# DEFORMATION AND BEARING CAPACITY OF FOUNDATION WITH VARIOUS SHAPES UNDER STATIC LOADING

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## 1. INTRODUCTION

One of the most fundamental and important problems in the field of geotechnical engineering is prediction of bearing capacity and settlement of foundations of buildings and other structures. It is worth noting that extensive experimental and theoretical studies on the bearing capacity of foundation have been carried out on strip footings with infinite length which ultimately are about rectangular shape practically, which means that their bearing capacities are commonly determined easily by multiplying the bearing capacity of strip footing with an appropriate "SHAPE FACTOR". The fact is that those used shape factors are about empirical or proposed values (Terzaghi, 1950) and they do not have enough theoretical and experimental background therefore, this plan of research stems its importance from the fact that the function for shape factor should be justified obviously because the deformation and failure of the ground beneath the footings are basically three-dimensional problem if the footings are rectangular in shape, the mechanism of failure could also be very different from that of two-dimensional. This problem is important especially if the behavior of foundation is evaluated by means of scaled model tests, not only the scale of the foundation structure, but also the size of particles of the ground and the magnitude of gravity force acting in the ground could affect this factor. In order to clarify these aspects, Tokyo Metropolitan University conducted small-scaled model tests of strip, rectangular and square foundations and three-dimensional failure patterns have been observed.

## 2. MODELLING AND EXPERIMENT TESTS

Different Ratio of their length to width (Strip, Rectangular and Square) small-scaled models of Footings (Fig.1) have been tested by using some developed Mechanical apparatus (Fig.2). The foundation model ground has formed by Colored and layered sand deposit within a soil container. In each test, the whole tested soil had been submerged completely by water after finishing from loading stage (loading speed was approximately 0.5mm/min) and several of vertical cross sections (profiles) had been performed in the tested soil according to (N-S) and (E-W) directions at different distances from the center to be closely monitored and the three-dimensional failure mechanism be observed and recorded (Fig.3).

## 3. TEST RESULTS AND DISCUSSION

According to the three-dimensional analysis of the deformations and the mechanism of failure of foundation model ground taking into consideration the development of the shear banding, The main observations from the performed tests were as following; it has been noticed that the failure zone was very Small and the deformed mass of soil were limited to very narrow area only just below the foundation such as punching (Square Footing case). Moreover, many slip surfaces appeared within the passive wedge of the tested soil and the soil wedges below the foundations take different shape from the assumed one according to Terzaghi's bearing capacity theory (Fig.4). Apart from that, it has been noticed that the slip surface extends horizontally to a length more than 5 times of the width of the footing (Strip Footing) case whether, the slip surfaces in each side extend horizontally to a distance shorter than 2 times of the width of the square footing which means that the bearing capacity in the case of (Strip Footing case) was higher than those for rectangular and square footings (Fig.5). It is useful to mention that at the end of each test, the relation between (Stress-Settlement) has been recorded and graphed and the peak point of loading has been determined for each graph as a next step after modifying the recorded (Stress-Settlement) graphs (Fig.6), therefore, some new shape factors have been calculated using the geometric properties of the tested foundations as shown in (Table.1), which differ extremely from those proposed by Terzaghi, this is because of that three-dimensional failure mechanism differs highly from the two-dimensional model of failure mechanism .

## 4. CONCLUSIONS

The bearing capacity of the tested foundation was highly influenced by the vertical depth below the foundation and the horizontal extent of the failure zone; therefore, the capacity becomes more if the extent of the failure zone is more because the main contributing source of the bearing is the weight of the mass of soil in the failure zone. As a result, it is highly expected that there is a significant effect of the shape factors on the mass of soil in the failure zone (the mechanism of failure) and more researches in this concern are required.

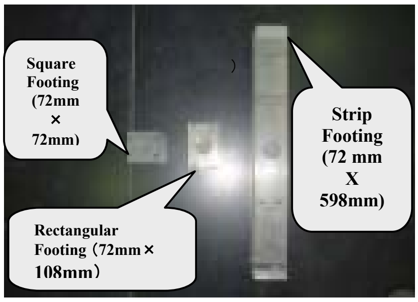
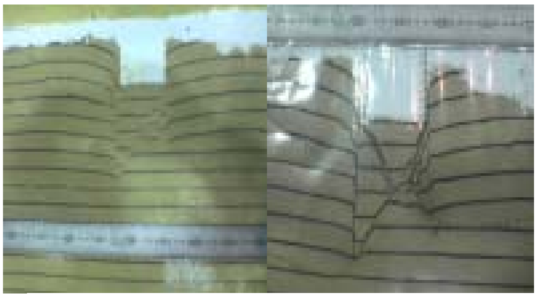



**Fig.1: Small-scaled footings' dimensions.**

**Fig.2: The soil container and the other Mechanical used for model testing of footings.**

**Fig.3: Several cross sections (profiles) in the tested soils to (N-S) & (E-W) directions At different Distances from the center (Square Footing Case).**



**g.4: Many slip surfaces appeared under the Footings take a different shape from that assumed one theoretically.**

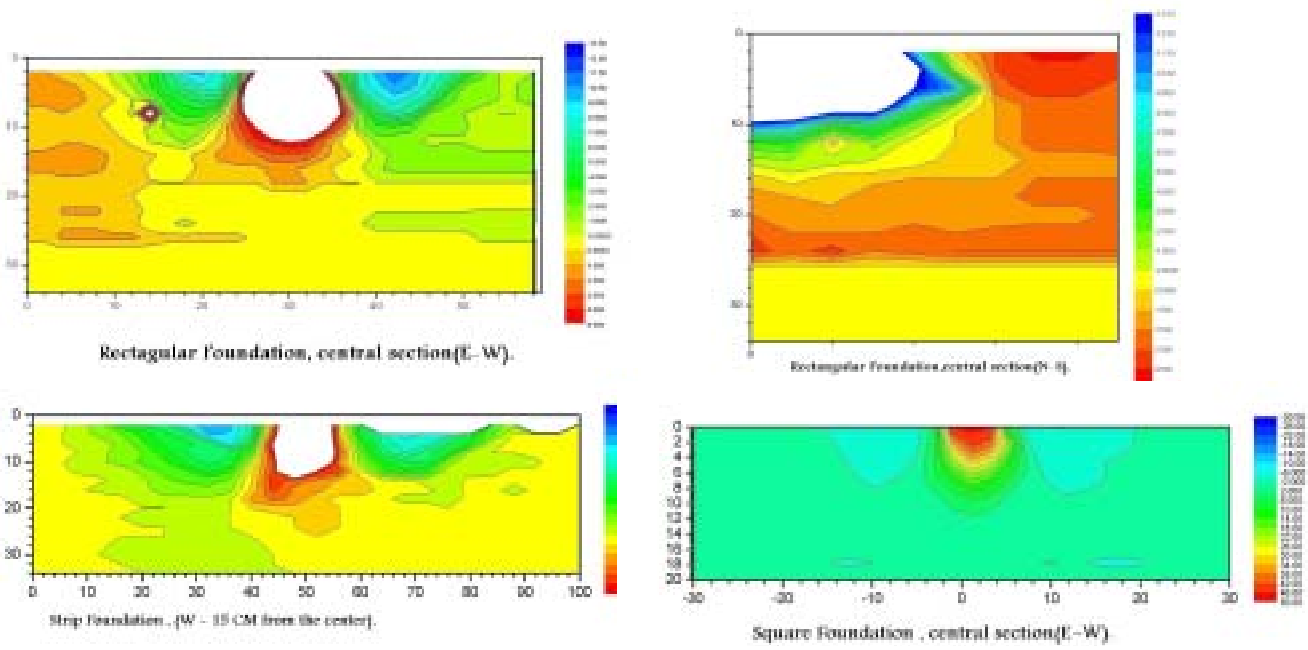



**Fig.5: Three-dimensional analysis of the vertical deformations and the mechanism of failure of tested foundation models.**

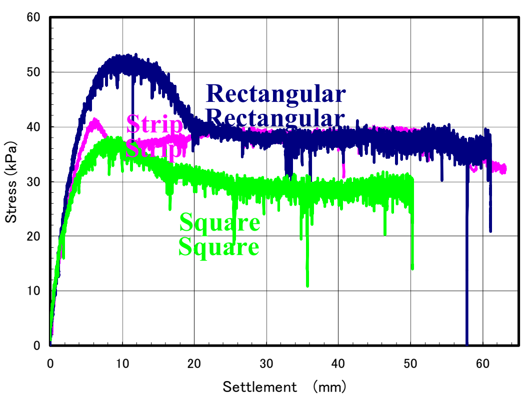



**Fig.6: modified (Stress-Settlement) graphs for (Strip, Rectangular and Square Foundations).**

| | B/L | Area (cm$^2$) | Peak load (N) | Peak stress (kPa) | Shape factor | |
|---|---|---|---|---|---|---|
| | | | | | test result | by Terzaghi |
| STRIP FOUNDATION | ∞ | 430.6 | 1750 | 40.6 | 1.0 | 1.0 |
| RECTANGULAR FOUNDATION | 1.5 | 77.8 | 400 | 51.4 | 1.27 | 0.87 |
| SQUARE FOUNDATION | 1.0 | 51.8 | 190 | 36.7 | 0.90 | 0.80 |

**Table.1: Summary of tested foundation geometry and calculated shape factors from the test results.**
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