EFFECT OF SKIRT TO CIRCULAR FOOTING ON CLAY SUBJECTED ON VERTICAL LOADING

Prepared as one of the requirement for achieving Bachelor Degree (Strata I) of Civil Engineering

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DECLARATION

Hereby I am as the author declared that this Final Project is prepared and presented by myself, except the quotations and summaries that I have explained from all the sources and put on the bibliography.

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Surakarta, 23 Desember 2016

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Abstrak

Fondasi merupakan bagian terpenting pada struktur bangunan. Hal-hal yang harus diperhatikan dalam merencanakan fondasi yaitu nilai daya dukung dan penurunan. Diperlukan adanya upaya perbaikan dan penyelidikan baik pada tanah ataupun fondasi. Penelitian ini dilakukan untuk mempelajari pengaruh penambahan *skirt* pada fondasi telapak lingkaran untuk mengurangi penurunan pada lempung lunak sebagai salah satu solusi tersebut. Terdapat sembilan variasi pengujian laboratorium fondasi telapak lingkaran yang terbuat dari baja diameter 75 mm, 100 mm, dan 150 mm dengan panjang *skirt* 100 mm dan 150 mm pada tanah lempung lunak dengan mempertahankan kadar air dan metode pemadatan yang sama. Hasil penelitian menunjukkan bahwa penambahan *skirt* sangat efektif untuk mengurangi penurunan fondasi pada lempung lunak yang ditinjau pada beban yang sama 1 kN. Peninjauan pada rasio L/D pada diameter yang sama juga menunjukkan bahwa semakin tinggi rasio L/D maka penurunan fondasi yang terjadi semakin kecil. Serta pada peninjauan pada penurunan 3 mm dengan diameter sama menunjukkan semakin panjang skirt semakin besar beban yang ditahan fondasi.

Kata Kunci: fondasi, fondasi telapak lingkaran, lempung, penurunan, *skirt*.

Abstract

Foundation is an important part in building structure. Designing the foundation has to consider the bearing capacity and the settlement. It is necessary to improve and to investigate either on the soil or on the foundation. This research performed to study the effect of skirt on circular footing to reduce the settlement on clay as the alternative solution. There were nine variation experiment laboratory of the circular footing made of steel diameter 75 mm, 100 mm and 150 mm with length of skirt 100 mm and 150 mm on clay by keeping the similar water content and compaction method. The results show that the skirt is effectively to reduce the foundation settlement on clay which is observed on similar load 1 kN. The observations on L/D ratio on similar diameter also show that the higher L/D ratio the smaller settlement. It is also the observations on settlement 3 mm with similar diameter show that the longer skirt the higher load which arrested by the footing.

Keywords: foundation, circualar footing, clay, settlement, skirt.

1. INTRODUCTION

Foundation is the part of structure which serves exclusively to transmit load from structure on to the sub-soil. One of the causes of the building collapse is the instability of the foundation, either the foundation design or the instability of soil. As known, clay is classified as one of the problematic soils due to its low shear strength and excessive settlement. Therefore, it is necessary to improve and to investigate either on the soil or the foundation design. In order to solve these problems, a vertical plates or skirts made out of steel are attached to the footing or called skirt foundation.

Amr Z. EL Wakil (2013) studied the skirt circular footing to improve the bearing capacity on sandy soil. The research was performing eighteen laboratory experiments on circular footing of different diameter and skirt length. The investigation on the effect of skirt length and relatives density of sand on ultimate load from the laboratory tests was found that the skirts are more beneficially in case of footing on loose sand that in case of medium and dense sand. Ashraf and Wasim (2010) reported that the improvement of bearing capacity is remarkable, using both partially replaced sand pile with and without confinement by skirts. Golmoghani and Rowshanzamir (2013) evaluated bearing capacity of skirted footing on sand. The test results were found that using structural skirts may improve the footing bearing capacity up to 3.68 times greater than the average value of calculated ultimate bearing capacity of foundations with the same depth of skirt. Isvan F. Satria (2016) reported that the additional of skirt on the circular footing is very effective to improve the ultimate bearing capacity on the sand soil. With the same diameter of circular footing, as the length of skirt increases, the ultimate bearing capacity increases.

2. METODE

To study the behavior of the effect of skirted footing on clay, six laboratory tests of skirted footing and three other without skirts were conducted on small scale model of circular footing machined from steel plates having diameter (D) equal to 75 mm, 100 mm, 150 mm and of thickness 20 mm. The thin circumferential skirts are welded firmly and accurately around the periphery of footing, of thickness in 10 mm. Their lengths were 100 mm and 150 mm, measured after welding to footing. The skirt length (L) to the footing diameter ratio (L/D) are 1.33 (100/75), 1.00 (100/100), 0.67 (100/100), 2.00 (150/75), 1.50 (150/100), 1.00 (150/150) and three unskirted footing L/D are 0.00. The model footings have smooth face and notch at the center of top face for mounting piston to transfer the load when testing. There are two open hole drilled at the top face of footing to observe the top surface of the soil.

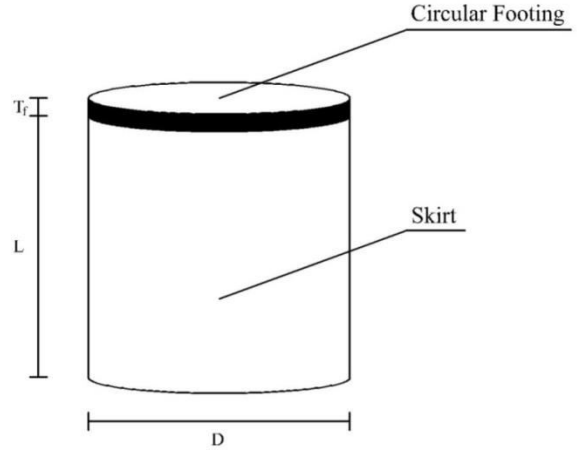

Figure 1 Skirt Circular Footing Model

Where,

D = diameter of skirt circular footing

L = length of skirt

T_f = thickness of footing

The material used in this research is clay that comes from Sukoharjo, Central of Java, Indonesia. The soil was keeping the same formation of water content and compaction method in each laboratory test. The bin was made of steel cylinder shapes having height 500 mm and diameter 600 mm, with the top side circle is opened. The vertical loadings are measured by frame load testing machine with hydraulic loading machine, it has maximum load is 250 kN. Two dial gauge used to measure the footing vertical displacement. Both were placed on the top face of footing. The compaction was used the hammer with 5.5 lbs (2.5 kg) weight and 12 inch (305 mm) free fall height.

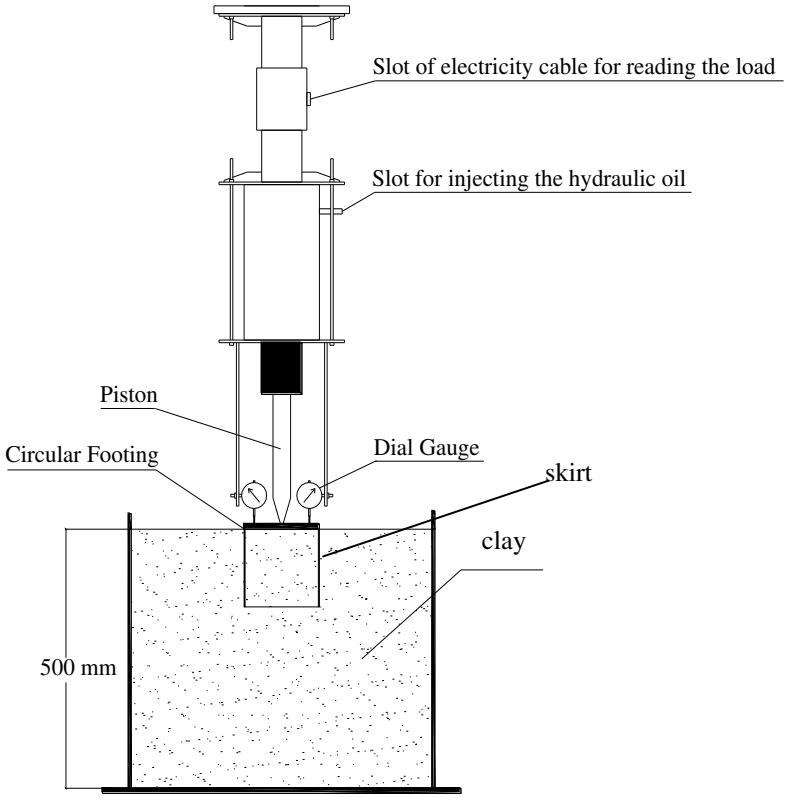

Figure 2 Sketch Setup of Testing Procedures

First step is preparing and setting up the equipments and clay that comes from same location. The soil is dried on the temperature (27-30°C) and sieved with sieve no. 4. *Second* step is investigating the air-dried water content. *Third* step is conducting the laboratory test. The value of water content for this research must be kept in same condition for all nine models laboratory test. Add the water into the soil on the bin and mix them until homogenous. Then, compact the soil for 10 layers of the

bin and blow 100 blows for each layer. Set the soil bin on the hydraulic loading machine and place the skirt footing with L/D = 1.33 right on center of the bin, push it until all the skirt is already inside the soil. Observe the top surface of the clay inside the skirt via two open holes on the footing. Set the two dial gauges on the left and the right position to observe the vertical displacement. Then running the hydraulic loading machine, observe and record all of the magnitude that occurred on each dial. The settlement value is shown on the two dial gauges and the load value is shown on the digital device of the hydraulic loading machine. The last is stopping the loading when the load decrease as the indication that the foundation failure.

The subsequent experiment, conduct the same test as sequence before but it just replace the footing with value L/D = 0.0 (unskirted circular footing), 1.33, 1.00, 0.67, 2.00, 1.50, 1.00 (skirted circular footing). Final step is analyzing all the data and concluding accomplished laboratory tests.

3. RESULT AND DISCUSSION

The research is conducted in similar water content and compaction method. The water content was investigated around 15%. This value kept for all testing model as reference. The result of the investigation shows load settlement curves for all model footing. The general result are presented in figure 3-5. The horizontal and vertical axes show the load and settlement value respectively.

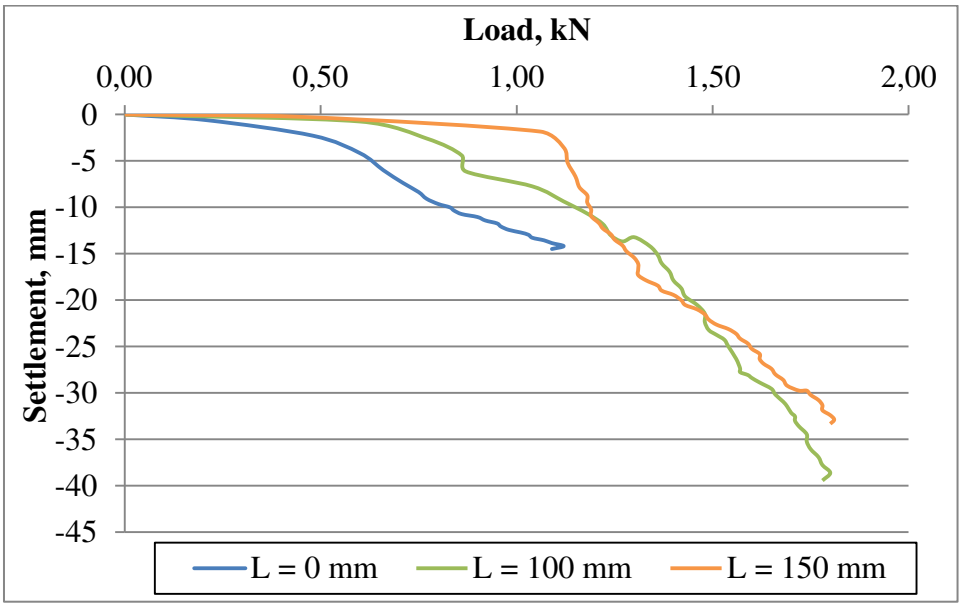

Figure 3Load-Settlemnet Relationship for Footing Diameter 75 mm

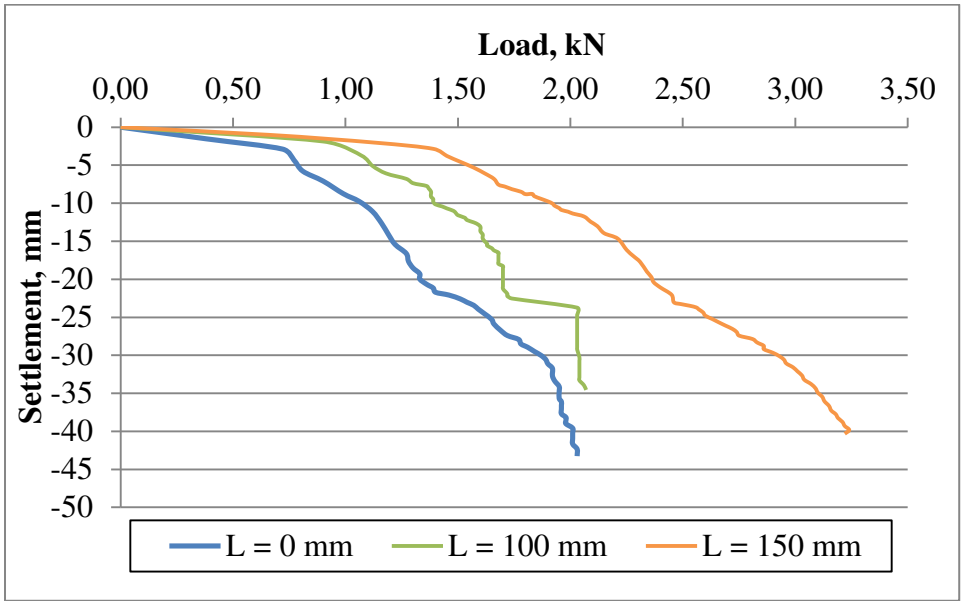

Figure 4Load-Settlement Relationship for Footing Diameter 100 mm

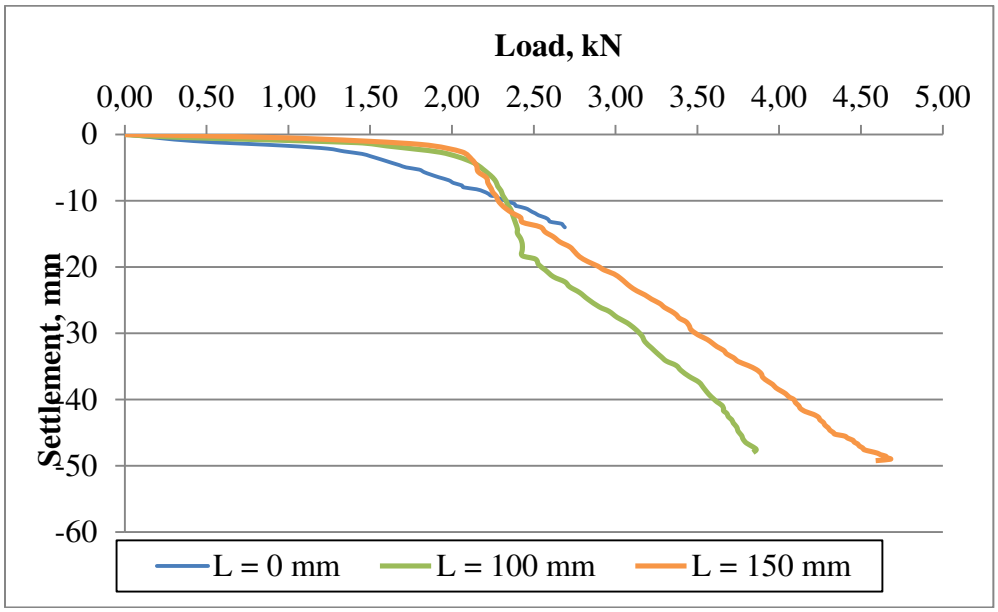

Figure 5Load-Settlement Relationship for Footing Diameter 150 mm

It can be seen from these figures that the load-settlement relationship for all curves are fairly linear for small-load range, and that the relationship are nonlinear for large-load ranges and does not exhibit any peak value.

3.1 Settlement in Similar Load as Reference

In order to investigate the magnitude of settlement due to the influence of the additional skirt to circular footing, it has to observed on the similar value of load (P, kN). It is taken 1 kN. The analysis of settlement in similar load (1 kN) is shown on figure 6-8.

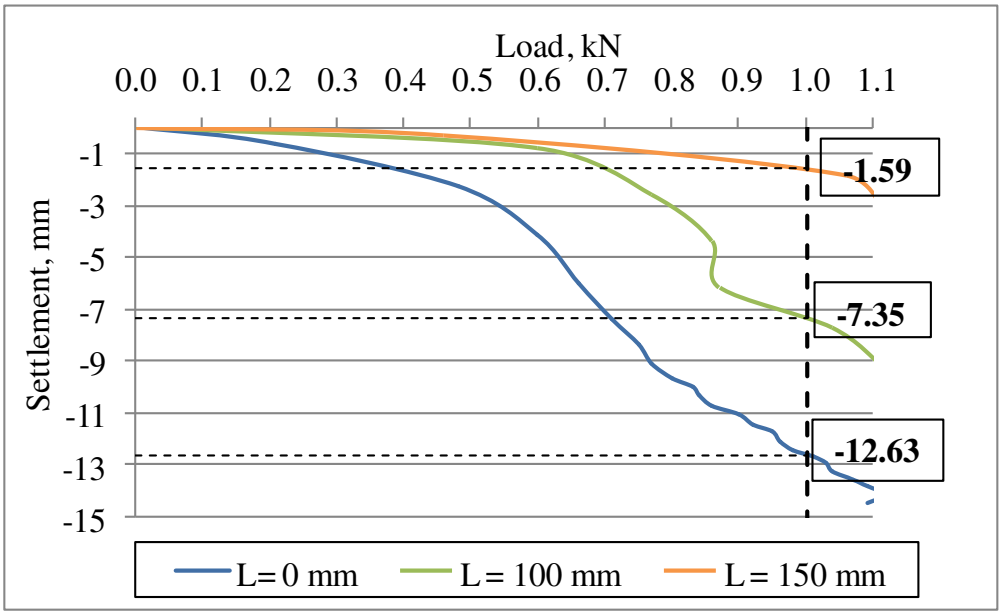

Figure 6Settlement Analysis on Footing Diameter 75 mm

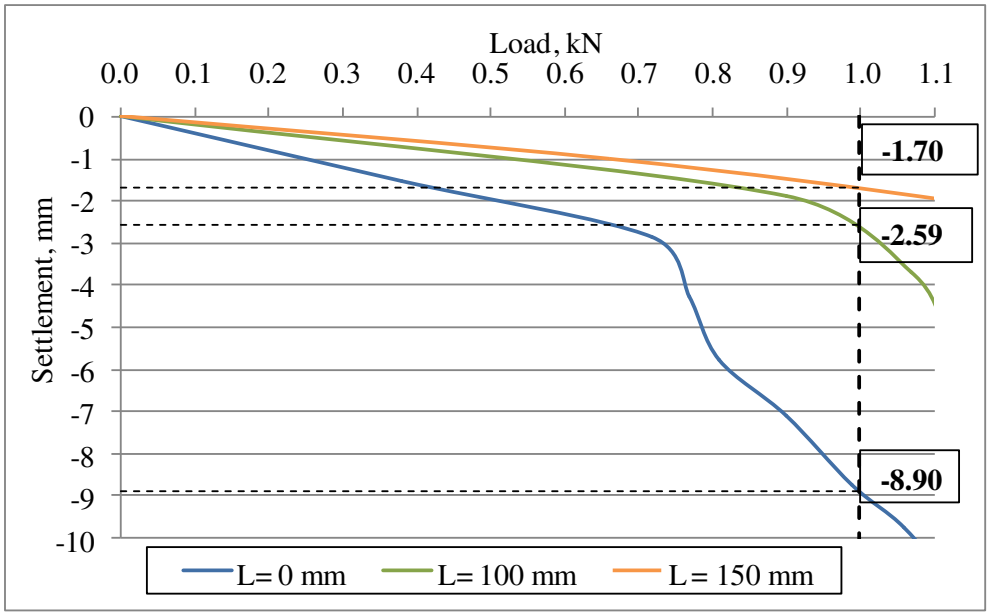

Figure 7Settlement Analysis on Footing Diameter 100 mm

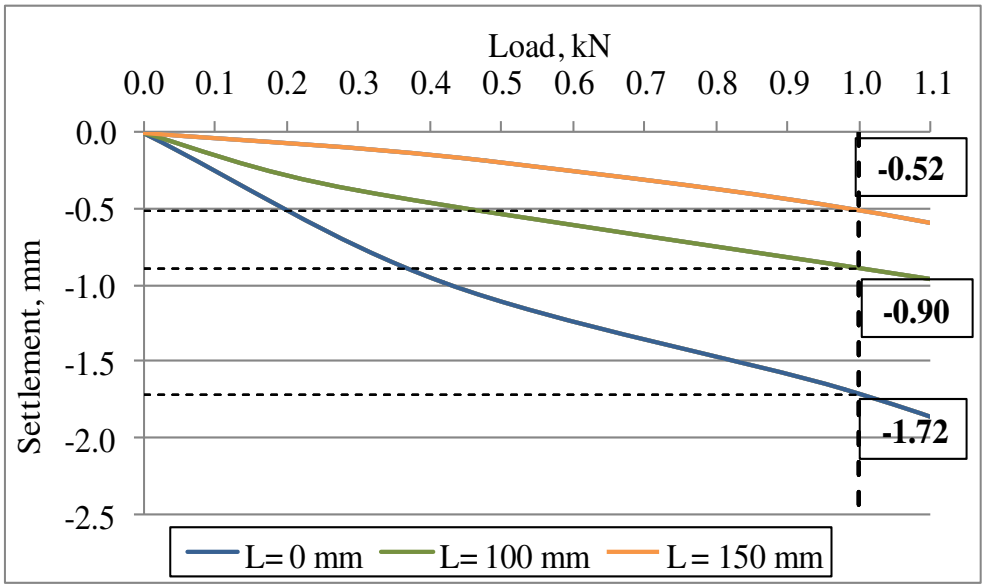

Figure 8Settlement Analysis on Footing Diameter 150 mm

These figures shown the analysis of settlement on the similar load (1 kN) and table 1 gives the result of the settlement magnitude that caused by different skirt length on the similar diameter of circular footing

Table 1Settlement Magnitude on Load 1 kN

Footing diameter D (mm)	Skirt length, L (mm)	L/D	Settlement (S) (mm)
75	0	0.00	12.63
75	100	1.33	7.35
75	150	2.00	1.59
100	0	0.00	8.90
100	100	1.00	2.59
100	150	1.50	1.70
150	0	0.00	1.72
150	100	0.67	0.90
150	150	1.00	0.52

The magnitude of settlement which is caused by the different skirt length indicated that the longer skirt the smaller settlement. It is shown on diameter (D) 150 mm with the length (L) 0.00 mm= 1.72 mm of settlement, (L) 100 mm= 0.90, (L) 150 mm= 0.52 mm.

Table 1 also shows the different condition on L/D ratio, which is observed from the similar diameter and different skirt length. The higher L/D ratio the smaller settlement. Figure 9 presented.

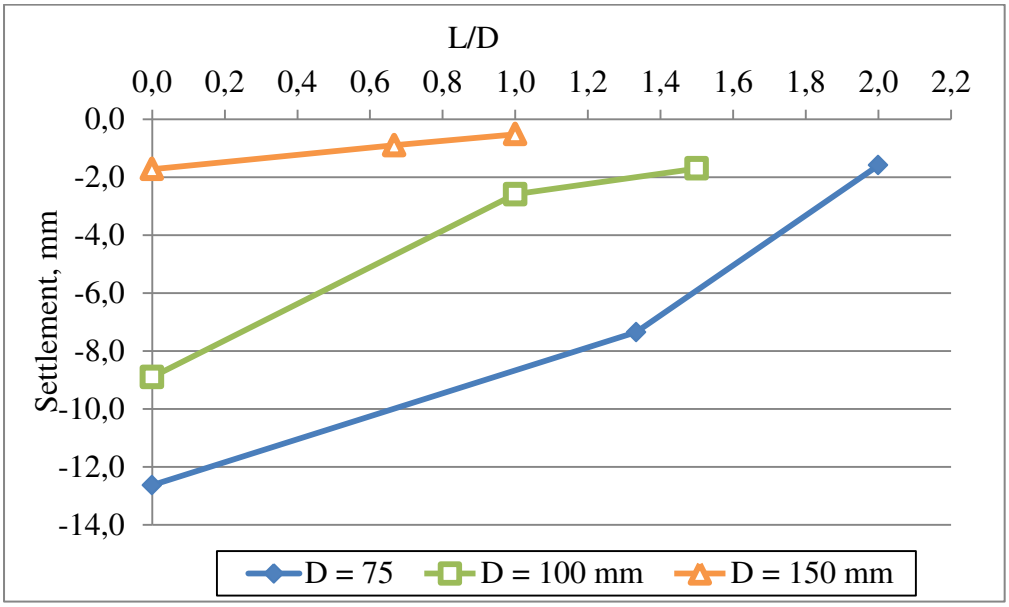

Figure 9L/D Ratio-Settlement Relationship, Different D

The figure 9 shows that the smallest settlement of skirt circular footing is the footing that attached by the longest skirt 150 mm to the widest diameter 150 mm.

3.2 Load in Similar Settlement as Reference

Base on the test and investigation of six models of skirt footing and three models of unskirted footing, figure 3-5 were shown that the curve does not exhibit any peak value. To study the load magnitude due to the influence of the variant skirt length to the different diameter, it could be observed in the similar settlement in 3 mm. figure 10-12 are presented.

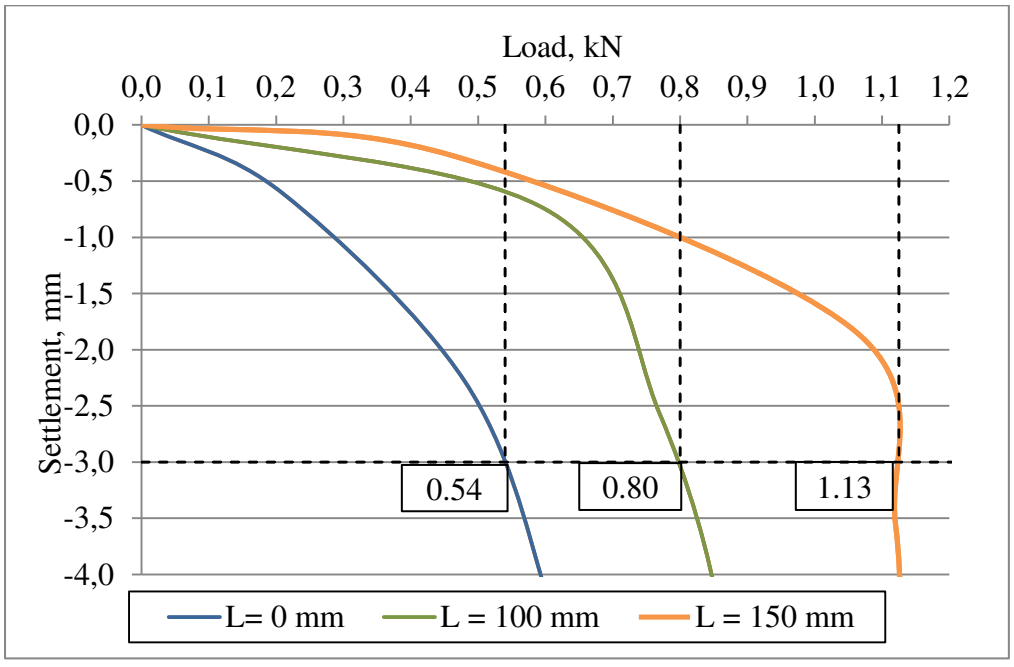

Figure 10Load in Similar Settlement on Footing Diameter 75 mm

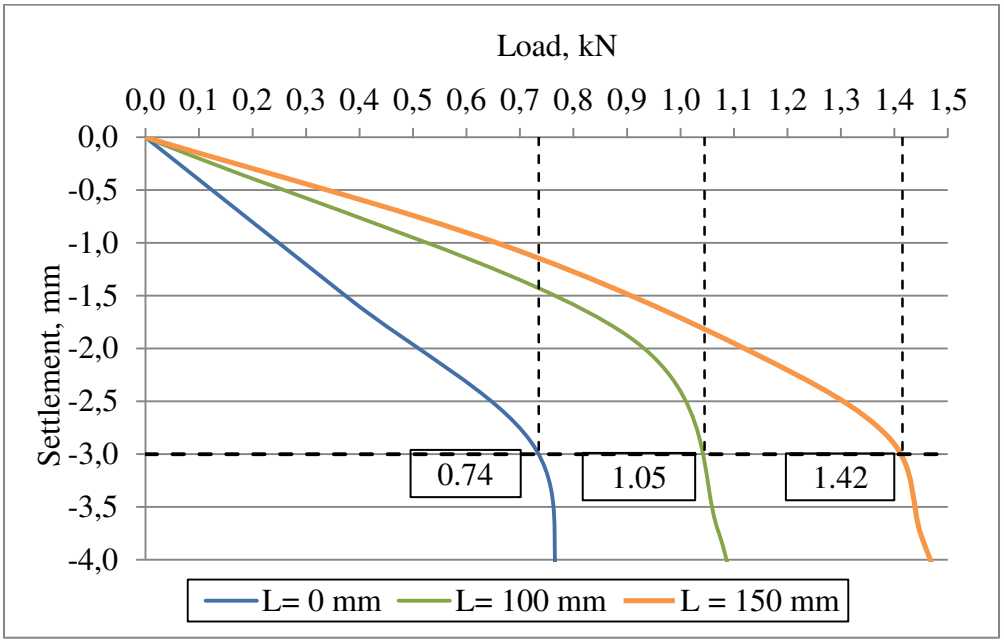

Figure 11Load in Similar Settlement on Footing Diameter 100 mm

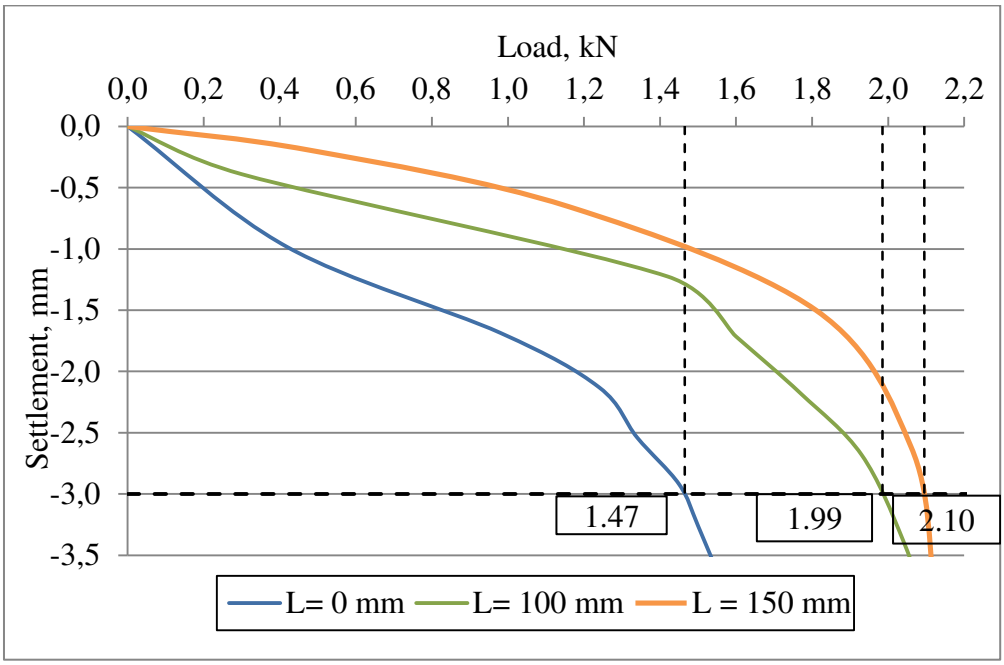

Figure 12Load in Similar Settlement on Footing Diameter 150 mm

The figures show that the longer skirt the higher load in similar diameter. It also happen on L/D ratio which is observed in similar diameter with different skirt length. The figure 13 shown

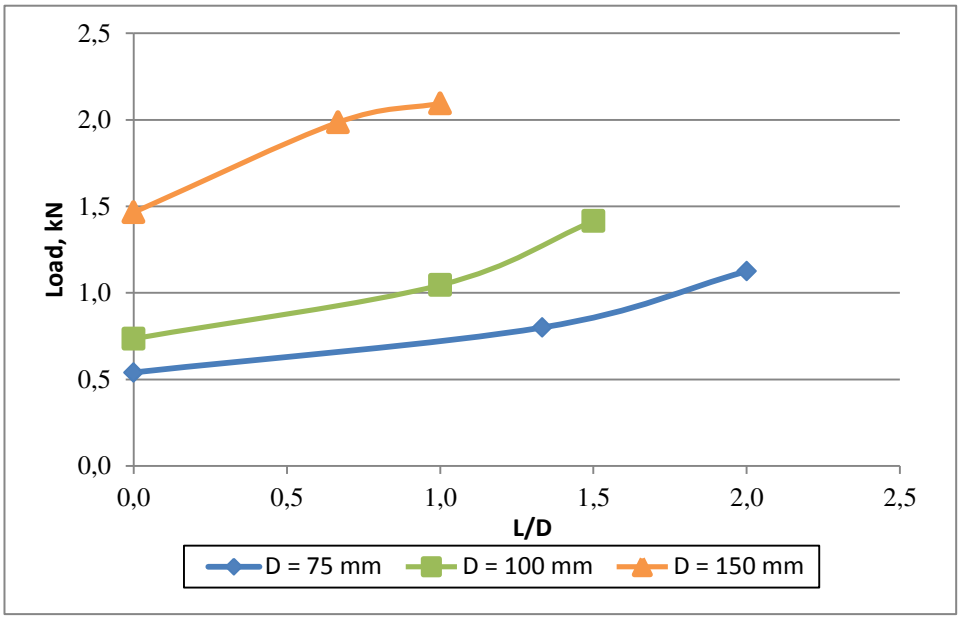

Figure 13L/D ratio-Load relationship in Similar Settlement 3 mm, Different D

The figure presented that the higher L/D ratio the higher load in similar settlement 3 mm with different diameter.

4. CONCLUSIONS

From the accomplished laboratory tests, the following may be concluded:

1. The additional skirt on circular footing is effective to reduce the settlement on clay.as can be seen when it is observed on the similar load om 1 kN load on the same diameter of circular footing, the longer skirt the smaller settlement.
2. The magnitude of settlement for the influence of skirt length to the footing diameter, L/D ratio observed on the similar diameter of footing different length of skirt. It shown that the higher L/D ratio the smallest settlement.
3. The magnitude of loading of the skirted and unskirted circular footing observed on similar settlement in 3 mm, it is explained that at the diameter of footing, the longer skirt the higher load.

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