muatan dari struktur ke tanah. Rok digunakan untuk memperbaiki daya dukung pijakan dangkal pada tanah pasir tanah liat atas dengan membatasi tanah di bawah dan mengandung aliran plastik tanah. Mereka digunakan sebagai alternatif pondasi yang dalam di tanah dengan kekuatan rendah di permukaan, formulasi kapasitas bantalan digunakan dalam analisis kegagalan. Penelitian ini dilakukan pada sembilan percobaan laboratorium pada pondasi baja pilar dengan lebar lebar masing-masing dengan lebar baja 75 mm, 100 mm dan 150 mm dengan panjang rok 100 mm dan 150 mm pada pasir atas tanah liat dengan cara menjaga kadar air dan metode pemadatan yang sama, Hasil dari laboratorium menunjukkan bahwa rok tersebut efektif untuk mengurangi pondasi pondasi pada pasir atas tanah liat yang diamati pada beban serupa 1 kN. Pengamatan pada rasio L / B pada lebar yang sama menunjukkan bahwa rasio L / B terhadap pemukiman lebih kecil. Beban umumnya meningkat, bila diamati pada permukiman 3 mm dengan lebar yang sama, hal ini menunjukkan bahwa bila menaikkan panjang rok meningkatkan nilai beban pada pijakan.

Kata kunci: daya dukung, pondasi, pondasi alas kaki, permadani, rok.

1.INTRODUCTION

1.1Back ground

The foundation is element of the building structure which connects the structure to the ground, and transfers loads from the structure to the ground. The foundation function passes the load from the top of the structure to the bottom layer of soil. The design of the foundation for a construction depends on the type of foundation that is suitable for the building, it's depending on several factors, mainly the building function and the generated load, the condition of the soil surface, the sufficient bearing capacity, the non-hazardous reduction of the building and the cost of the foundation with the cost of the building. Since the soil's bearing capacity and strength are the factors for choose the foundation type of the construction, the stable soil and good bearing capacity of the construction planning is quite simple, otherwise if the soil is unstable and the bearing capacity is poor then the construction planning should be more complex. The foundation will also decrease, when there is a decrease of the foundation there are two that is the total decrease and the differential decrease. Because of the decline in the foundation of the building at the top will also have problems. The skirt foundation is one of the alternative designs used on unfavorable soil without having to improve the quality of the soil. The materials used for the foundation can be steel or concrete with the appropriate design. The skirts in this design are strived to increase the bearing capacity of the foundation. This study is to determine the bearing capacity of the foundation of square footing wrapped in clay upper sand soil.

1.2Problem formulation

Based on the introduction of the problem described above, the problem formulation of this study includes:

1. What is the effect caused by the many variations of the skirt dimensions on the bearing capacity of the skirt square footing in the clay upper sand ground?
2. How does the effect of use skirt on the square footing towards the settlement of square footing on layered soil?

1.3 Study Benefits

1.Provide an alternative how to improve the bearing capacity of the skirt of the covered square footing without improving the quality of the soil.

2. Provide new knowledge about the bearing capacity of the footprinted sole of the palm on the clay upper sand soil.

1. **BASICTHEORY**

1.1 Bearing Capacity of Shallow Foundation

A bearing capacity failure is defined as a foundation failure that occurs when the shear stresses in the soil exceed the shear strength of the soil. Bearing capacity failures of foundations can be grouped into three categories, as follows

2.1.a General shear failure

General shear failure ruptures and pushes up the soil on both sides of the footing. For actual failures in the field, the soil is often pushed up on only one side of the footing with subsequent tilting of the structure

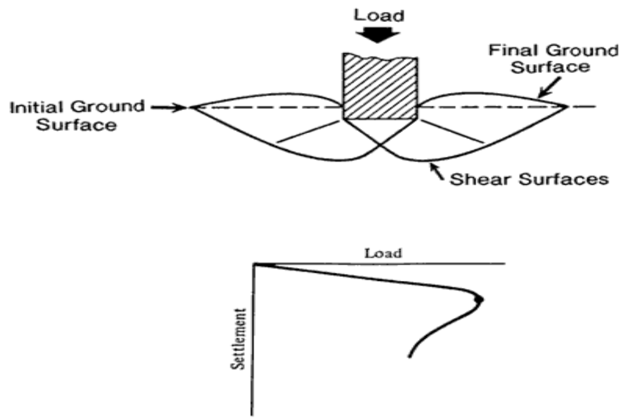


Figure1. General Shear Failure

- ## Local shear failure

Local shear failure involves rupture of the soil only immediately below the footing. There is soil bulging on both sides of the footing, but the bulging is not as significant as in general shear.

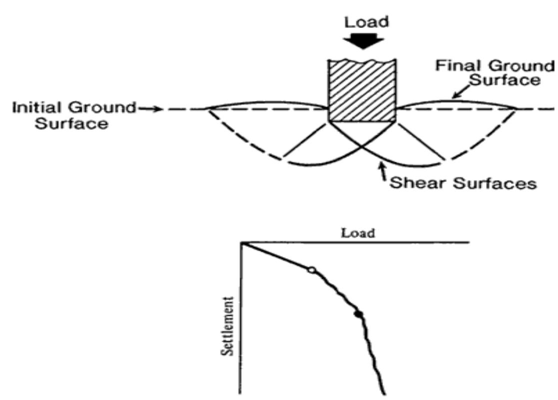


Figure 2. Local Shear Failure

- ## Punching shear failure

Punching shear failure does not develop the distinct shear surfaces associated with a general shear failure. For punching shear, the soil outside the loaded area remains relatively uninvolved and there is minimal movement of soil on both sides of the footing.

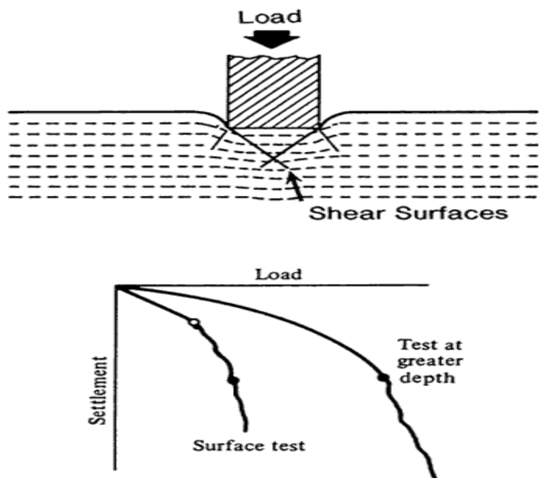


Figure 3. Punching Failure

2. RESEARCH METHOD

2.1 General

The purpose from this research is for determining the relationship between the settlement of clay upper sand and the load on the square footing with/without skirted. The research is conducted by comparing the six skirted square footing models with the three unskirted square footing model. There will be nine laboratory experiments. The layered soil will be kept on the same formation in every experiments.

- The dimension of the six skirted square footing models, it can be seen in the table 1.

Table 1.Dimension of Skirted Square Footing

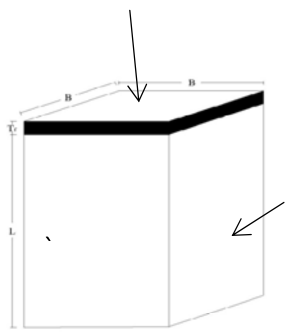
L (mm)	100	100	100	150	150	150
B (mm)	75	100	150	75	100	150
L/B(mm)	1,33	1	0,67	2	1,5	1

- The dimension of the three unskirted square footing models, it can be seen in the table .2.

Table 2.Dimension of Unskirted Square Footing

L (mm)	0	0	0
B (mm)	75	100	150
L/B(mm)	0	0	0

Square footimgSquare footimg



Skirt

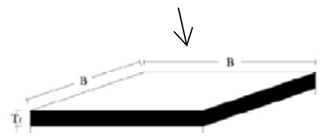


Figure 4. Skirted Square Footing ModelFigure 5.Unskirted Square Footing Model

Soil pin. It is made of one cylinder as high as 500 mm and a diameter of 600 mm, with the upper side circle open. The loading frame machine has a maximum of 250 KN, digital device loading and two-dial gauge attached vertically to the top surface of the footing for visible displacement. The piston is long and conical at the end, just above the notch.

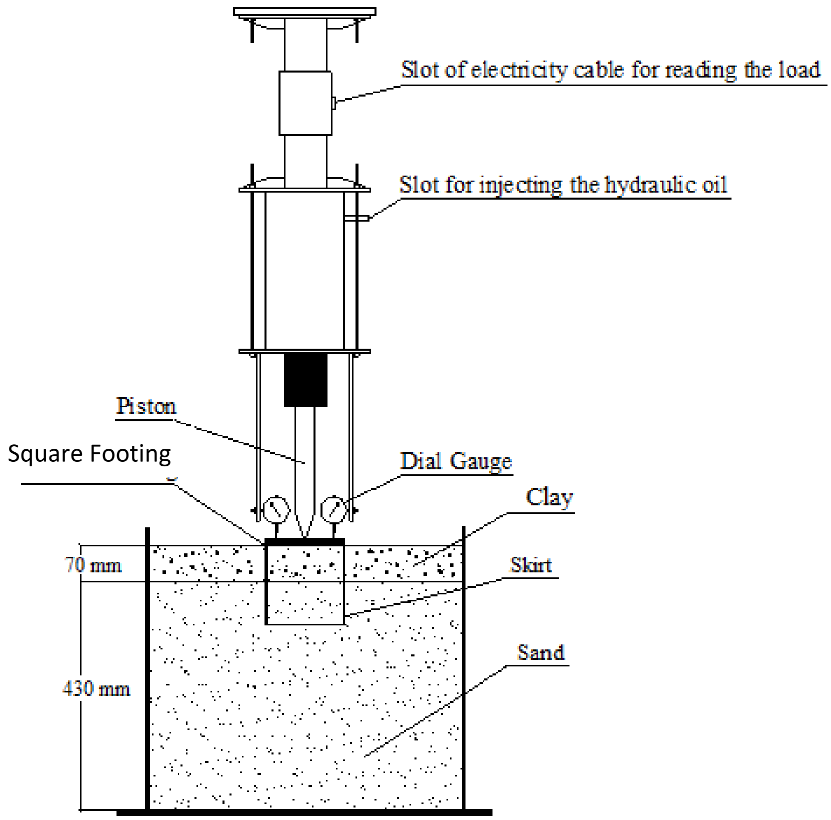
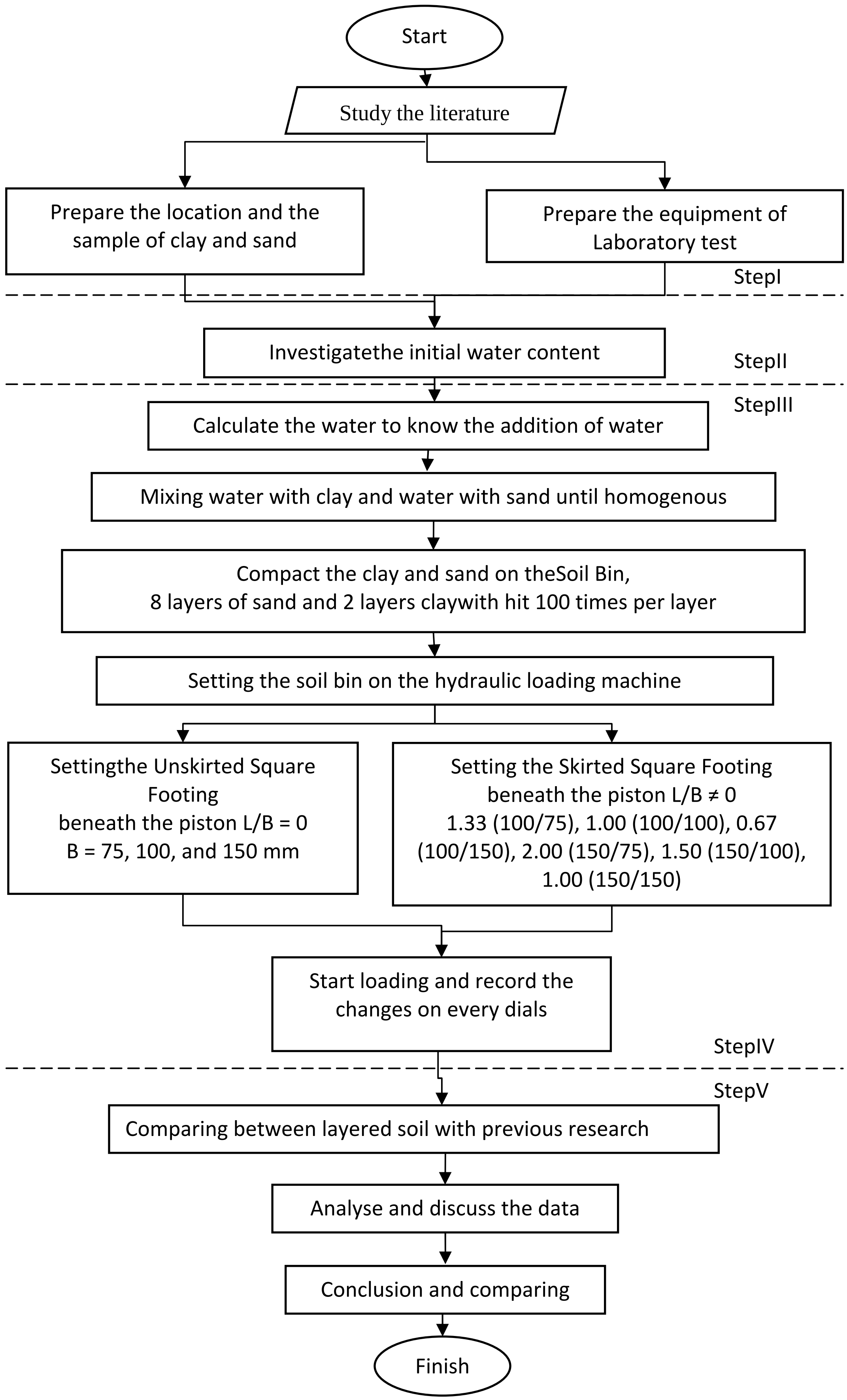


Figure6. Sketch Setup of Testing Procedures

4.Research Step

Some steps conducted for this research that will described in figure. as follow:



Start
Study the literature
Prepare the location and the sample of clay and sand
Prepare the equipment of Laboratory test
StepI
Investigatethe initial water content
StepII
StepIII
Calculate the water to know the addition of water
Mixing water with clay and water with sand until homogenous
Compact the clay and sand on theSoil Bin,
8 layers of sand and 2 layers claywith hit 100 times per layer
Setting the soil bin on the hydraulic loading machine
Settingthe Unskirted Square Footing
beneath the piston L/B = 0
B = 75, 100, and 150 mm
Setting the Skirted Square Footing
beneath the piston L/B ≠ 0
1.33 (100/75), 1.00 (100/100), 0.67 (100/150), 2.00 (150/75), 1.50 (150/100), 1.00 (150/150)
Start loading and record the changes on every dials
StepIV
StepV
Comparing between layered soil with previous research
Analyse and discuss the data
Conclusion and comparing
Finish

5. ANALYSIS AND DISCUSSION

5.1 General Test Results

The investigation of “Effect of clay upper sand soils on skirt footing due to vertical loading” was conducted of square footing model resting on clay upper sand, six skirted footing the width of footing (B) 75 mm, 100 mm,150 mm with length (L) 100 mm and 150 mm, and three unskirted square footing with the width 75 mm, 100 mm, 150 mm. This experiment has been conducted with similar value of water content and method of compaction. The water content test was investigated around 15% for layered soils as the reference for all testing model and that value was always kept for all 9 footing models.

Then the results of the study are shown in Figure V.1, Figure V.2 and Figure V.3 below. The horizontal axis shows the load value (kN) and the vertical axis showing the decreasing value (mm).

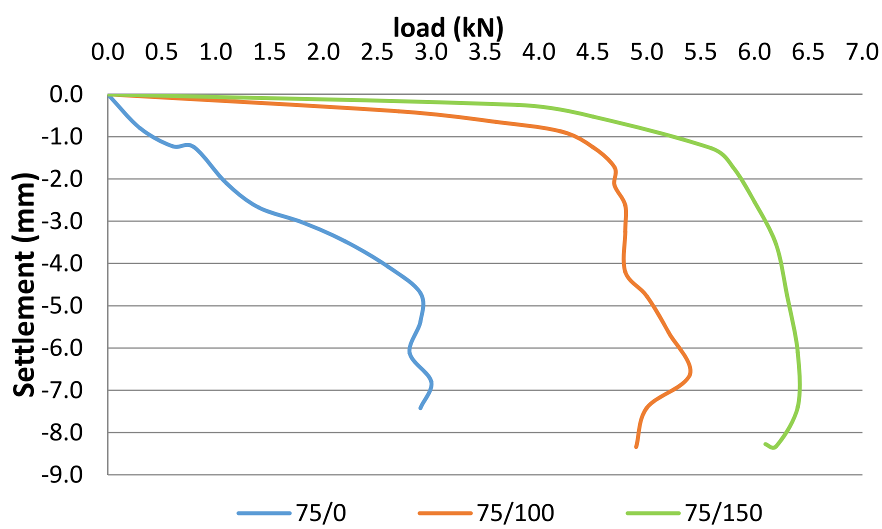


Figure 8. Load-settlement relationship for footing width 75 mm

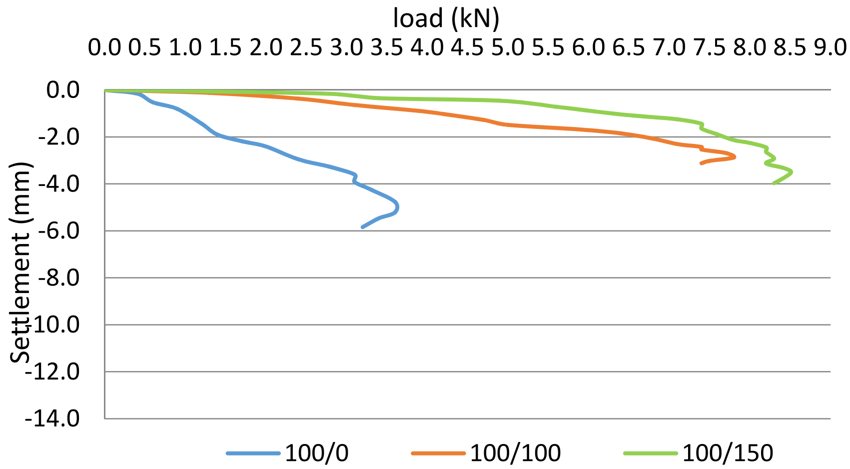


Figure9. Load-settlement relationship for footing width 100 mm

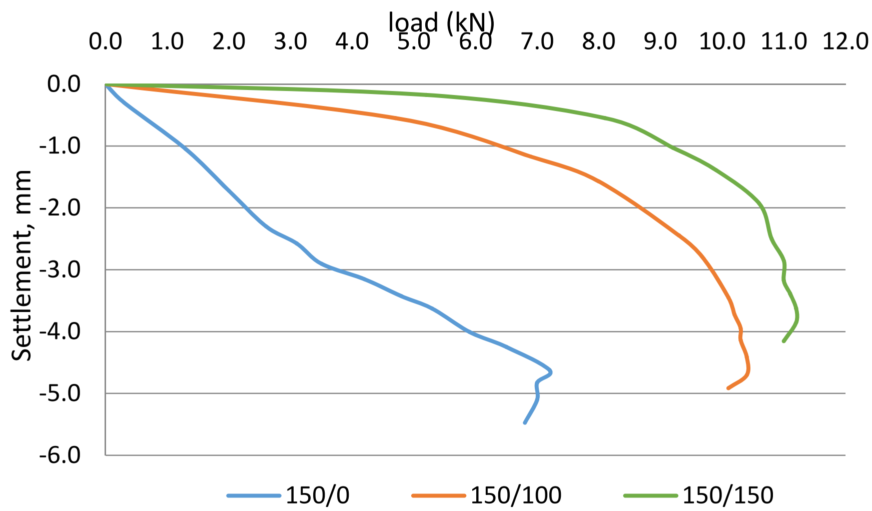


Figure10. Load-settlement relationship for footing width 150 mm

From the graph above it can be seen that all tests reach the maximum load and the largest value is achieved by the foundation of size B = 150 mm and L = 150 mm, so this study can compare the maximum load to the value of the settlement that occurred in each experiment.

6.Decrease Value on the Same Load Condition

To know the value of the settlement that occurs on the foundation due to loading, then taken at the same load condition. The load of 1 kN is used as a reference in this study on all samples. The analysis of the settlement value under the load conditions of 1 kN is shown in Figure11, 12 and 13.

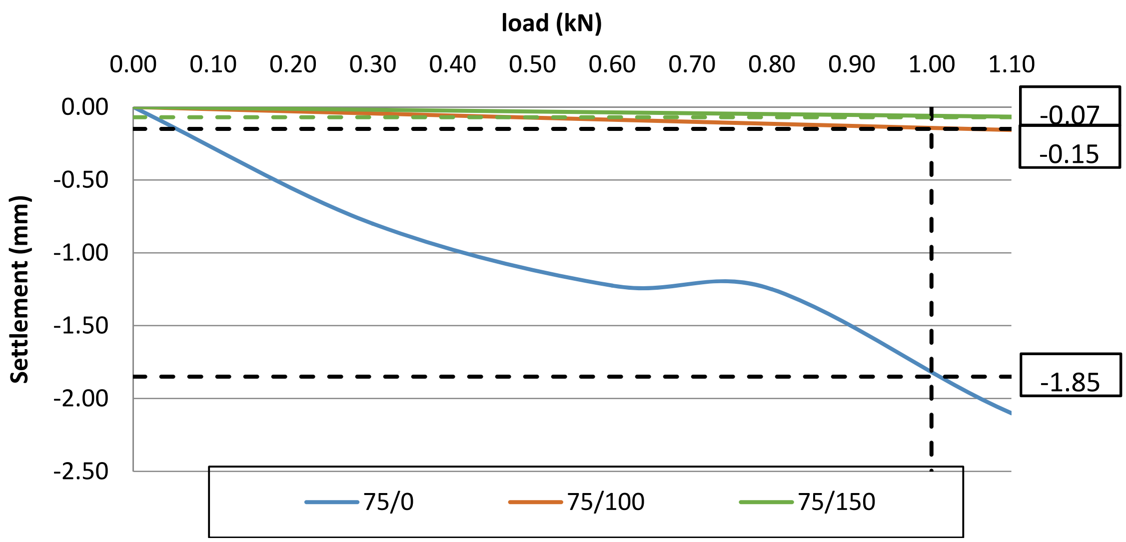


Figure11. Settlement analysis on footing width 75 mm

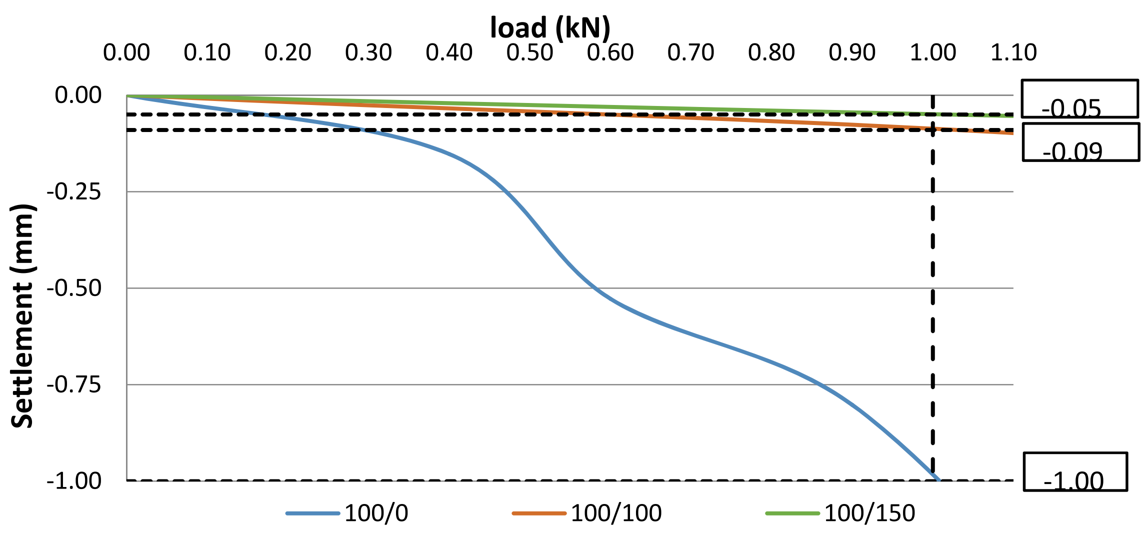


Figure12. Settlement analysis on footing width 100 mm

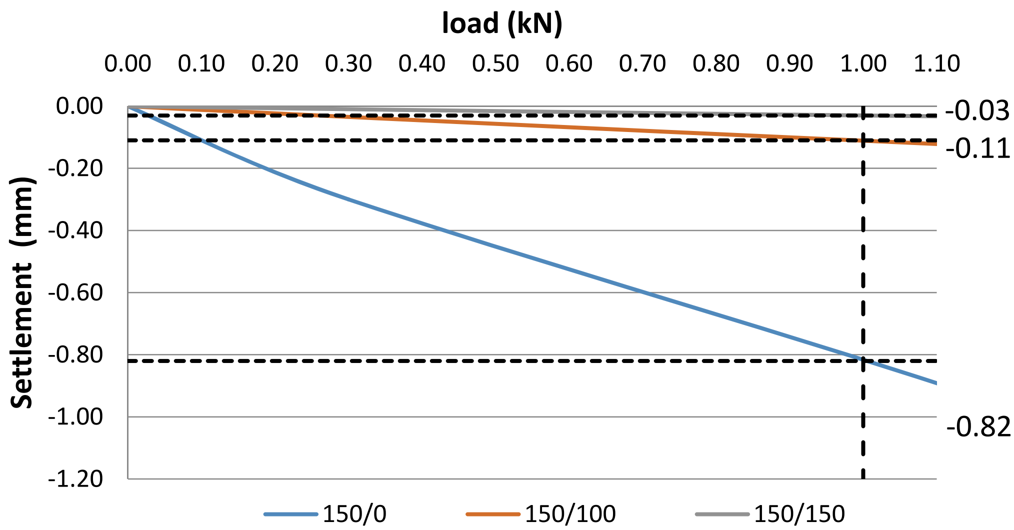


Figure13. Settlement analysis on footing width 150 mm

In the Figures11, 12, and 13. can be seen the amount of the settlement that occurs when the load of 1 kN. Then in Table 4. gives the magnitude of the settlement caused by the length of the different skirt at the same width of the square footing foundation.

Table 3. Settlement magnitude on load is 1 kN

Foundation Width, B (mm)	Skirt length L (mm)	L/B	Settlement (S) at 1 kN, (mm)
75	0	0,00	-1.85
75	100	1,33	-0.15
75	150	2,00	-0,07
100	0	0,00	-1.00
100	100	1,00	-0.09
100	150	1,50	-0.05
150	0	0,00	-0.82
150	100	0,67	-0.11
150	150	1,00	-0,03

From the table above can be seen that the magnitude of the settlement that occurs when the load of 1 kN value is smaller as the size of the skirt length increases. This can be seen from the bearing capacityof foundation with width (B) = 150 mm with skirt length (L) 0.00 mm = -0.82 mm; (L) 100 mm = -0.11 mm; (L) 150 mm = -0.03 mm. Table V.1 shows the L / B values, which are observed from the same width and the differentlength of skirts. When the L / B ratio is large, the settlement value is smaller. To know the magnitude of the ratio of L / B can be seen in FigureV.7.

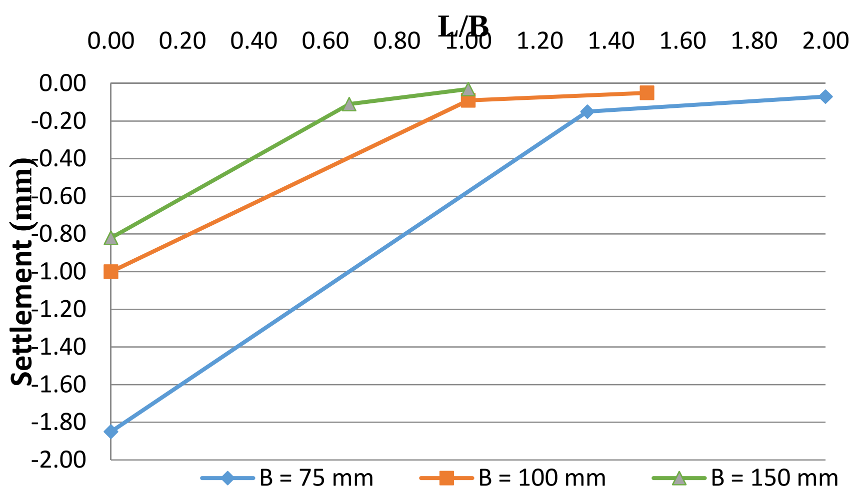


Figure14. the L/B Ratio-Settlement Relationship, Different B

7.Compare the Ultimate Bearing Capacity in the Maximum Load

To determine the effect between the variation of the width of the foundation and the variation of the skirt length of the foundation to the maximum load capable of retaining the foundation, the following will show the maximum load table of various variations of the width and length of the foundation skirt.

1. Maximum load unskirted foundation (L = 0 mm)

   The analysis of the maximum value of the maximum load on the unskirt foundation is shown in Figure15. following.

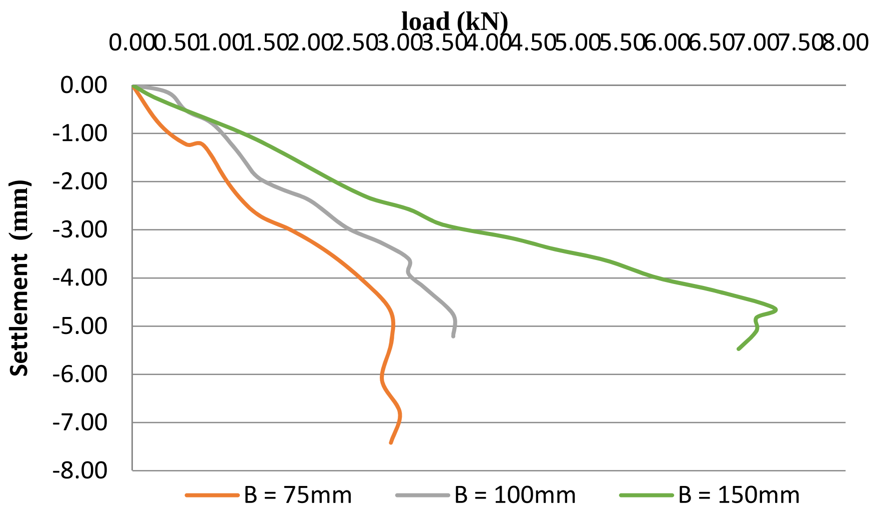


Figure15. The relationship between the maximum load and settlement of unskirted foundation.

Table 4 The maximum load of unskirted foundation.

Foundation Width, B (mm)	Skirt length L (mm)	Maximum Load (kN)	Percentage (%)
75 mm	0 mm	3.0	0
100 mm	0 mm	3,6	20
150 mm	0 mm	7.2	140

From the Figureand table above can be seen that with the increase of the size of the foundation width, the maximum load value that can be accepted by the foundation has increased is 20% and 140% respectively.

2. Maximum load with skirt foundation (L = 100 mm and L = 150 mm)

The analysis of the maximum value of the maximum load on the skirted foundation is shown in Figure16. and 17

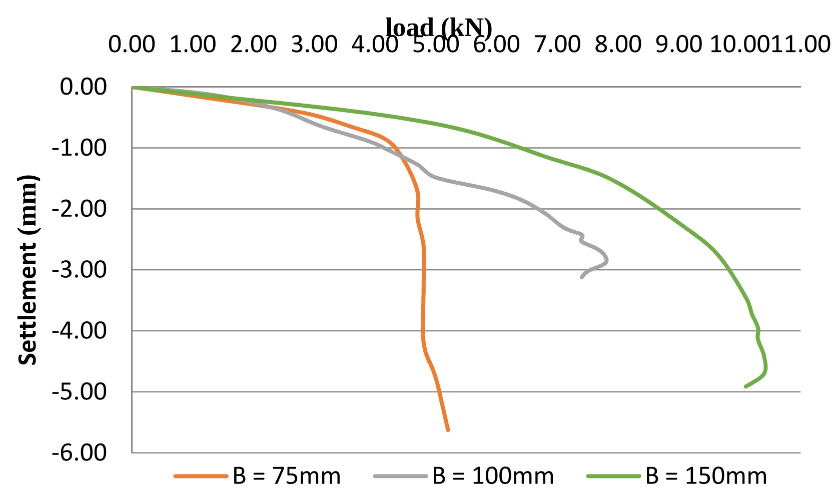


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Figure16. The relationship between the maximum load and settlement of skirted foundation L = 100 mm.

Table 5 The maximum load of skirt foundation L = 100 mm.

Foundation Width, B (mm)	Skirt length L (mm)	Maximum Load (kN)	Percentage (%)
75 mm	100 mm	5.4	0
100 mm	100 mm	7.8	44.44
150 mm	100 mm	10.4	92.59

Foundation Width, B (mm)	Skirt length L (mm)	Maximum Load (kN)	Percentage (%)
75 mm	150 mm	6.4	0
100 mm	150 mm	8.5	32.81
150 mm	150 mm	11.2	75

Settlement (mm)

0.
-1.
-2.
-3.
-4.
-5.
-6.
-7.
-8.
-9.

.

FigureV17 The relationship between the maximum load and settlement of skirted foundation L = 150 mm.

Table 6 The maximum load of skirt foundation L = 150 mm.

In the table above has presented the value of the maximum load both from the variation of the width of the foundation and the variation of the length of the skirted foundation. From the above comparison it can be seen that by increasing the size of the foundation width without using the skirt footing, the highest increase in bearing capacity is 140% (B = 150 mm; L = 0 mm). Whereas in the skirt footing L = 100 mm, the largest settlement was 92.59% (B = 150 mm, L = 100 mm) and with skirt L = 150 mm increase of 75% (B = 150 mm; L = 150 mm). So it can be concluded that by adjusting the skirt footing on the foundation will increase the bearing capacity of the foundation.

8.CONCLUSION

The research data analysis and discussion has gets the answer of its problem formulation. They are:

1. The value of bearing capacity of clay upper sand for skirted and unskirted square footing observed that at the same width of footing, the longer of skirt the higher of load and bearing capacity.
2. The magnitude of settlement for the influence of skirt length to footing width, L/B ratio observed on the similar width of footing with different length of skirt. It shown that the higher L/B ratio the smaller settlement.
3. The additional of skirt on the square footing is effective to reduce the settlement on the clay upper sand. As can be seen when it is observed on the similar width footing and different length of skirt, the longer skirt the smaller settlement.

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