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Experimental and Numerical Analysis of Conical Shell Strip Footing Reinforced in Multi-Layered Soil

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ABSTRACT

Shell Foundations are Considered as the Best Shallow Foundation to Transfer Heavy loads to Weaker Subgrade soil. Use of Shells in Foundation as Mainly in Roofs, Which Helps to Saving the Materials and Labour. In this Paper,Conical shell Strip Footing are used. Conical shell Strip Footing is Mainly used for Tower like Structures. The load Carrying Capacity ofConical shell strip Footings on Unreinforced and Reinforced Layered soil were Determined by Laboratory tests. Here a very thin layer of sand is Placed above clayey soil and placing reinforcement in different depth. The models of shell Footings were Constructed on the Basis of Suitable Testing tank. The model test Results were Verified using PLAXIS 3D. The load Carrying Capacity of Conical shell strip Footing with Reinforcement Showing Maximum Values as Compared with without Reinforcement. The results shows that load carrying capacity increases with Increase in Number of Reinforcement layers. So shell Strip Footing with Maximum Number of Reinforcement layers Shows lowest Settlement and high load Carrying Capacity.

Keyword-- Clay, Conical Shell Strip Footing, Reinforcement, Sand

I. INTRODUCTION

Construction of a structure in weak soils is mainly a difficult part. Mainly that type of soil contains low bearing capacity, high settlement, high compressibility. So some kind of reinforcement or any other materials are added to decreases the settlement and increases the bearing capacity. In normal condition the soil which exist in nature is not homogenous its layered. But most of the analysis is carried out on the basis of homogeneity. The main design factor of the analysis of footings as bearing capacity. This bearing capacity can be varied by many factors like type of reinforcing materials, number of reinforcement layer, location of first layer of reinforcement, and importantly some ratios like first layer of reinforcement to the width of footing u/B, length of reinforcement layer to the width of footing b/B.

Shell footings contains some geometric models such as conical, pyramidal, hyperbolic and spherical footings. The main use of this type of footings in roofs which may leads to reduces the material and labour costs. Due to straight line property helps for easy shuttering.

In this paper a new approach is adopting to study the behavior of strip footings are resting on different depth and different number of layers of reinforcement to valide the effect of reinforcement. Here the selected footings are conical shell strip footings which is used for tower like structures. The present study discusses about the experimental and numerical analysis of conical shell strip footings with or without reinforcement. This footings are placed at layered soil as sandy soil and clayey soil. And to compare the load carrying capacity and settlement of the systems.

I.

i.

II. EXPERIMENTAL STUDY

i. ***Materials used***

Two types of soils were used to conduct the experiment as sandy soil and clayey soil.

TABLE I
PROPERTIES OF CLAY

Properties of clay	Values
Natural moisture content	110%
Specific gravity	2.27
Liquid Limit	172%
Plastic Limit	69%
OMC	28%
Dry Density	1.29g/cc
Clay content	65%
Sand	20%
Silt	15%
Cohesion	21KN/m^2

Angle of internal friction	4^0

TABLE II
PROPERTIES OF SAND

Properties of sand	Values
Specific Gravity	2.67
Cu	6.67
Cc	2.96
Angle of internal friction	36^0
Height of fall	32cm
Corresponding relative density	50%

ii. Reinforcement

Woven geotextile was used in the present experimental study.

Fig. 1. Woven Geotextile

iii. Testing tank

Dimension analysis was done to determine the size of tank and model footing. Size of tank dimensions are 600x600 mm in plane and 550mm in depth. The inside walls of the tank are polished to reduce the friction with the soil. The tank was built as mild steel.

Loading frame of 2KN capacity is made using channel section. Load is applied by rotating a shaft in clockwise direction. A calibrated proving ring of 2KN capacity is attached to the shaft. Vertical settlement is measured using two dial gauges of least count 0.01mm.

Fig.2.Experimental setup

iv. Foundation model

The shell strip footings models were made of mild steel with constant width B = 80 mm in horizontal projection with depth 140mm and length as 160mm.

Fig. 3. Conical shell strip footing

v. Model testing

In this paper, layered soil is used so clay and sand is filled in the tank. Clay layer is placed below the sand layer. A total number of 10 tests were conducted as in experimental setup. This testing is conducted on reinforced and unreinforced soil. Here the soil is reinforced by woven geotextile that was placed at different depth. The initial depth as u is 0.4B below from the foundation tip. The reinforcement is also fixed as 4B. Footing is placed on sand (sand thickness =10.4cm and clay layer = 39.6cm for conical shell strip footing).Load is applied on the unreinforced and reinforced soil.Reinforcement is placed like:- a)1 reinforcement in the interface of clay soil and sand layer. b)1 reinforcement at the middle of sand layer in two-layer soil. c)Reinforcement placed at clay layer at 3.2 cm depth. d)Reinforcement placed at clay layer at 6.4 cm depth. e)Reinforcement placed at clay layer at 9.6 cm depth. f)1 reinforcement at the middle of sand layer and 1 reinforcement in the interface of two soils.g) 1 reinforcement at the middle of sand layer, 1 in the interface of two soils, and 1 in clayey soil (3.2cm depth). h) 1 reinforcement at the middle of sand layer, 1 in the interface of two soils, and 2 in clayey soil (3.2cm and 6.4cm depth). i) 1 reinforcement at the middle of sand layer, 1 in the interface of two soils, and 3 in clayey soil (3.2cm , 6.4cm and 9.6cm depth).

III. EXPERIMENTAL RESULTS

TABLE III
RESULT OF CONICAL SHELL STRIP FOOTING

	Load
Unreinforced	0.38
Reinforcement in middle of sand layer	0.54
In b/w sand and clay	0.51
3.2cm in clay	0.49
6.4cm in clay	0.47
9.6cm in clay	0.42

Middle of sand, in b/w sand and clay	0.6
Middle of sand, in b/w sand and clay,3.2cm in clay	0.66
Middle of sand, in b/w sand and clay,3.2,6.4cm in clay	0.78
Middle of sand, in b/w sand and clay,3.2,6.4 and 9.6 cm in clay	0.8

Effect of depth and number of layers of reinforcement

a. Effect of number of layers to the failure load

Number of layers of reinforcement increases with increases the failure load.

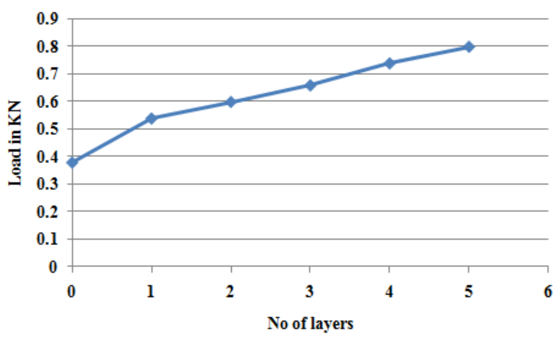

Fig. 4. Load Vs No of layers

b. Effect of depth of reinforcement placed to the failure load

The depth of placing the reinforcement increases with decreases the failure load.

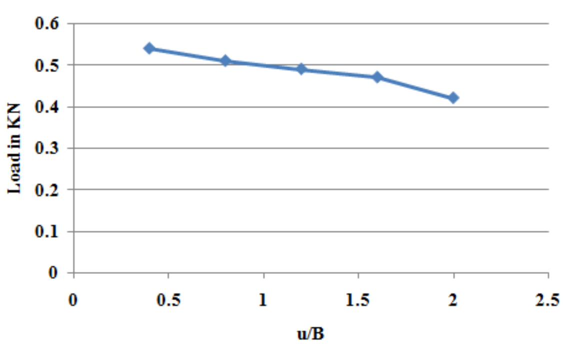

Fig. 5. Load Vs u/B

c. Effect of number of layers to the load carrying capacity ratio

Number of layers of reinforcement increases with increases the load carrying capacity. LCR load carrying capacity is the ratio of reinforced load to the unreinforced.

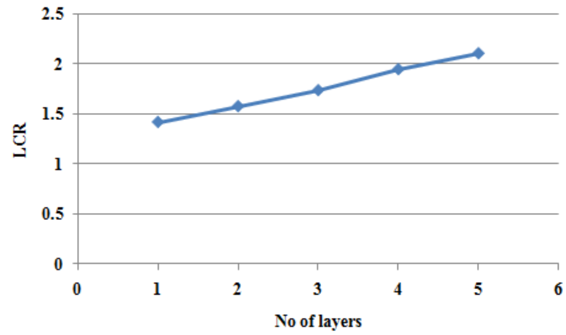

Fig. 6. LCR Vs No of layers

d. Effect of depth of reinforcement placed to the load carrying capacity

The depth of placing the reinforcement increases with decreases the load carrying capacity.

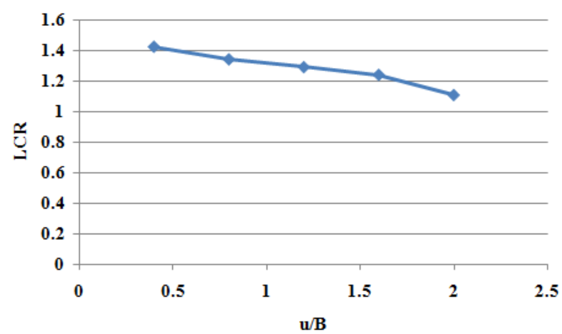

Fig. 7. LCR Vs u/B

e. Effect of depth of reinforcement placed to the settlement reduction ratio

The depth of placing the reinforcement increases with decreases the settlement reduction ratio.

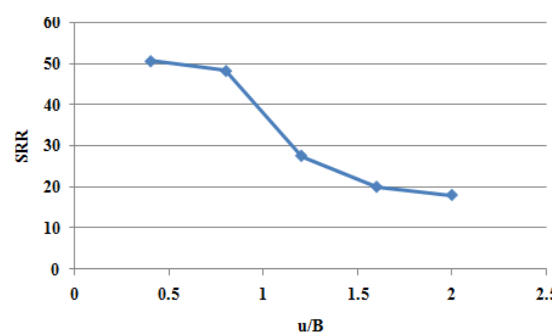

Fig. 8. SRR Vs u/B

IV. NUMERICAL RESULTS

Numerical analysis is done on the basis of PLAXIS 3D.PLAXIS 3D is a three dimensional finite element program, developed for analysis of deformation, stability and also the groundwater flow in geotechnical engineering. The following are the corresponding modeling and deformation figures.

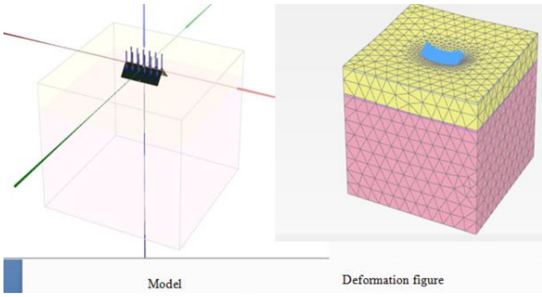

Fig. 9. Conical unreinforced

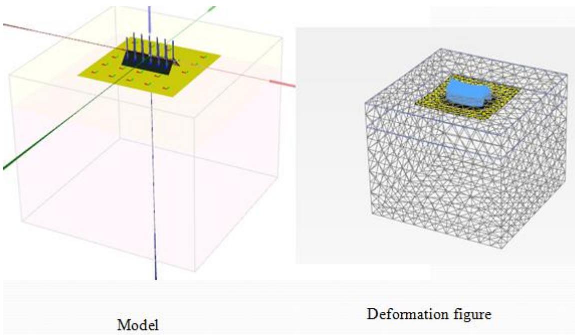

Fig. 10. Reinforced in middle of sand layer

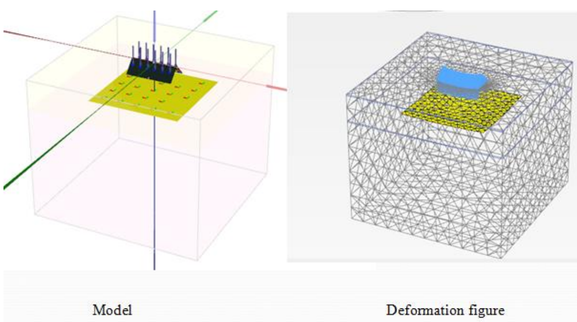

Fig. 11. Reinforced in b/w sand and clay

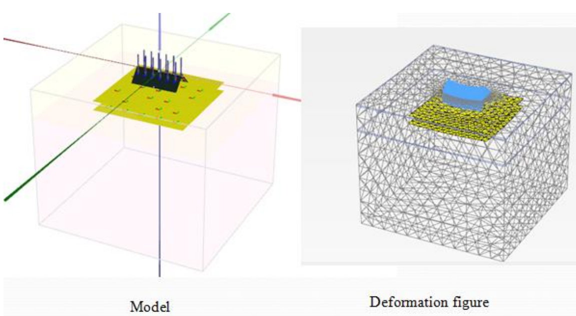

Fig.12. Middle of sand, in b/w sand and clay

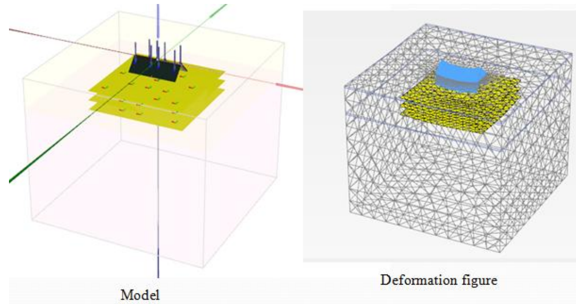

Fig. 13. Middle of sand, in b/w sand and clay, 3.2cm in clay layer

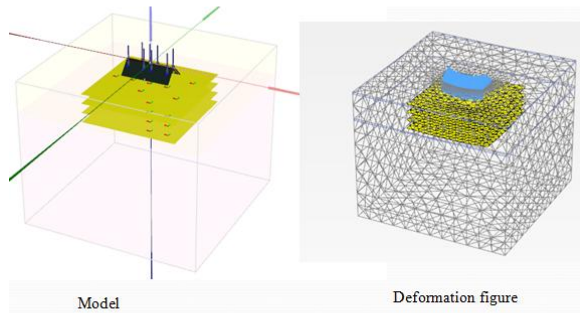

Fig.14. Middle of sand, in b/w sand and clay, 3.2 and 6.4cm in clay layer

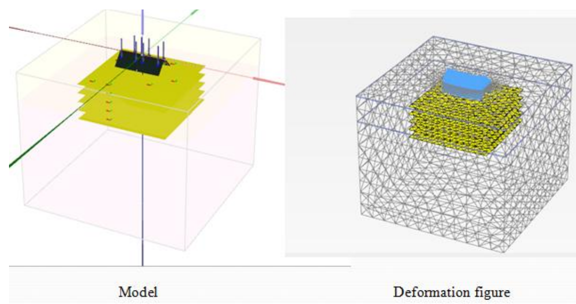

Fig. 15. Middle of sand, in b/w sand and clay, 3.2, 6.4 and 9.6cm in clay layer

TABLE IV
EXPERIMENTAL AND NUMERICAL RESULT OF CONICAL SHELL STRIP FOOTING

	Experiment	Numerical
Unreinforced	0.38	0.34
Reinforcement in middle of sand layer	0.54	0.5
In b/w sand and clay	0.51	0.47
3.2cm in clay	0.49	0.44
6.4cm in clay	0.47	0.42
9.6cm in clay	0.42	0.38
Middle of sand, in b/w sand and clay	0.6	0.53
Middle of sand, in b/w sand and clay,3.2cm in clay	0.66	0.58
Middle of sand, in b/w sand and clay,3.2,6.4cm in clay	0.78	0.72

Middle of sand, in b/w sand and clay,3.2,6.4 and 9.6 cm in clay	0.8	0.76

V. CONCLUSION

In the present paper, the geotechnical behavior of conical shell strip foundation with and without reinforcement was investigated experimentally. Then the compared values will be again compared with numerical values.

A number of tests were performed experimentally and numerically to evaluate the load carrying capacity of conical shell strip footing supported on the clayey soil overlaid with a small thickness layer of sand and addition of reinforcement at different depths from the base of the footing. The following are the most important conclusions.

The load carrying capacity of conical shell strip footing with reinforcement shows highest value. Reduction in settlement for reinforced footings is higher than unreinforced footings. The number of layers of reinforcement increases with increases the load carrying capacity. First layer of reinforcement increases with decreases the load carrying capacity. In case of load carrying capacity ratio, number of layers increases with increases and first layer of reinforcement increases with decreases. In case of settlement reduction ratio, first layer of reinforcement increases with decreases the value. In numerical analysis as compared with experimental, experimental shows higher load carrying capacity than numerical analysis.

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