IFERP

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 4, Issue 7, July 2019

Effect of Vertical Loads on Skirted Circular Footing in Slope

[1] Manju P.S, [2] Oshin Ann Mathews

[1] P.G. Student, [2] Assistant Professor

[1][2] Department of Civil Engineering, IES College of Engineering, Chittilappilly, Thrissur, India

[1]manjups01@gmail.com [2] oshin.ann@gmail.com

***Abstract*—Many situations exist where the foundations must be constructed on or near slopes. Buildings, bridges, and abutments in hilly regions are the examples of such constructions. Foundation must be properly designed for such cases. Cost saving is considered when using shallow foundations instead of deep foundations to support structures, near or on slopes. But in such cases, the ultimate bearing capacity would be reduced because the footing is closer to a slope crest. An alternative method to improve the ultimate bearing capacity was investigated by using skirted circular footing. Skirted circular footings are more economical than deep foundation. In this study laboratory investigation on the effect of vertical loads on skirted circular footing in slopes were determined. The experiments were done using plate load test by varying the parameters such as length to depth ratio of the footing, distance from the crown of the slope to the edge of the footing. The results indicate that skirted circular footing has high ultimate bearing capacity.**

***Index Terms*—Crown of the slope, Plate load test, skirted circular footing, slope crest**

1. INTRODUCTION

Many structures such as houses, bridges, transmission line towers are constructing near the slope. Constructions near the slope cause problems to the structure such as reduce bearing capacity of the foundation and collapse of slope. Construction of structures near the slope requires more site planning and design consideration to minimize the problems to the structure. In those cases deep foundations are generally preferred. Shallow foundations are cost saving than deep foundation but if it is used instead of deep foundation the bearing capacity will be reduced considerably. Different types of surface footings such as circular, rectangular and strip footing are available. Among the surface footings Circular and rectangular footings have higher bearing capacity compared to that of strip footings. Comparing between these two circular footing is more economical than rectangular footing because of the lesser amount of reinforcement steel. Confinement on the side of the footing increases the bearing capacity of the shallow footing. Skirts form an enclosure in which soil is strictly confined and acts as a soil plug to transfer super-structure load to soil. Skirted foundations are the shallow foundations which satisfy bearing capacity requirement, and to minimize the embedment depth and dimensions of the foundation. Skirts improve the bearing capacity of shallow footings on sandy soil by constraining the soil beneath. In this paper present a study on the effect of vertical loads on skirted circular footing in slopes by varying the skirt length to diameter ratio and the distance from the distance from the edge of the footing to crown of the slope. The experiment is conducted by using plate load test by varying the parameters. Studies on skirted footing on slopes have been conducted. Studies on skirted footings with different shapes were reported, e. g. Francesco castelli et al. (2011), M. A. Islam and C. T. Gnanendran (2015). Experiments conducted on skirted footings for e. g. Amr Z et al. (2013), T. Prasanth et al. (2017), S. Golmoghani et al. (2013), Dr.Mariamma Joseph et al. (2018), Renaningsih et al. (2005), M.E.I Sawf et al. (2005), Hisham T. Eid et al. (2013). Studies on various shaped footings are also have been conducted for e. g. Mohammed Y. Fattah et al.(2014). However researchers have not investigated the behavior of skirted circular footing in slopes subjected to vertical loading.

Fig. 1 Skirted circular footing under wind turbine

All Rights Reserved © 2019 IJERMCE

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 4, Issue 7, July 2019

2. MATERIALS USED

Soil used in this study is locally available sand. Footings used in this study are circular footing and skirted circular footing.

Diameter of the circular footing is 100mm and have a thickness of 5mm. Skirts provided around the circular footing have a thickness of 3mm. Three skirt lengths are taken in this study and they are 100mm, 150mm, 200mm. so that the skirt length to footing diameter varies from 1, 1.5, and 2.

Fig. 2 Sand

Fig. 3 Skirted Circular Footing

Parameters	Value
Specific Gravity	2.65
Effective size, D10 (mm)	0.21
D30 (mm)	0.33
D60 (mm)	0.52
Uniformity coefficient, Cu	2.47
Coefficient of curvature, Cc	0.99
Gradation of sand	SP
Maximum density (g/cc)	1.71
Minimum density (g/cc)	1.42
Sand density (30% RD) (g/cc)	1.5
Angle of internal friction (30% RD) (degree)	30

3. EXPERIMENTAL PROGRAMME

The effect of vertical loading on skirted circular footing is investigated using laboratory model experiments. The experiments were done in a test tank having a size of 1500mm x 500 mm x 600 mm, made up of steel sheet of thickness 5mm. Sand is filled in the tank in layers. Predetermined quantity of soil is filled in the layers having a thickness of 100mm. Desired density is achieved by compacting each layer. The tank is provided with an attachment of rigid mild steel inclined frame at desired angle in order to prepare a slope of height of 400mm starts from a distance of 200mm from tank bottom.. Only after completing the compaction and placing of footing the steel sheet is removed.

Hydraulic jack is used to apply the axial load by means of a which was clamped to the reaction frame and its hose was connected to the lever system. The load was applied to the skirted circular footing by using reaction frame through the hydraulic jack and proving ring. A calibrated proving ring of capacity 100 kN and dial gauge of 25 mm capacity with sensitivity of 0.01 mm are used for measuring loads and displacement respectively. Over which proving ring is connected in order to measure the applied load. A dial gauge is provided for the measurement of corresponding settlements. The test set up is shown in figure

All Rights Reserved © 2019 IJERMCE

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 4, Issue 7, July 2019

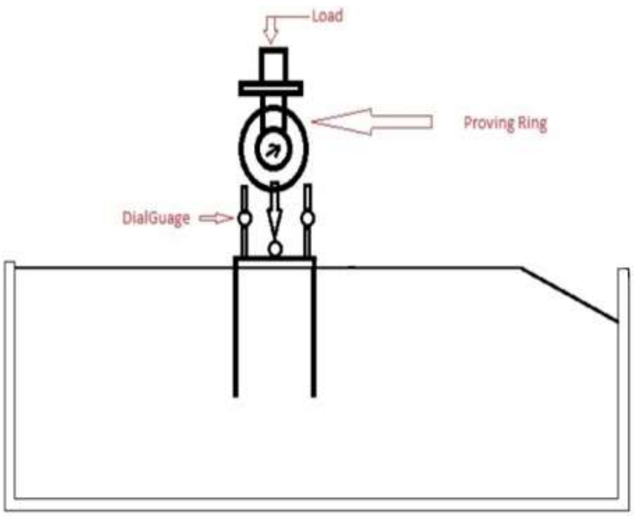

Fig. 4 Schematic Diagram of Test Set up

Fig. 5 Axial loading set up

A series of tests were conducted to determine the effect of vertical loading on skirted circular footing and circular footing in slopes by varying the L/D ratio and distance of footing from the crown of the slope by keeping the slope angle constant as 30^0.

4. RESULTS AND DISCUSSIONS

Load settlement behavior of skirted circular footing resting on slope was studied for Vertical loading condition. The effect of vertical load for footing resting on slope was studied in detail for three values of distance from crown. The results were shown in terms of load given and the settlement occurs to understand the effect of vertical load. Figure 6 shows typical load-settlement curve for the footing resting at a critical distance of 1D that is 100mm from the crest of slope subjected to vertical load.

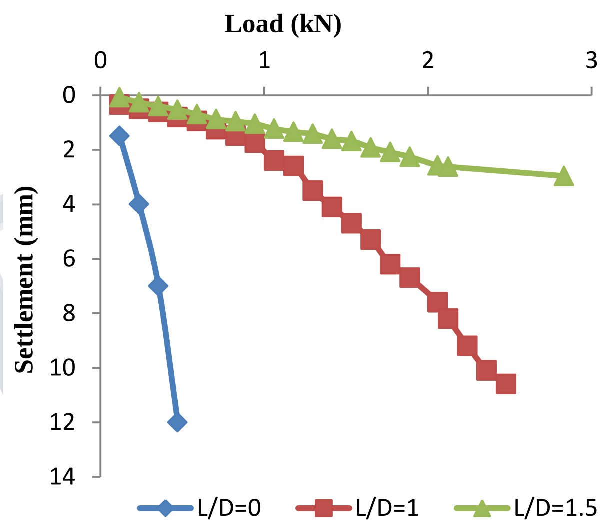

Fig. 6 Axial load – settlement graph of skirted circular footing with different L/D ratio at a distance of 10cm from the crown of the slope

The advantage of skirted circular footing over the circular footing can be found in the Fig 6, Fig 8 and Fig 9. By providing the skirt around the footing the ultimate bearing capacity increases. The increase in ultimate bearing capacity is due to the confinement of soil in between the skirt. As the ultimate bearing capacity increases the settlement get decreased. Vertical load carrying capacity increases as the skirt length increase up to 150mm or L/D ratio = 1.5. The increase in skirt length increases the confinement of soil in the skirt and this increase the ultimate bearing capacity of the footing there by decreasing the settlement. When the distance from the crown of the slope increases the bearing capacity is increases and the settlement decreases by 75% in loose fill.

All Rights Reserved © 2019 IJERMCE

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 4, Issue 7, July 2019

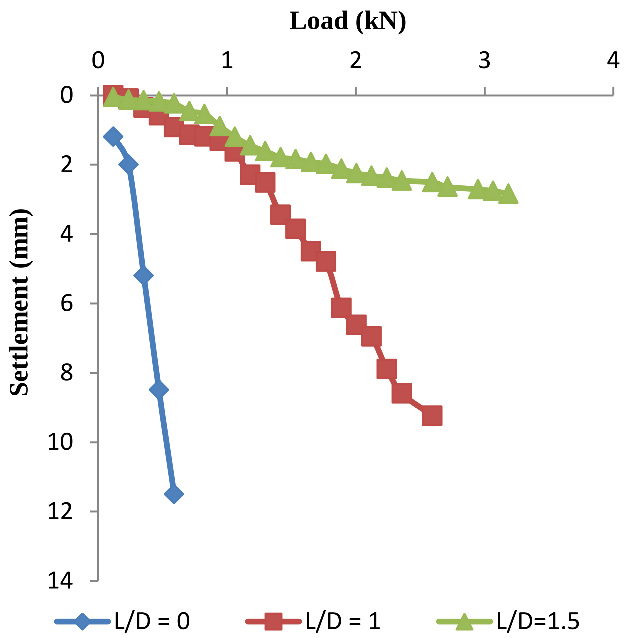

Fig. 7 Axial load – settlement graph of skirted circular footing with different L/D ratio at a distance of 20cm from the crown of the slope

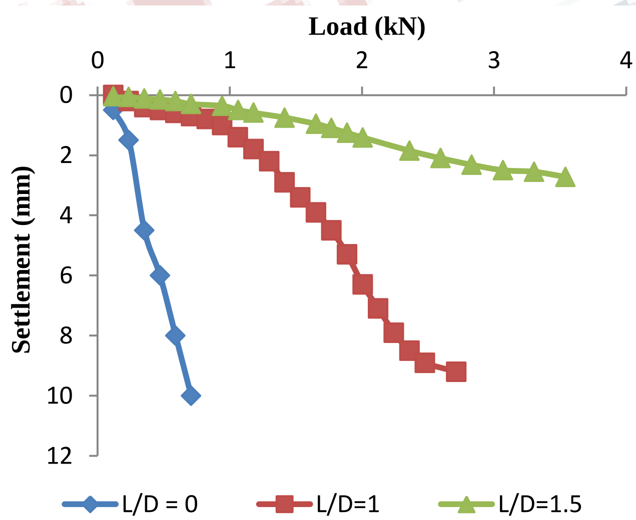

Fig. 8 Axial load – settlement graph of skirted circular footing with different L/D ratio at a distance of 30cm from the crown of the slope

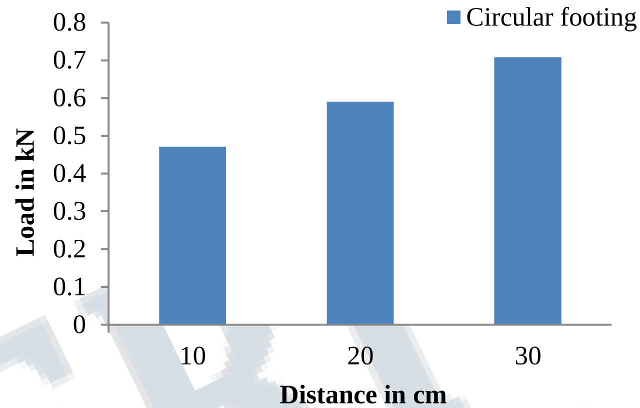

Fig. 9 Ultimate axial load capacity variation of circular footing without skirts in loose sand at various distances from the crown of the slope

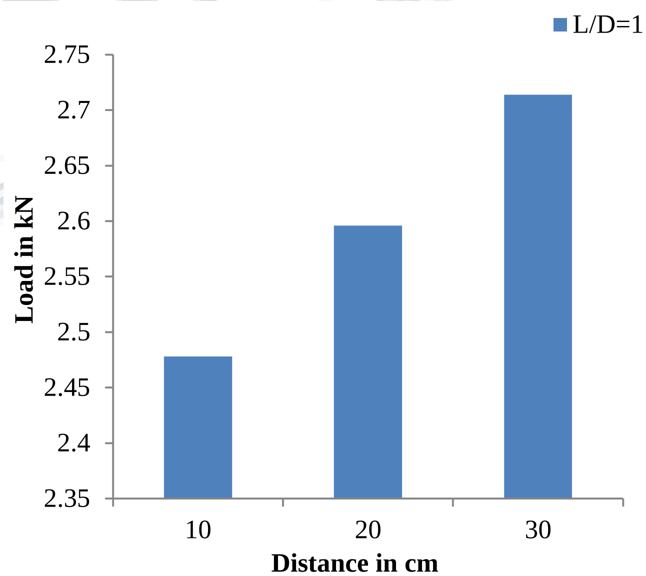

Fig. 10 Ultimate axial load capacity variation of skirted circular footing with L/D = 1 in loose sand at various distances from the crown of the slope

All Rights Reserved © 2019 IJERMCE

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 4, Issue 7, July 2019

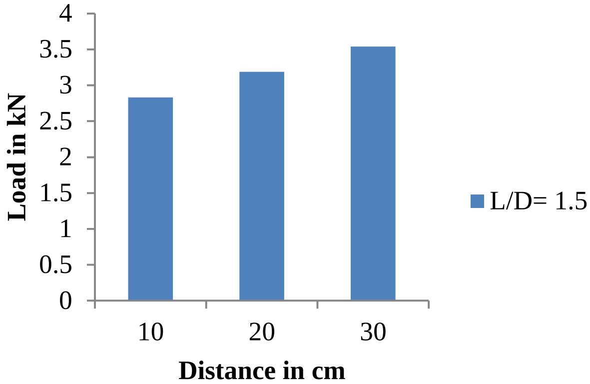

Fig. 11 Ultimate axial load capacity variation of skirted circular footing with L/D = 1.5 in loose sand at various distances from the crown of the slope

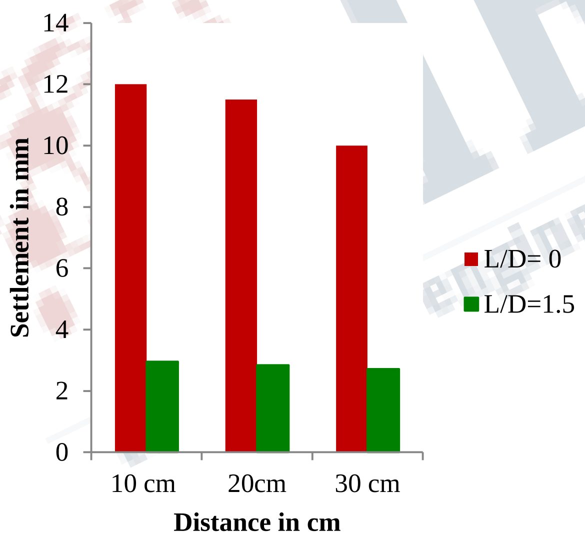

Fig. 12 Settlement variation of circular footing and skirted circular footing (L/D =1.5) at various distances from the crown of the slope

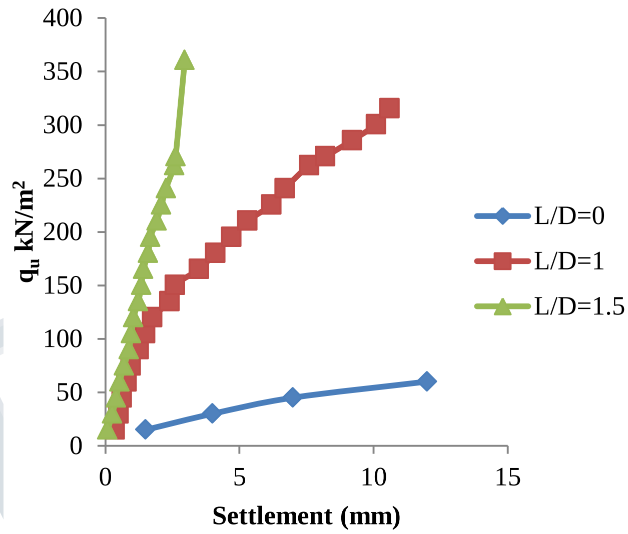

Fig. 13 Relationship between ultimate bearing capacity and settlement of skirted circular footing with different L/D ratio at a distance of 10cm from the crown of the slope

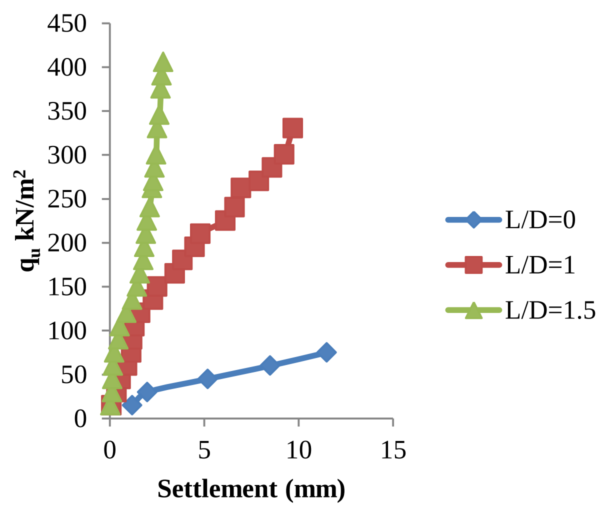

Fig. 14 Relationship between ultimate bearing capacity and settlement of skirted circular footing with different L/D ratio at a distance of 20cm from the crown of the slope

All Rights Reserved © 2019 IJERMCE

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 4, Issue 7, July 2019

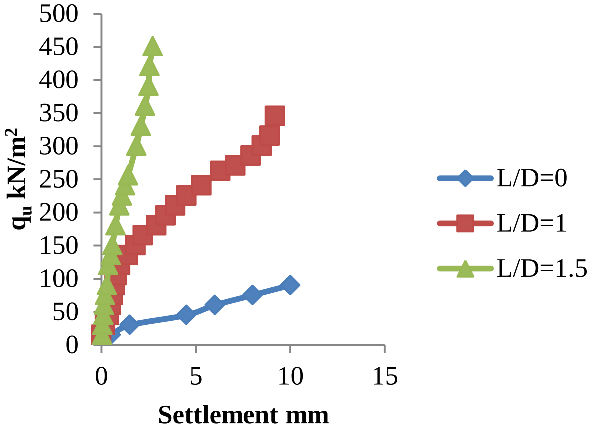

Fig. 15 Relationship between ultimate bearing capacity and settlement of skirted circular footing with different L/D ratio at a distance of 30cm from the crown of the slope

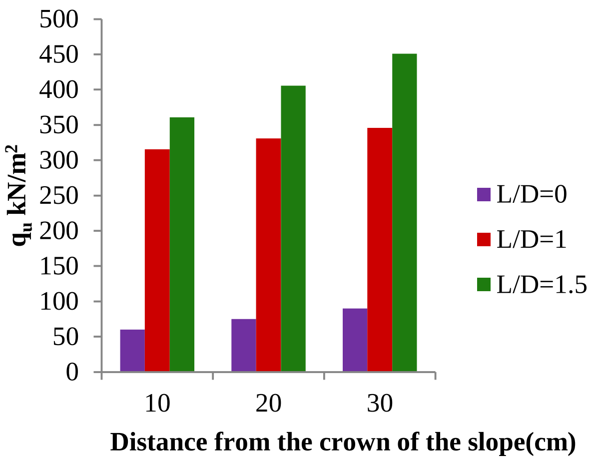

Fig. 16 Relationship between ultimate bearing capacity and distance from the crown of the slope with different L/D ratio

CONCLUSION

- Skirted circular footing has high vertical load carrying capacity than a circular footing.
- As the L/D ratio increase up to 1.5 the bearing capacity increases.
- Skirts improve the bearing capacity up to 5 times of the circular footing.
- As the distance from the crown of the slope increases the bearing capacity increases.
- By the increase of bearing capacity the settlement get decreased up to 75%.

REFERENCES

1. Francesco castelli and Valentina Lentini, "Evaluation of bearing capacity of footing on slope," ICE Virtual Library, vol. 2, pp. 112-118, December 2011.
2. Hisham T. Eid, "Bearing capacity and settlement of skirted shallow foundations on sand," ASCE, pp. 645-652, 2013.
3. M. A. Islam and C. T. Gnanendran "Behaviour of a Strip Footing Near Slope Crest Under Vertical Cyclic Loading," ASCE, pp . 31-40, 2015.
4. Mariamma Joseph and A.S Anju, "Behaviour of skirted footing resting on sea sand," International Journal of scientific Research and Engineering Trends, pp. 471-475, 2018.
5. M.E.I Saawf and A. Nazer, "Behavior of circular footing resting on confined granular soil," ASCE, pp. 359-366, 2005.
6. Mohammed Y. Fattah, Kais T. Shlash, Husham A. Mohammed, "Bearing Capacity of Rectangular Footing on Sandy Soil Bounded by a Wall," Springer, pp. 7621–7633, August 2014.
7. Renaningsih, Isvan Fajar Satria, Agus Susanto and Anto Budi Listyawan, "Method to Increase Ultimate Bearing Capacity of Skirted Circular Footing," AIP Conf, pp. 1-8, 2017.
8. S. Golmoghani-Ebrahimi and M.A. Rowshanzamir, "Experimental Evaluation of Bearing Capacity of Skirted Footings," Civil Engineering and Architecture, pp. 103-108, 2013.
9. T. Prasanth and P. Rajendra Kumar,"A study on load carrying capacity of skirted Foundation on sand," international journal of science and research, vol. 6, pp. 2231-2235, June 2017.
10. Z Amr and EL Wakil, "Bearing capacity of skirted circular footing on sand," Alexandria engineering journal, pp. 359-364, March 2013.

All Rights Reserved © 2019 IJERMCE