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STUDY OF ECCENTRICALLY LOADED RING FOOTING ON SAND

DR. A. I. DHATRAK[1], P. P. GAWANDE[2]

1. Associate Professor, GCOE, Amravat-444603.
2. P.G. Student, GCOE, Amravati-444603

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Abstract: For any load-based structure, the foundation is very important and has to be strong to support the entire structure. For the foundation to be strong, the soil around it plays a very critical role. The performance of a structure mostly depends on the performance of foundation. Since it is a very important part, so it should be designed properly. Ultimate bearing capacity problem can be solved with the help of either analytical solution or experimental study. First one can be studied using theory of plasticity or finite element method, while the second is reached through performing laboratory model test. A number of works have been carried out for the evaluation of a ultimate bearing capacity of foundation.

Keywords: Foundation, ultimate bearing capacity, eccentric loading

Corresponding Author: DR. A. I. DHATRAK

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1. INTRODUCTION

Now- a- days, more and more ring footings are use for axi-symmetric structures. Ring footings are generally used to support columns or walls of axi-symmetrical structures, which are normally circular in plan.A ring footing may be used as a foundation for water towers, transmissiontowers, television antennas, silos, chimneys, and oil storage,because it provides a more suitable and cost-effective design. The use of ring footing decrease the amount of material used and it is more economical. As these structures are tall buildings, their foundations are frequently subjected to bending moments (caused by lateral loads such as wind or earthquakes) in addition to vertical loads, leading to an eccentric loading condition. Due to eccentric loading, the ring footing is susceptible to tilt, causing a significant decrease in the bearing capacity of the footing. This drawback can be overcome by using ring footing of suitable radius ratio.

Due to the increase in use of these foundations it is required to investigate its behavior. The behavior of ring footing can be found out by small scale model studies. The behavior includes the load–displacement response and ultimate bearing capacity.

II **LITERATURE REVIEW**

Sr. No	References	Evaluation Approach
1	Zhu (1998)	Centrifuge modelling and numerical analysis of bearing capacity of ring foundations on sand.
2	Mehrjardi (2008)	Bearing capacity and settlement of ring footings.
3	Dhar*et.al* (2013)	Behavior of rigid footing under inclined and eccentric loading.
4	Atalar*et.al* (2013)	Bearing capacity of shallow foundation under eccentrically inclined load.
5	Albusoda*et.al* (2013)	Bearing capacity of eccentrically loaded square foundation on compacted reinforced dune sand over gypseous soil.
6	Algin, H.M., (2014)	Elastic settlement under eccentrically loaded rectangular surface footings on sand deposits.

III METHODOLOGY

The main objective of experiment is to study the behavior of eccentrically loaded small-scale ring footings resting on reinforced soil.

Test Material and their Properties

- Test sand

For the model tests, cohesionless,washed, dried, and sorted by particle sizewas used as the foundation material. It was composed ofrounded to subroundedparticles, as shown in fig.1.Properties of sand is shown in table1.

Figure 1: Sand

Table 1 : Properties of sand

Sr. No.	Properties	Value
1	Specific Gravity	2.69
2	Υ_{max}	16.254 kN/m^3
3	Υ_{min}	15.76 kN/m^3
4	Bulk Density (kN/m^3)	15.953 kN/m^3
5	Height of Fall (cm)	30 cm
6	Angle of Internal Friction	32^o
7	Coefficient of Uniformity C_u	2.234

8	Coefficient of Curvature C_c	1.021
9	Effective Size D_{10}	0.47
10	I.S. Classification	Medium sand, SP grade

- Model Footing

The model ring wasfabricated by using mild steel plate. Model footing consisting of 100mm outer diameter and different inner diameters was considered. The inner diameters 20mm, 40 mm, 60 mm were considered.

Experimental Setup

Experimental setup for testing consist of test tank, hydraulic jack, load cell, proving ring, dial guage and loading frame.

- Test Tank

Tank size was decided on the basis of IS code and from the result of some literature. IS 1888-1962 says that minimum size should be at least 5 times the width of test plate to develop the full failure zone without any interference of side.Test tank is made of 4mm thick having internal dimensions 600mm×600mm in plan and 400mm high.

Figure 2: Test Tank

- Reaction Frame

The reaction frame used for applying loads on the model footing, consisted of a one horizontal member and two vertical members made of IS channel section.

- Hydraulic Jack

A hydraulically jack was used to apply the load on the ring footing during test.

- Proving Ring

Proving ring was used during experiment to measure the appliedload on the foundation during the experimental work. Proving ring of 2kN was used to measure load. When load is applied, the load is transmitted from proving ring to the footing via this metallic ball.

- Dial Gauge

Two number of dial gauges were used for measurement of settlement during the experimental work.

IV PROCEDURE FOR TEST SETUP

The detailed test procedure adopted for experimental investigation is explained below-

Preparation of Sand Bed

The tank of 600 mm x 600 mm x 450 mm was filled with the dry sand of 2mm passing and retaining on 450µ sieve up to a depth of 100 mm tank by using the sand raining technique (hopper method). Prior to that, the side walls of the tank was made smooth by coating with a lubricating gel to reduce the boundary effects. Whenever the sand was deposited up to the location of the desired layer the top surface of the sand was leveled.

Figure 3: Test Arrangement

Model Plate Load Test Procedure

For the experimental work, the model plate load tests was conducted on sand as per IS 15284 (Part 1): 2003 to evaluate the bearing capacity and settlement. After preparation of sand bed, the model footing was placed at the centre of the tank. Then two dial gauges placed on the flanges of the footing. The load was applied on the footing with the help of screw jack in increments. Each load increment was approximately equal to 1/5th of the expected ultimate load. The load transferred to the footing was measured through proving ring placed between the footing and screw jack. Footing settlements was measured through two dial gauges placed on either side of the centre line of the footing. The footing settlement was reported as the average value of the readings taken at the two different points. The experimental test setup is shown in Figure 3.

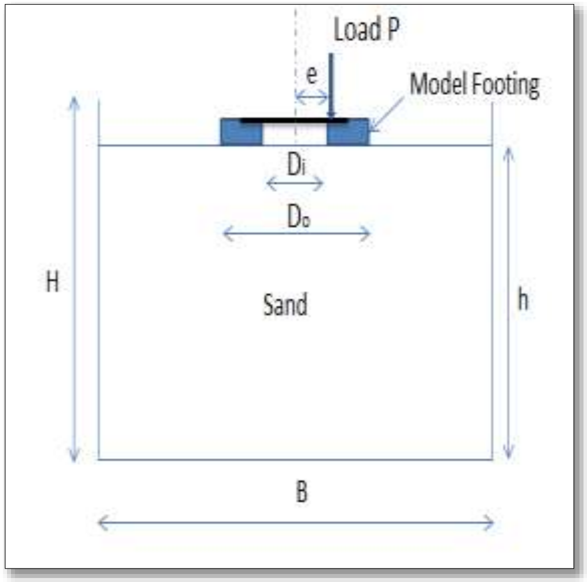

Figure 4: Equipment Setup

Where, e = Eccentricity

P = Load intensity

D_i = Inner diameter of footing

D_o = Outer diameter of footing

h= Depth of sand

B = Width of tank

H = Height of tank

Di/Do= Inner to outer diameter ratio (Ring radii ratio)

e/Do = Eccentricity to outer diameter ratio.

V RESULT AND DISCUSSION

The various parameters for study include inner to outer diameter ratio, and eccentricity of loading. The details of parameters study is given in table3.

Table 3: Details of Size of Model Footing

Sr. No.	Outer Diameter (D_o)	Inner Diameter (D_i)
1	100mm	20mm
2	100mm	40 mm
3	100mm	60mm

Ring footing of different ring radii ratios (Di/Do) 0.2, 0.4, 0.6 was used with different ratio of eccentricity e/Do = 0, 0.05, 0.1, 0.15 on sand. The corresponding load settlement graph is drawn. The load settlement graph at different e/Do ratio for Di/Do=0.2 is shown in figure 5.

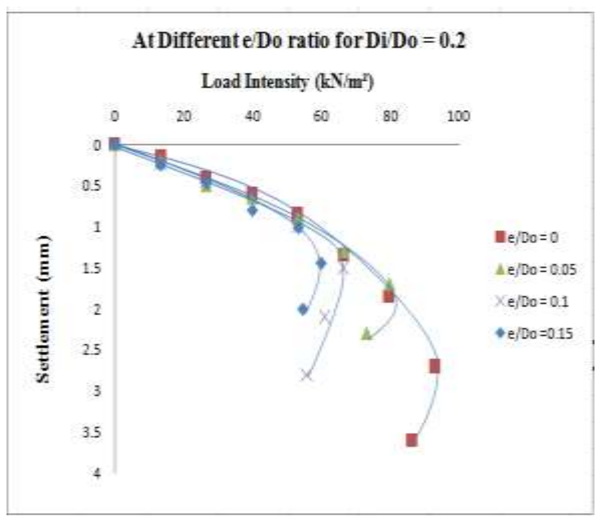

Figure 5: At Different e/Do ratio for Di/Do=0.2

The load settlement graph at different e/Do ratio for Di/Do=0.4 is shown in figure 6.

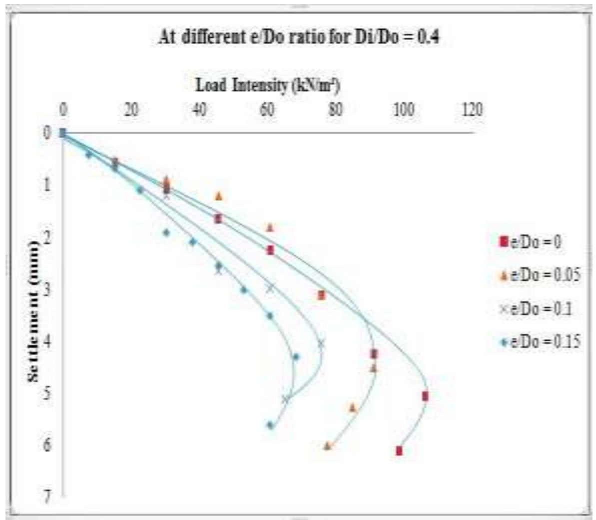

Figure 6: At Different e/Do ratio for Di/Do=0.4

The load settlement graph at different e/Do ratio for Di/Do=0.6 is shown in figure 7.

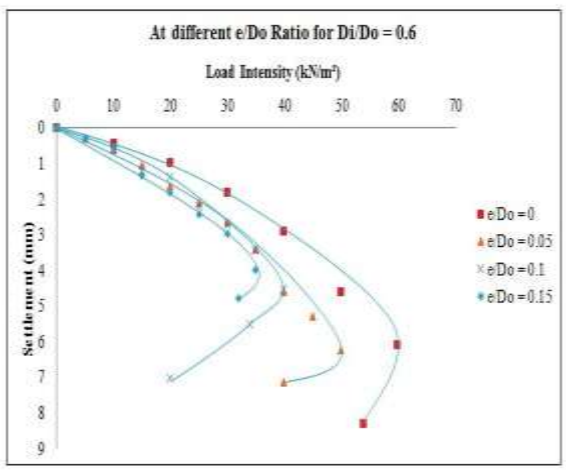

Figure 7: At Different e/Do ratio for Di/Do=0.6

CONCLUSIONS

Based on experimental investigation the following conclusions can be drawn-

- The bearing capacity of ring footing is found to be maximum at ring radii ratio (Di/Do) of 0.4.
- As eccentricity increases bearing capacity decreases.

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