Experimental Study of Various Shaped Isolated Footings under Monotonic Loading on Loamy Soil

Zubair Ahmad Lone[1], RafeeManzoor[2], Mohd. Kashif Khan[3], Syed Mohammad Ashraf Husain[4]
[1, 2, 3, 4] Department of Civil Engineering
[1, 2, 3, 4] Integral University, Lucknow

Abstract- *In the present study behaviour of four footing specimen when exposed to monotonic loading on loamy soil is observed. Four footing specimens rectangular, circular, square and triangular in shape having similar surface area (150cm2) with plate thickness equal to 8mm have been used. The loading arrangement consisted of a soil filled tank, loading machine, load cell, digital load indicator. A tank of size 45 cm x 45 cm x 45 cm was filled with soil. Total height of fill was kept as 30cms. It was divided in three parts and filling was done in three stages also. In each stage soil was filled and compressed keeping density of each soil equal to field density. The intensity – settlement curves for all four footings are plotted under monotonic loading. Based on the test results conducted on numerous shaped footings under monotonic loading on loamy soil, it is determined that for same stratum and footing area under similar loading conditions the performance of footing is extremely influenced by shape of footing under the monotonic type of loading. In this case the settlement was seen lesser in case of square and maximum in triangular footing. The intensity - settlement behavior grows and plastic deformation reduces with change in shape of footing from triangular shape to square shape footing.*

Keywords- Bearing Capacity, Footing, Loamy Soil Settlement.

I. INTRODUCTION

Bearing capacity of soil is one of the characteristic problems in foundation engineering. Footings are used in many fields such as wall foundations, offshore platforms, and machinery foundations. The bearing capacity varies with soil and also the settlement of footing. The settlement of soil also depends upon loading condition such as static loading, cyclic loading, and repeated loading. So far, the studies are limited to square, circular and rectangular footings under monotonic and cyclic loading. When structures are open to variable frequent loadings, they might fail due to loads much lesser than the collapse load. While in case of cyclic loading the design of foundation requires special consideration compared to the static case.

The design of foundation needsenough knowledge of settlement of footing. The method of foundation design needs that they must possess sufficient safety against failure and settlement need tokeep within the satisfactory limit. These requirements are dependent on the bearing capacity and compressibility of soil. It is usually believed that the settlement norm is more critical than the bearing capacity in the designs of shallow foundations. By limiting the total settlements, differential settlements and any subsequent distresses the structure are confirmed to be safe. The shape of footing may also show animportant role in settlement of footing. Two distinct shaped footing may act differently on same soil with different load condition. The study is carried out using loamy soil as strata. In this test study the density and moisture content of the soil were kept same as existing in the field. Load intensity -settlement curves under monotonic loading are plotted and studied.

II. OBJECTIVES OF THE STUDY

Experimental work is performed to study the following objectives.

a. To find the suitability of different shaped footings by physical lab tests.
b. Tocompare the settlements of fourseveral shaped footings under monotonic loading on loamy soil.
c. To study the load intensity-settlement behaviour of different shaped footing under monotonic loading on loamy soil.

III. EXPERIMENTAL PROGRAME

a. GENERAL

In this experimental work four different shaped footing specimens with same cross sectional area isto be tested under monotonic loading on loamy soil.

a. The footing specimens are circular, triangular, rectangular andsquarein shape.
b. To account the applied load a load meter and a load cell is used.
c. Loading, unloading and reloading was done hydraulically.
d. Settlements were recorded by digital indicator fixed in loading machine.
e. The density and moisture content were kept same as existing on the field.

f. Load intensity –settlement curves are plotted to study the effect of shape of footing on settlement of soil for monotonic loading.

b. TEST SPECIMENS

Four different shaped footing specimens having same surface area (150cm2P) with plate thickness equal to 8 mm have been used. For the study the details of test specimens are given in table-1.

Table 1: Size of isolated footings

S.NO	FOOTING SHAPE	SIZE IN CENTIMETERS
1	SQUARE	12.3 cm X 12.3 cm
2	TRIANGULAR	Each Side of 18.16
3	CIRCLE	Dia 13.8 cm
4	RECTANGULAR	15 cm X10 cm

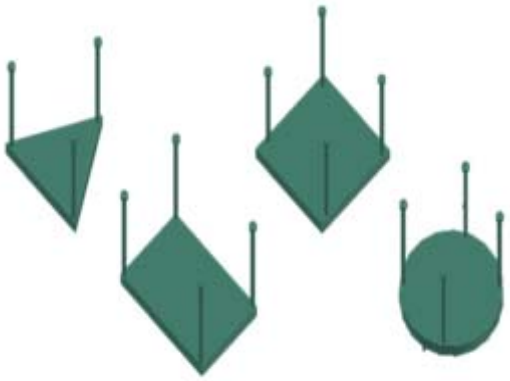


Figure 1: Shape of Footing Models

c. SOIL STRATA USED

a. Each specimen has been tested on loamy soil.
b. Density of loamy soil was kept equal to 16.68KN/m3

d. INSTRUMENTATION

The footing samples are tested under monotonic loading, load was applied axially at centre of footing. A load cell is used to apply load while settlements are measured by digital indicator, fitted in the hydraulic machine. The loading arrangement and instrumentation is as follows.

Figure 2: Experimental Setup

Figure 2: Experimental Setup.

e. LOADING ARRANGEMENT

The loading arrangement consisted of a soil filledtank, UTM, load cell, digital load and settlementindicators. A tank of size 45 cm x 45 cm x 45 cm was filled with soil. Total height of fill was kept as 30cms. It was divided in three parts and filling was done in three layers. In each stage soil was packed and compacted keeping density equal to field density equal to 16.68 KN/m3. For loading the footing an automatic Universal Testing Machine (UTM) is used. The UTM was a constant strain rate machine and was capable of constant strain rates in the range of 0.01 mm/min to

500 mm/min. The machine was connected to a computer where the load and settlement was recorded. The load applied to the footing at a constant strain rate of 1.0 mm/min, the settlement and corresponding increase in load was recorded at a settlement interval of 0.1 mm.The loading arrangement is shown in Figure above.

f. TEST PROCEDURES

The testing under monotonic loading has been carried out as follows:

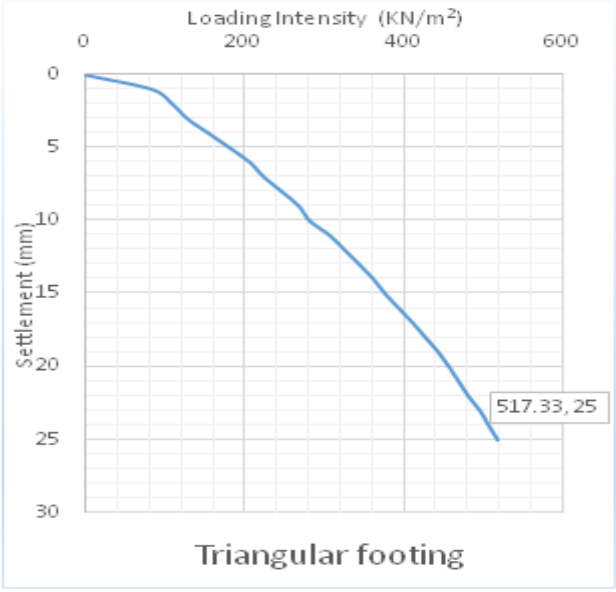
a. The soil sample taken from the field was filled up to a height of 10cm and then compacted and again a second layer of 10cm is filled and compacted. Top layer being of 10cm.The compaction was done to achieve field density.
b. The footing specimen was placed centrally and load was applied vertically through hydraulic jack.
c. The load was applied at a constant rate of 1mm/min.
d. Readings of the settlement indicator were noted at each increment of load.
e. After each testing the soil was again disturbed and then again compacted for next specimen.
f. The same procedure has been followed for all the four footing specimen.

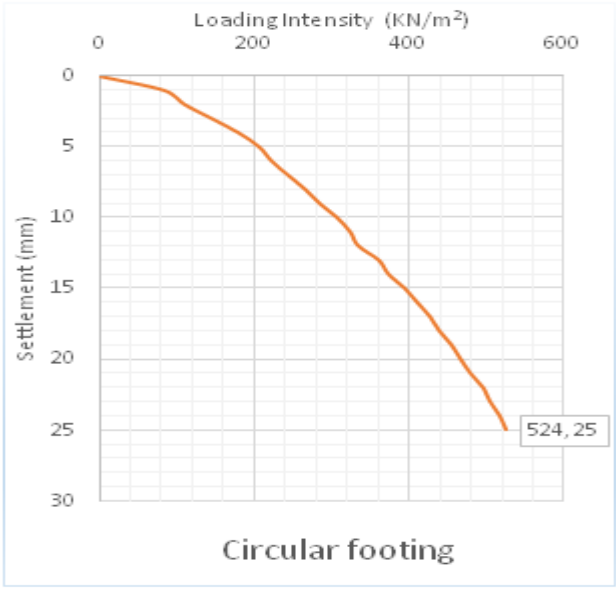
IV. TEST RESULT

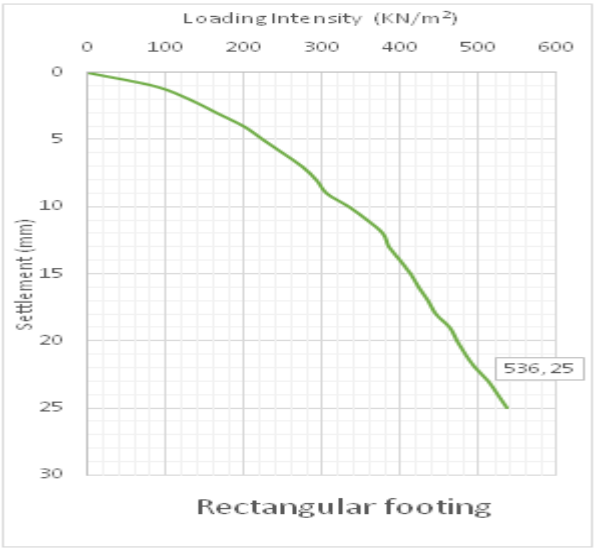
The study was been carried out on four different shaped footing as defined above. The Load Intensity vs Settlement behaviour of these footings achieved under loamy soil has been presented in the form of Load Intensity vs Settlement curve under monotonic loading.

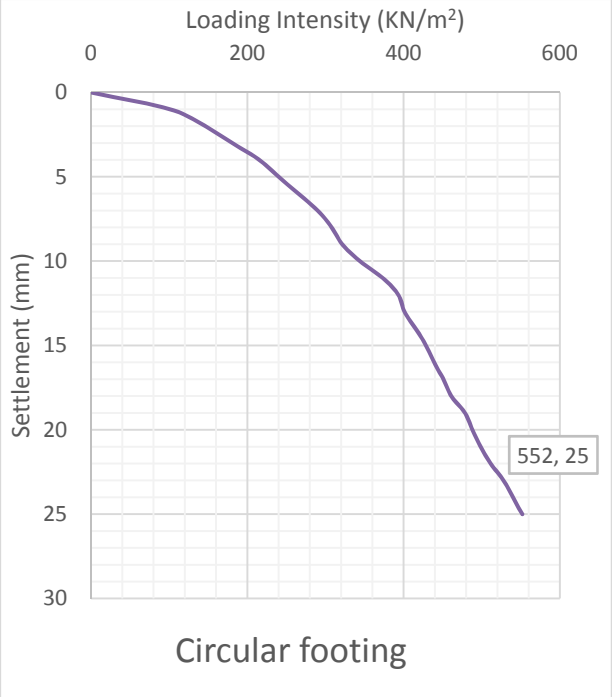
V. DISCUSSIONS

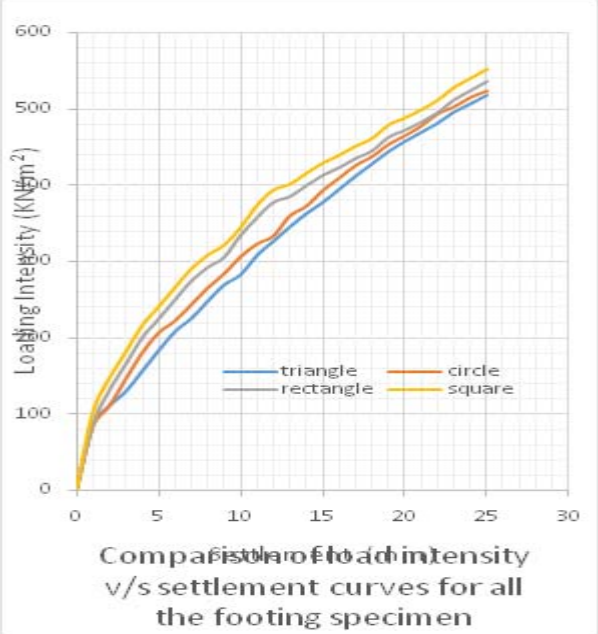
Below Monotonic loading Load intensity – settlement curve the nature of load intensity – settlement curve is similar for all types of footings considered. From graph it can be seen that initially it is linear and then it drops swiftly.The settlement for triangular footing is moredistinct than the other footings. In loamy soil the loading recorded for triangular footing is517.33 KN/m2 at 25 mm which isminimum and for square footing it is a large loading intensity of 552 KN/m2 at 25mm settlement.Which is maximum loading intensity at the same settlement.











VI.CONCLUSION

This experimental program is conducted to relate the behaviour of circular, square, rectangular and triangular shaped footing model when they are subjected to monotonic loading on loamy soils as strata to a uniform settlement of 25mm. Based on the results obtained from the settlement shown in table-2 it can be concluded that triangular footing shows minimum monotonic loading being required to achieve the settlement of 25mm while the square footing requires greater loading intensity of 6.70% than of triangular loading till the same settlement.

Table 2: Data Obtained

Footing	Settlement (mm)	Loading intensity KN/m^2P	% increase in loading
Triangular	25	517.33	-
Circular	25	524	1.28
Rectangular	25	536	3.608
Square	25	552	6.70

REFERENCES

[1] Byrne B.W., Houlsby G.T.,& Martin C.M. (2002) “Cyclic Loading of Shallow Offshore Foundations On Sand “Department of Engineering Science, The University of Oxford, United Kingdom.

[2] Dr. U.B. ChoubeyP P, DipeshGoswamiP P, Ankur Karma “Experimental Study of Various Shaped Isolated Footings under Monotonic And Incremental Cyclic Loading On Sandy Soil”. IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 7, September 2014.

[3] C. Lavanya, A. Sreerama Rao, N. Darga Kumar, (2013) “Influence of admixtures on load – settlement behaviour of copper slag – cushioned expansive soil bed.” Proceedings of Indian Geotechnical Conference December 22-24, 2013, Roorkee.

[4] Fellenius B.H., &AltaeeA. (1994) “Stress and settlement of footings in sand.” Proceedings of the American Society of Civil Engineers, ASCE, conference on vertical and horizontal deformations for foundations and embankments, geotechnical special publication, gsp, no. 40, college station, TX, June 16 - 18, 1994, vol. 2 pp.1760 - 1773.

[5] Gottardi G., Houlsbyand G. T., & Butterfield R., (1999) “Plastic Response of Circular Footings on Sand under General Planar Loading.”. Geotechnique 49, No. 4, 453-469.

[6] H.N Ramesh, Dr.L.manjesh, VijayaKumar.H.A., (2013) “ Effect of Static and Cyclic Loading on Behaviour of Fiber Reinforced Sand” IOSR Journal of Engineering (IOSRJEN) e-ISSN: 2250-3021, p-ISSN: 2278-8719 Vol. 3, Issue 9 (September. 2013), ||V3|| PP 56-63

[7] Dr. U. B. Choubey, JagdeshwerPatidar "Experimental Study of Various Shaped Isolated Footings under Monotonic and Incremental Cyclic Loading on Yellow Soil" IJEDR1404008 International Journal of Engineering Development and Research.

[8] Nagaraj, T.K. Ullagaddi, P.B., (2010) "Experimental Study on Load Settlement Behaviour of Sand Foundations." Indian Geotechnical Conference – 2010, GEOtrendz December 16–18, 2010

[9] Dr. U. B. Choubey, Ankur Karma, DipeshGoswami 09-2014. "Experimental Study of Various Shaped Isolated Footings under Monotonic and Incremental Cyclic Loading on Black Cotton Soil" International Journal of Emerging Technology and Advanced Engineering

[10] ShajaratiAmir, Sorensen Kris Wessel, Nielsen SorenKjaer& Ibsen Lars Bo, (2012) "Behaviors of Cohesionless Soils during Cyclic Loading." Published 2012 by Aalborg University Department of Civil Engineering Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark Printed in Aalborg at Aalborg University ISSN 1901-7278 DCE Technical Memorandum No. 14.

[11] Tavakoli H.R., Shafiee A., and Jafari M.K., (2008) "Effect of cyclic loading on undrained behavior of compacted sand/clay mixtures." The 14thP World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.