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Behaviour of Raft Foundation with Vertical Skirt Using Plaxis 2d

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Abstract:- Skirted foundation is one in which vertical or inclined wall surrounds one or more sides of the soil mass beneath the footing. Skirted foundation is an alternative approach required for improving the bearing capacity of raft foundation by using "structural skirts" fixed to the edges of the raft foundation. Construction of vertical skirts at the base of the raft foundation confines the underlying soil and generates a soil resistance on skirt side that helps the footing to resist sliding. The present work focused on the analysis of two sided and one sided skirted raft with and without vertical skirt using a finite element software PLAXIS 2D. The studied parameters include the raft sizes,skirt depth and then compared with those of raft without vertical skirt. The results indicated that using structual skirts for raft foundation has a significant effect in improving the bearing capacity. This improvement increases with the skirt depth with varying raft sizes for two sided raft foundation vertical skirt with decrease in settlement. Whereas in one sided raft foundation with vertical skirt there is increase in both bearing capacity and settlement.Thus finite element analysis presented in this study helped in better understanding and identifying the failure pattern of skirted raft with and without skirt for raft foundation with vertical skirt.

Keywords:- Raft Foundation, Structural Skirt, PLAXIS 2D, Bearing Capacity, Settlement.

I. INTRODUCTION

The shallow footing fails due to the shear failure of soil beneath it. When the load gets transferred on the soil immediately below the strata, the footing moves sideways by shear failure. By confining the soil under the footing, such failure can be effectively controlled and thus the failure mechanism. Thus by providing skirt wall, the load from the superstructure is transferred to the strata below the bottom of the skirt wall. In this manner, it may be forecast that a raft laid at ground level with skirt walls at edges to confine the soil beneath, it will have a load carrying capacity approximately equal to or greater than that of a raft founded at a depth equal to the depth of confinement provided. It may also be forecast that this type of confinement will control the tilt and hence increase the load bearing capacity of footing resting on non-uniform soil condition in which some portion of the soil is weak compared to other. Therefore, it is an alternative approach for improving the bearing capacity of raft foundation. This approach is based on the use of "structural skirts" fixed to the edges of the foundation. This method of improvement does not need excavation of the soil, and hence it cannot be restricted by the presence of a high water table. Structural skirts fixed to the edges of shallow foundations have been used for a considerable time, principally to increase the "effective depth" of the foundations in marine and other situations where water scour may be a problem. However, the use of such structural skirts in conjunction with conventional raft foundations for improving bearing capacity and reduction in settlement has not been widely employed. On this basis numerical study have been carried out to study the behaviour of raft foundation with two sides and one side vertical skirt and compared with the behaviour of raft foundation without any skirt.

II. LITERATURE REVIEW

Mahiyar and Patel (2000) 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. The footing subjected to uniaxial eccentric loads can be designed for no or negligible tilt by giving the footing an angle shape. The ultimate bearing capacity will be higher when Φ is higher.
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 footings and modifies the load–displacement behaviour.

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. While comparing the performance of footings with and without skirt, on uniform

soil condition with the same Df/B ratio, the improvement factor was found to be decreased from 8% to zero with increase in Df/B ratio. From the cost analysis, it is evident that skirted raft is more economical than raft.
Azzam and Farouk (2010) studied laboratory model tests and numerical study on the behaviour of a strip footing with structural skirts adjacent to a sand slope with different skirts depth, location of the skirted footing relative to the slope crest and the slope inclination. They conclude that stabilizing the earth slope using structural skirts with adequate depth in the conjunction of strip footing adjacent to slope crest has a significant effect in improving the soil bearing capacity.

Nazir and Azzam (2010) studied the behaviour of circular footing resting on partially replaced sand pile with/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/without confinement by skirts.

Raft foundations are widely used in supporting structures for many reasons such as weak soil conditions or heavy columns loads. The raft foundation may require more area to transfer heavy load or need to place at greater depth to keep stress level within permissible bearing capacity.

The literature shows that confinement of soil below footing, provision of skirt for strip footing, square footing and circular footing improves the bearing capacity and reduces the settlement of foundation under concentric as well as eccentric loading. In order to give an optimum solution for raft foundation with skirt and to provide economical foundation, there is need to study of skirted raft foundation with different parametrical aspect. Keeping in view this aspect, this work lead to study parametric effect on behaviour of skirted raft foundation with vertical skirt using PLAXIS 2D software.

III. NUMERICAL MODELING

The geometry of the finite element soil model adopted for the analysis is 15B X 20B with varying raft sizes B= 10m, 15m, 20m, 30m with skirt depth (Ds) from 0.25B to 3B .Figure 1 shows the geometry model of raft foundation without skirt and Figure 2 shows raft foundation with two side vertical skirt for one typical case of 10 m raft size and skirt depth.

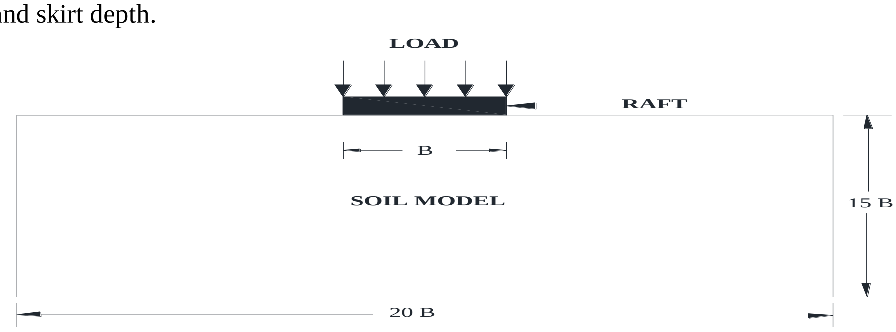

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Figure 1: Geometry Model of Raft Foundation without Skirt

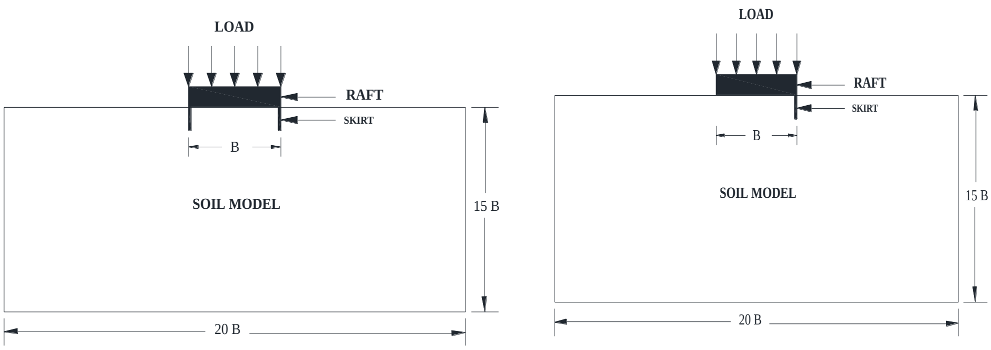


Figure 2: Geometry Model of Raft Foundation with two sides vertical Skirt and one side vertical skirt

IV. SOIL PROPERTIES

The properties of soil used in the analysis are as follows in Table 1.

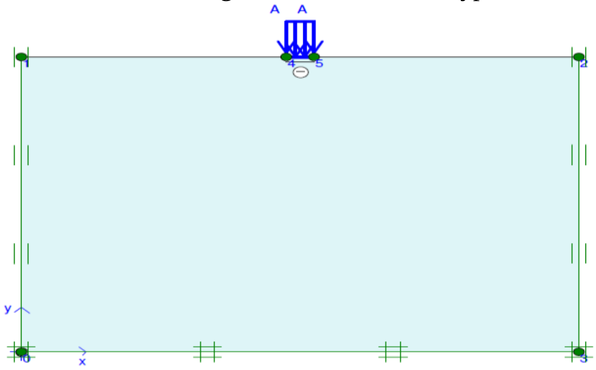
Table 1: Material Properties for study

Parameter	Value
Type of material	Sand
Material Model	Hardening Soil Model

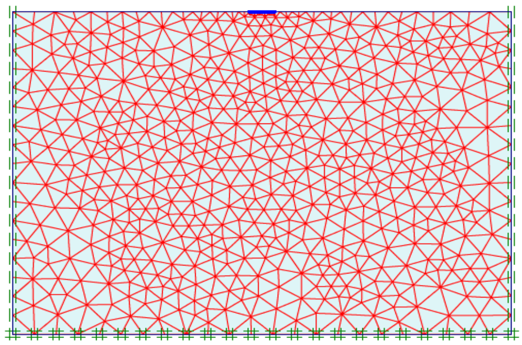
E50(KN/m^2)	40000
Dry density(KN/m^3)	17
Power (m)	0.5
Cohesion	0.1
Friction angle(ϕ)	32°
Angle of dilatancy	2°
Interface reduction factor R_{inter}	0.67
Axial stiffness for steel skirts EA,(KN/m)	31500

V. REULTS AND DISSCUSSION

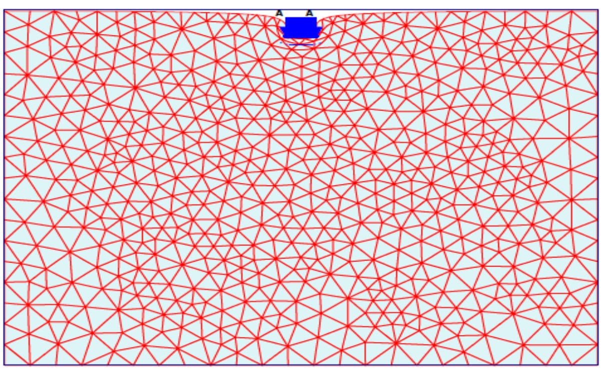
Using above modelling and soil properties analysis was carried out in PLAXIS 2D for raft foundation without skirt, with two side and one side vertical skirt. The modelling and results obtained in PLAXIS 2D is being shown in Figures 3 for raft foundation without any skirt and for raft foundation with two sided and one side vertical skirt in Figures 4 and 5 for one typical case of 10 m raft size and skirt depth.



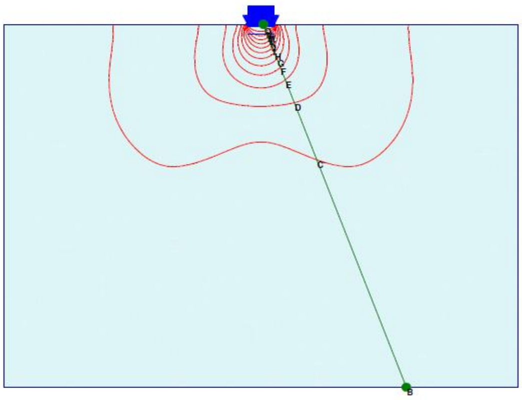
(a): Geometry Model in PLAXIS



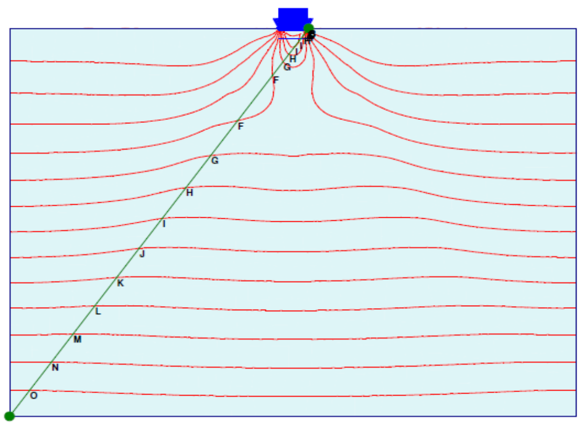
(b): Meshing



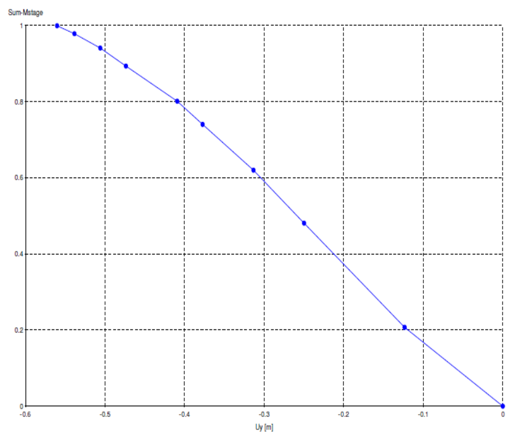
(c): Deformed Mesh



(d): Total Displacement Contours

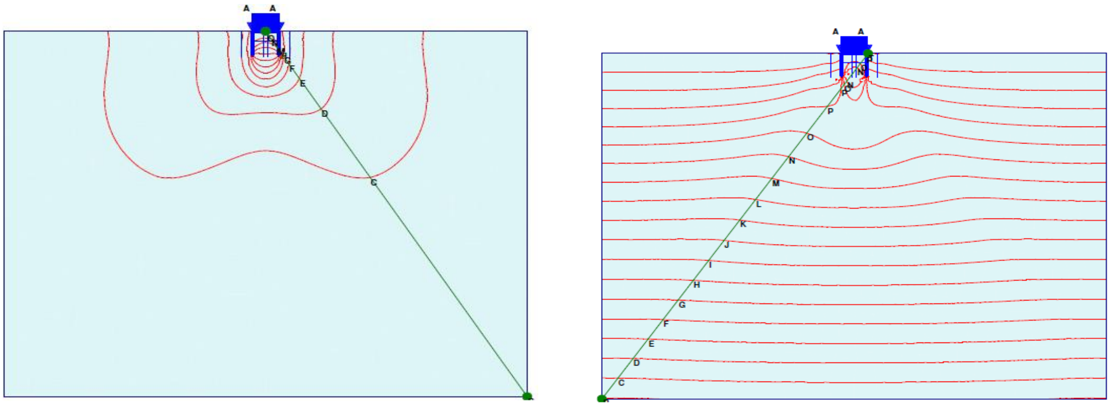


(e): Stresses Contours



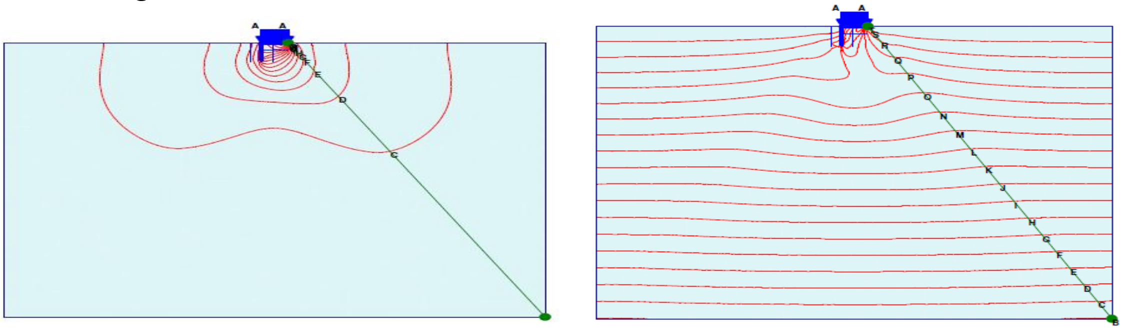
(f): Load-Displacement Curve

Figure 3: Results in PLAXIS 2D for Raft Foundation without Skirt



(a): Total Displacement Contours **(b): Stresses Contours**

Figure 4: Results in PLAXIS 2D for Raft Foundation with Two Side Vertical Skirt



(a): Total Displacement Contours **(b): Stresses Contours**

Figure 5: Results in PLAXIS 2D for Raft Foundation with One Side Vertical Skirt

The results were plotted for bearing capacity obtained from load-displacement curve. Figure 6 shows load displacement curve for 10m raft foundation with two side skirt with different skirt depth. The maximum applied pressure is 1000 kN/m^2 load for which settlement is measured and at settlement 100 mm which is permissible settlement for raft foundation, the corresponding safe bearing capacity noted. Results shown in Table 2 and Table 3 are for 10 m raft with increasing skirt depth for two sided and one sided vertical skirted raft respectively. The increase in bearing capacity and reduction in settlement for varying raft size and skirt depth can be seen in Figures 7 for two sides skirt raft foundation. However, for one side skirt raft foundation, bearing capacity increases with skirt depth but settlement increases for skirt depth of 2B and remain constant as shown in Figures 8.

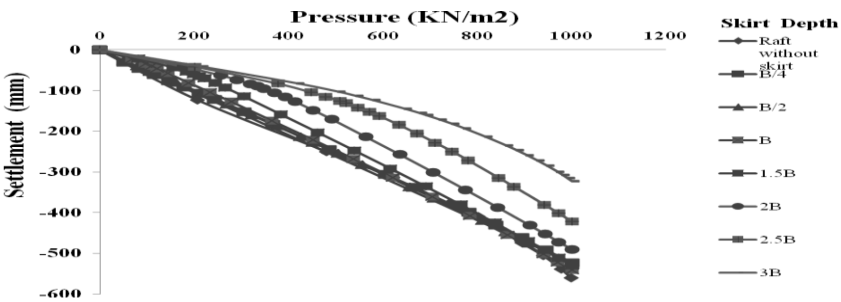


Figure 6: Load –Settlement Curve for 10m Raft Foundation with Vertical Skirt on both side for different Skirt Depth

Table 2: Results for one Typical Case of 10 m Raft and Skirt Depth for Two Side Vertical Skirt Raft Foundation

Ds/B	0	0.25	0.5	1	1.5	2	2.5	3
Settlement for 1000 kN/m^2 (mm)	561	523	527	541	529	490	422	323
Bearing Capacity for 100 mm Settlement (kN/m^2)	166	202	205	232	285	361	434	493

Table 3: Results for one Typical Case of 10 m Raft for 10 m Skirt for one Sided vertical Skirt Raft Foundation

Ds/B	0	0.25	0.5	1	1.5	2	2.5	3
Settlement for 1000 kN/m^2(mm)	560	602	634	703	729	736	737	706
Bearing Capacity for 100 mm Settlement (kN/m^2)	168	196	200	208	230	248	272	282

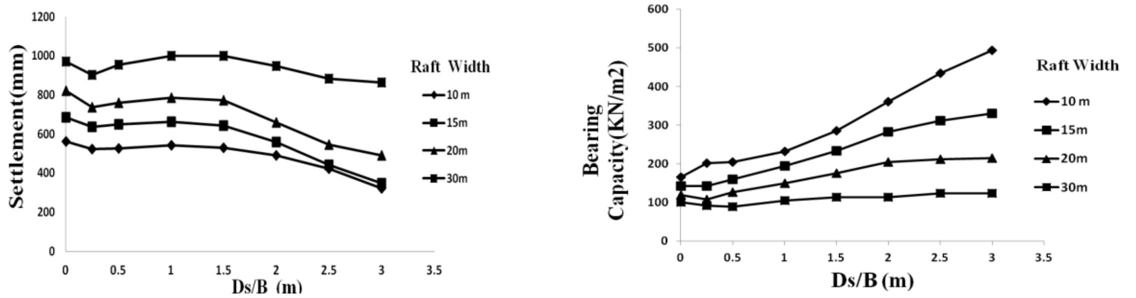


Figure 7: Settlement and Bearing Capacity vs Ds/B for two sides vertical skirt raft foundation for different raft sizes

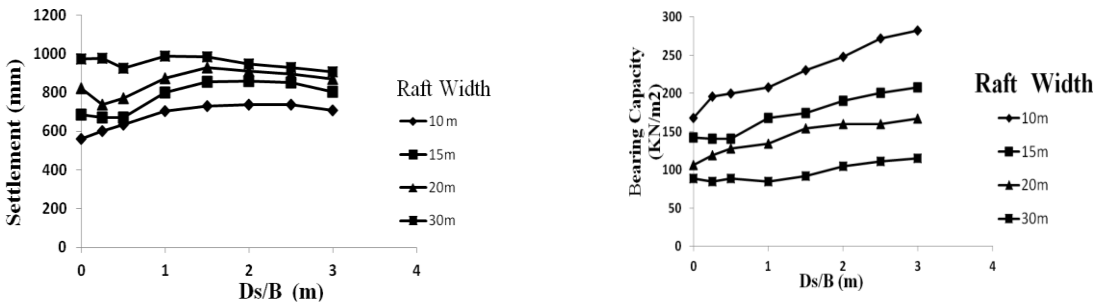


Figure 8: Settlement and Bearing Capacity vs Ds/B graph for one side vertical skirt raft foundation for different raft sizes

VI. CONCLUSIONS

Construction of vertical skirts at the base of the footing confines the underlying soil and generates a soil resistance on skirt side. This leads to improvement in the performance of footings. From present research work in general, it can be concluded that

- Increase in skirt depth increases bearing capacity.
- Two sided vertical skirt raft foundation shows decrease in settlement with increase in skirt depth.
- One sided vertical skirt raft foundation shows increase in settlement. This increase in settlement may be due to sliding.

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