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Behaviour of Circular Skirted Footing Resting on Sea Sand

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Abstract:- *Skirted foundation is one in which vertical or inclined walls surrounds one or more sides of the soil mass beneath the footing. Skirted foundation is an alternative approach required for improving the bearing capacity and reducing the settlement of footing resting on soil. Structural skirts are being used underneath shallow foundations of offshore structures for many decades due to their advantages. These foundations are economical, as they lead to cost saving through reduction in materials and in time required for installation. In this study, a series of vertical load test was conducted for different skirt diameters. Tests were concluded on circular footing placed centrally on sea sand filled tank with and without skirts.*

Keywords– *Structural skirts, circular footing, offshore structures, bearing capacity, settlement.*

I. INTRODUCTION

There are many offshore structures, which have been used in India. As far as an offshore structure is concerned water scouring and the soils bearing capacity are the main problem. Geotechnical engineers have always been used in search of finding problem which is less expensive and less restricted by site conditions. In this case, the structural skirts hold good as an alternative method for the arised problem and also for improving the bearing capacity and reducing the settlement of footing resting on soil. A variety of methods of soil stabilization are known and well developed, but they can be expensive and can be restricted by the site conditions. The skirted foundation consists of a slab which may have any shape, but mostly the shape of the skirt is kept same as that of footing. Some portion of the structure may be on weak soil., in such cases, skirted foundations are used to gain stability for the structure and thus soils gets prevented from the lateral movement. The vertical skirts improve the capacity of the foundation by trapping the soil beneath the raft and between the skirts so that the applied soil is transferred to the soil at the skirt tips. The horizontal load carrying capacity is improved by the skirt and resists lateral sliding.

II. LITERATURE REVIEW

- Mahiyar and Patel (2000) has studied the finite element analysis of an angle shaped footing under eccentric loading. They concluded that one side vertical projection of footing confines the soil and prevents its lateral movement.

- Al – Aghbari (2007) studied a series of experimental tests to study the settlements of shallow circular foundations on sand with and without structural skirts. The test results indicate that the use of structural skirts reduces the settlement of footing.

- Salih and Joseph (2010) studied the results for footings with and without skirt, on uniform soil condition showing that the bearing capacity can be improved by a factor of 1.08 to 1.64 when skirt was provided with Df/B ratio of 0.25 to 1.0.

- Nazir and Azzam (2010) studied the behavior of circular footing resting on partially replaced sand pile with or without skirts and have found that the improvement of load bearing capacity is remarkably increased and decreased in the vertical settlement using both partially replaced sand piles with or without confinement by skirts.

The literature shows that confinement of soil below footing, provision of skirt for strip footing, square footing and rectangular footing improves the bearing capacity and reduces the settlement of foundation under concentric as well as eccentric loading.

III. METHODOLOGY

This chapter deals with the details of materials used, sample preparation and testing procedure that have been adopted.

1. Materials used

The materials used for the study are sea sand, and unplasticized polyvinyl chloride (PVC) pipes.

1.1 Soil

Table 1. Properties of soil

Properties of sand	Value
Specific Gravity	2.65
Coefficient of curvature	1.481
Coefficient of uniformity	1
Soil classification	Poorly Graded
c and ϕ	0, 28°

Experiments were carried out on sea sand taken from Kazhakuttom beach, in Trivandrum district. The figure 1 shows the particle size distribution of sea sand used for the study. Table 1 shows the properties of soil that was found out by carrying out different laboratory experiments

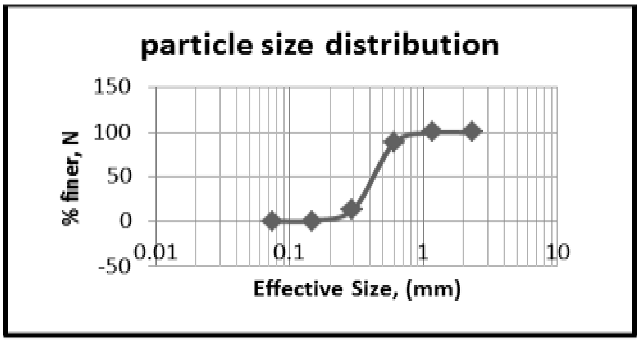

Fig 1. Particle Size Distribution of Sand

From the particle size distribution graph obtained by dry sieve analysis test, the effective size of the particle (D_{10}) is 0.27mm. The particle size distribution had a steep slope graph and as Cu value is less than, the soil is classified as poorly graded soil.

1.2 Skirt

The skirt used in the experiment was polyvinyl chloride (PVC). Skirts were used to laterally confine the sand. The rigid PVC pipes as per IS 4985:2000 specifications of different diameters 4cm, 6cm, and 10cm with length 30cm and thickness 1.5mm. The interior and exterior of the skirt were smooth.

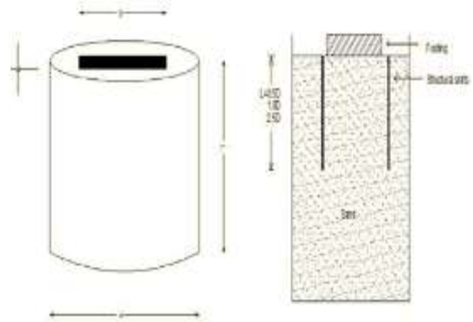

Fig 2. Geometrical Parameters of Skirt Foundation Model

2. Testing arrangement and methodology

Laboratory tests on skirted foundations were carried out in a steel square tank with internal dimensions 500mm x 500mm with thickness 5mm. The depth of tank was 600mm. Two dial gauges were used to measure the horizontal displacement and one dial gauge used to measure rotation. All the dial gauges were placed opposite to the loading arrangement.

In the tank, sand was filled in layers. Each layer of filling is 100cm thick. Loose state of soil is achieved by filling the sand with the height of fall of about 25mm. The skirt was placed at the centre. The load was applied incrementally on the foundation model. Each load increment was kept constant until the foundation displacement reaches the value of 0.01mm for 5min for 3 consecutive readings. The next load increment was applied. The failure load for the smooth skirted footing is obtained from the load settlement curve that was plotted from the different laboratory tests.

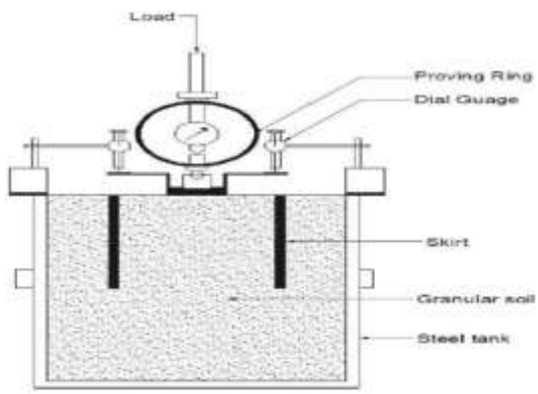

Fig 3. Schematic diagram for the set up of vertical load test

IV. RESULTS AND DISCUSSION

The graph is plotted between load and settlement with different diameters for corresponding length.

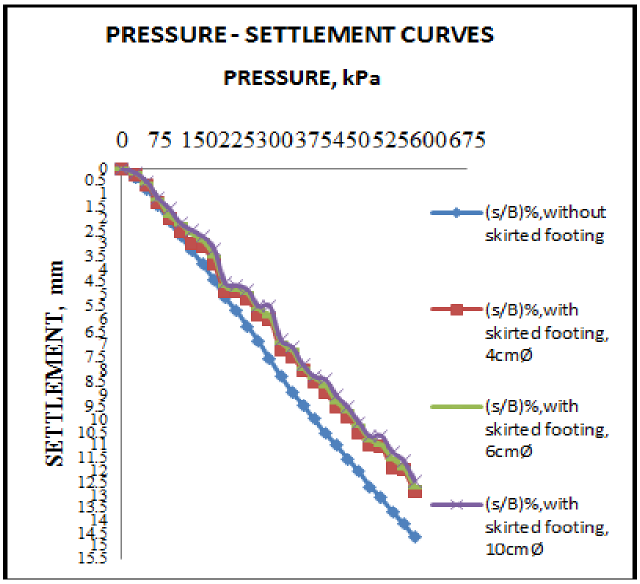

Fig 4. Load Settlement graph with different skirt diameters

From the above, it can be seen that as the diameter increases, the settlement reduces and the bearing capacity increases. That is, the increase in diameter distributes the uniformly to a greater extent. Due to this, the bearing capacity increases.

V. CONCLUSIONS

The purpose of this was to assess the variation in vertical load capacity of the skirted foundations at different skirt diameter. A series of experimental tests were carried out on a model test tank to evaluate the performance of structural skirts in terms of bearing capacity. From the test results, the following conclusions can be drawn:

- A structural skirt increases bearing capacity, reduces settlement in sand and modifies the load – settlement behavior of the footing.
- The displacement of the skirted footings depends on the load applied, and the diameter of the skirt.
- The ultimate bearing capacity of the skirted foundation increases with increase in skirt diameter.

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