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Assessing the Effect of Circular Skirted Footing on Bearing Capacity of Sea Sand

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***Abstract*: Skirted foundation is one in which vertical or inclined walls surround 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 tests was conducted for skirts with diameter and length. Tests were conducted on circular footing placed centrally on sea sand filled tank with and without skirts.**

***Keywords*: Structural Skirts, Circular Footing, Offshore Structures, Bearing Capacity, Settlement.**

1. Introduction

There are many offshore structures, which have been used in India. As far as an offshore structure is concerned water scouring and the soil bearing capacity are the main problem. Geotechnical engineers have always been in searching of finding a solution for the problem which is less expensive and less restricted by site conditions. In this case, structural skirts hold good as an alternative method for the arised problem and also for improving bearing capacity and reducing the settlement of footing resting on soil.

Skirted foundations are widely used in offshore, as a single foundation system for gravity based structure or as discrete foundation units at the corners of jacket structures and tension leg platforms. Skirts provided with foundations, form an enclosure in which soil is strictly confined and acts as soil plug to transfer super structure loads to soil. Skirt foundations have a wide variety of functions such as control of settlement during service life, less impact to environment during operation at installation site. Skirted foundations are used to satisfy bearing capacity requirement and to minimize the embedment depth and dimensions of the foundation.

This paper attempts to understand and evaluate the effect of the behaviour of skirts on sea sand. Skirts with different length and were used in this study and its effect on settlement and bearing capacity was evaluated.

2. Materials and experiments

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

A. Soil

In this study, Sea sand collected from Kazhakuttom beach, Trivandrum district was used. The properties of sand are given in table 1 and the grain size distribution curve is presented in Fig. 1.

Table 1
Properties of Sea Sand

Property	Value
Specific gravity	2.56
Coefficient of curvature, Cc	1.481
Coefficient of uniformity, Cu	1
Soil Classification	Poorly Graded Sand, SP
c, ϕ	c=0, ϕ=28°

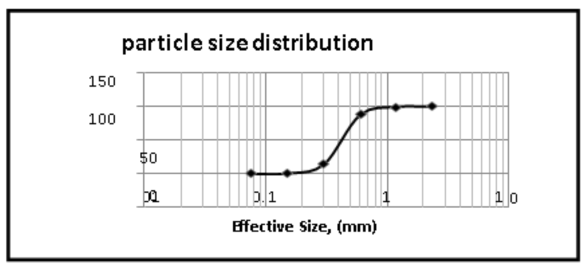

Fig. 1. Particle size distribution of sea sand

From the particle size distribution graph obtained by dry sieve analysis test, the effective size of the particle (D10) 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.

B. 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 varying length 5cm, 10cm, 15cm, 20cm, 25cm and 30cm with thickness 1.5mm. The interior and exterior of the skirt were smooth.

C. 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 the 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 with funnel 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 2mm. 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 different laboratory tests. Fig. 2 represents the schematic diagram for the setup of vertical load test.

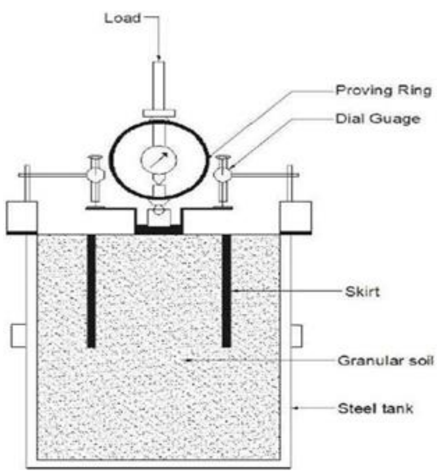

Fig. 2. Schematic diagram for the setup of vertical load test

3. Results and discussion

To study the behaviour of skirt foundation, vertical load tests were conducted on loose sand. The graph is plotted between load and settlement with varying length. Fig. 3 shows the load defection curves for skirts with different length.

From the figure below, it can be seen that, as the length increases, the bearing capacity also increases. That is, the increase in the length transfers the load to a safer area and is distributed to different layers. Now for the length, as the length was increased, the footing was deeply seated and the depth of foundation increased. Due to this, the bearing capacity of the skirted footing was increased with increase in length.

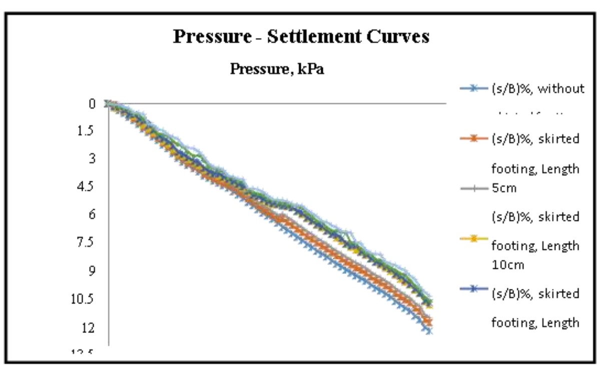

Fig. 3. Load settlement graph of skirt with varying length

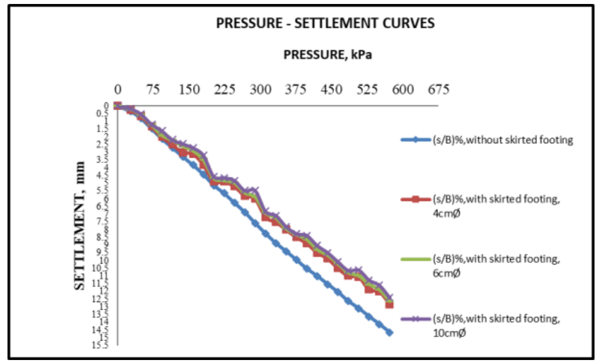

Fig. 4. Load settlement graph of skirt with different diameter

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.

4. Conclusion

The purpose of this study was to assess the variation in vertical load capacity of the skirted foundations at different length. 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:

1. The structural skirt increases the bearing capacity, reduces settlement in sand and modifies the load – settlement behaviour of the footing.
2. The displacement of the skirted footings depends upon the load applied and the length of the skirts provided.
3. As the length of the skirts increases, the bearing capacity also increases.
4. The ultimate bearing capacity of the skirted foundation increases with increase in skirt diameter.

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