Interference of Square Footing on Layered Soil Subjected to vertical Load

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Abstract

In this paper, an attempt had been made to analyzed two adjoining shallow square footings subjected to vertical load on layered soil. The finite element software MIDAS3Dwas used for the analysis. The soil was modelled as Mohr-Coulomb model. The present investigation indicates that for footing on layered soil, the bearing capacity of closely spaced footings reduces with increase in the spacing between the footings and is constant at larger spacing.The bearing capacity decreases with increase in the depth of top weak layer.

Keywords: *Square Footing,Layered Soil, Interference Effect, Bearing Capacity*

I. INTRODUCTION

The foundation are designed for transmitting the loads from a structure to soil without causing any shear failure or settlement failure of the foundation[1]. For any project, the choice of a suitable bearing capacity of soil becomes the most important. However, due to scarcity of urban land, it is unavoidable to avoid the existence of nearby structures or footings. These footings when come closer affect the bearing capacity of footing. The interference effect or such footing become more complicated as layered soil exists below footing.

The soil below footing exits in layers due to stratification.Its characteristics plays major role in transmitting the stresses. A layered deposit may present as strong layer reposing over the weak layer or weak layer resting on the strong deposit. The theory of elasticity and the finite difference method can be used for the solution.

However, with advances in numerical analysis and finite element software solution, understanding the behaviour of bearing capacity of two nearby square footings had become easier and correct. In present work, MIDAS3D FEM software had been used for analysis. The variation of bearing capacity of two nearby square footings was studied with respect to the depth of top weak layer and the clear spacing between two footings for vertical load.

II. LITERATURE REVIEW

A model study was carried out for understanding the effect of interference of footings on bearing capacity and settlement footings experimentally or numerically on single soil layered soil by various authors [2], [3], [4]. The bearing capacity of interfering footing was more than that of isolated footing of the same size. The settlement for a given load intensity decreases as the spacing between the footings decreases.

Similarly, experimental or analytical work also carried out for finding the effect of interference between two nearby footings on layered soil [5] [6]. Thebearing capacity and settlement of adjoining footing on layered soil is affected by spacing of footing, thickness of soil layer and shape of footings. The study is limited and hence this work is carried out for various parameters using finite element based software MIDAS 3D.

III. PARAMETERS

The geometry of the finite element soil model adopted for the analysis in MIDAS 3D was 20B X 15B with the width of square footing as B=2m.The various parameter studied are as shown in Table 1.

Table 1: Details of Parametric Study

Sr. No	Parameters	Details of parameter
1	No. of footing	2
2	Shape of footing	Square
3	Load	Vertical load
4	Width of footing	2
5	Ratio of width of footing to spacing of footing (S/B)	0,0.5,1,1.5, 2,3
6	Ratio of height of top weak layer to spacing of footing(H1/B)	0,0.5,1,2,3

7	Soil Properties Soil Layer 1 Soil Layer 2	γ = 15kN/m³ , Φ = 28^0 γ = 17kN/m³ , Φ = 33^0

IV. SOIL AND FOOTING PROPERTIES

The adjoining two footings having same properties were used in the analysis .The soil is considered as layered sand deposit having differentΦvalue and different Thickness of top layer was weak layer. The properties of soil used in the analysis are shown in Table 2 while the properties of foundation material are shown in Table 3.

Table 2: Material Properties for Soil

Sr. No	Properties	SOIL 1	SOIL 2
1	Unsaturated unit weight (kN/m^3)	17	19
2	Dry unit weight (kN/m^3)	15	17
3	Cohesion c (kN/m^2)	.0001	.0001
4	Poisson's ratio ν	0.3	0.3
5	Young's modulus E (kN/m^2)	3000	5000
6	Angle of internal friction (ϕ^0)	28^0	33^0
7	Material model	Mohr Coulomb	Mohr Coulomb
8	Type of material behavior	Drained	Drained

Table 3: Plate Properties for Study

Footing width (m)	2
Material model	Elastic
Young's modulus E (kN/m^2)	5 x 10^6
Poisson's ratio, ν	0.3
Equivalent thickness of footing (m)	0.1

V. NUMERICAL MODELLING

The typical square foundation placed on layered soil and subjected to vertical load is as shown in Fig. 1. The soil layer 1 was assumed to be weak soil layer than soil layer 2. The spacing 'S' and thickness of top weak layer 'H1' varied to understand the effect of interference of two square footings.Fig 2 shows two adjoining footing placed on soil model of 20B X 15B in MIDAS 3D.It also shows the displacement contour at middle of two footings. The load settlement curve obtained is shown in Fig 2.

As we know, maximum permissible settlement for the square footing is 50mm so that the allowable pressure for the 50 mm settlement by the footing was noted down for each configurations. The result were plotted for the allowable load of footing having 50mm settlement and the bearing capacity was calculated from drawing the tangent in load versus vertical settlement graph. The effect of depth of top weak layer with respect to spacing between the footings was also studied in terms of bearing capacity in each cases.

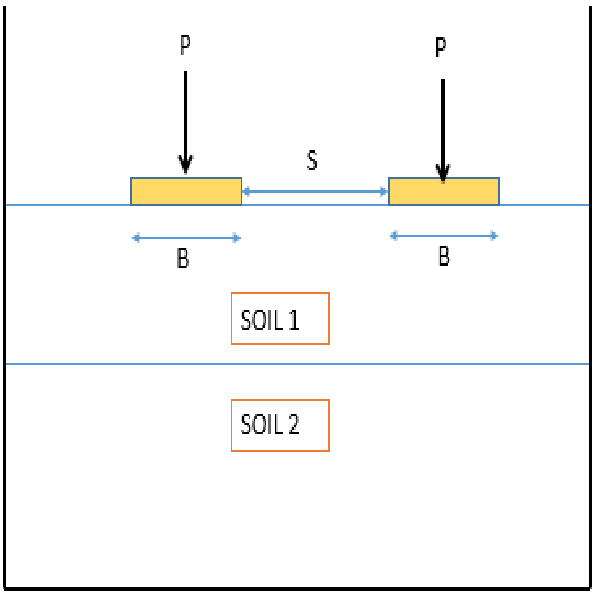
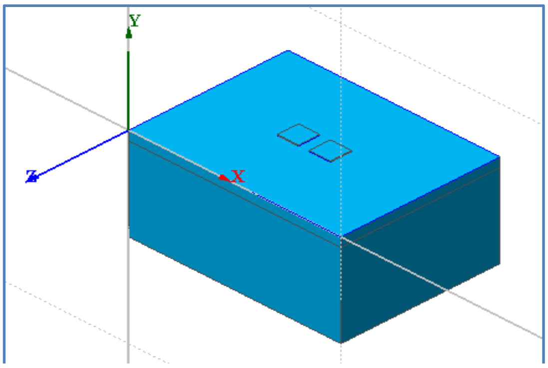
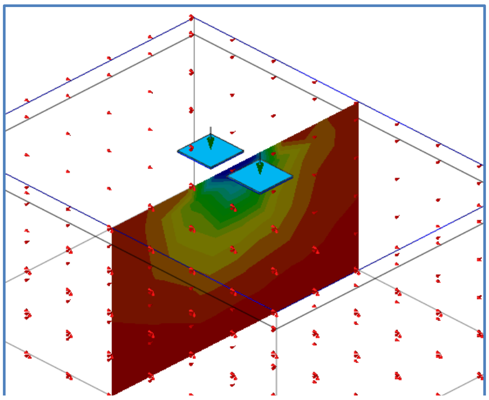


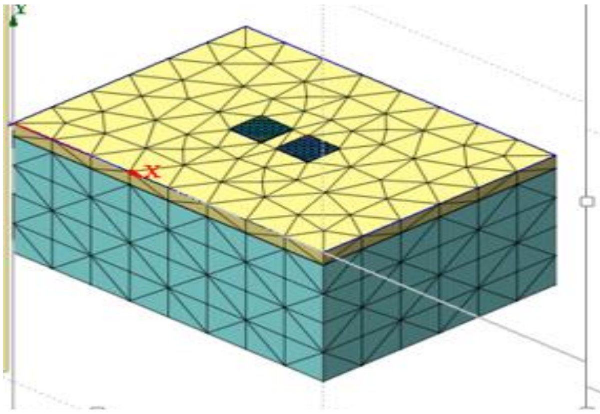
Fig. 1: Geometry Model of Square Footing



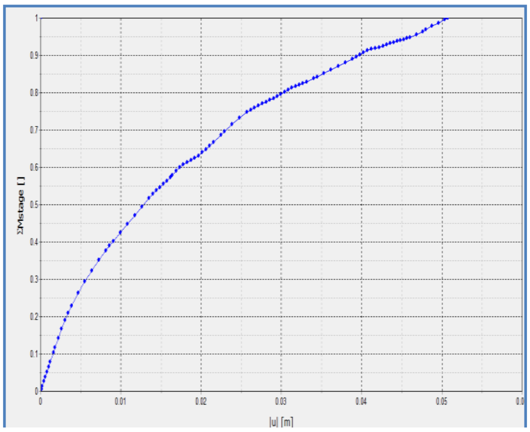
(a) Geometry Model in MIDAS



(c) Deformed Pattern



(b) Generated Mesh



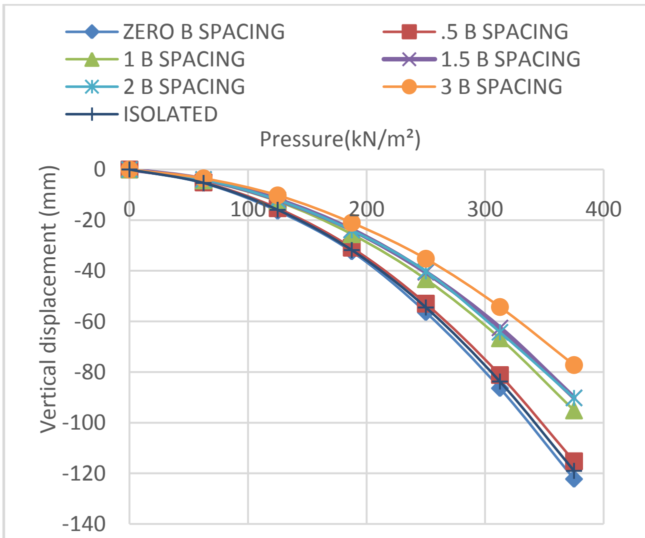
(d) Load-Displacement Curve

Fig. 2: Modelingin MIDAS 3D

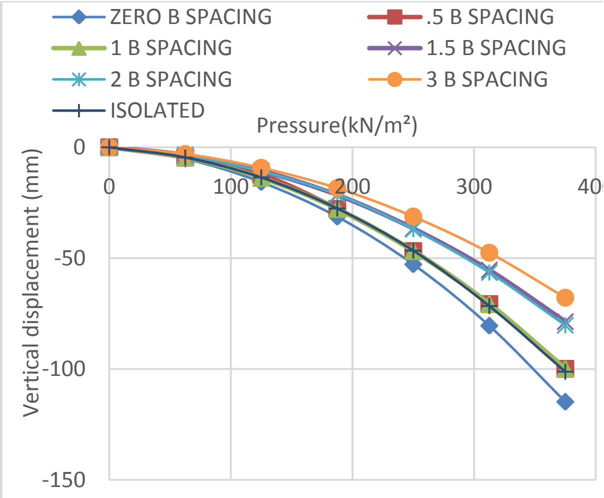
VI. REULTS AND DISSCUSSION

The analysis was carried out in MIDAS 3D for adjoining square footing resting on layered soil for different spacing and different thickness of top weak soil layer. For the typical case with 0.5B spacing of footing on layered soil,the modeling and results obtained in MIDAS 3D were shown in Fig.2. The ultimate load bearing capacity was obtained from load settlement curve by plotting two tangent. The bearing capacity was also obtained for 50 mm settlement from the same curve.

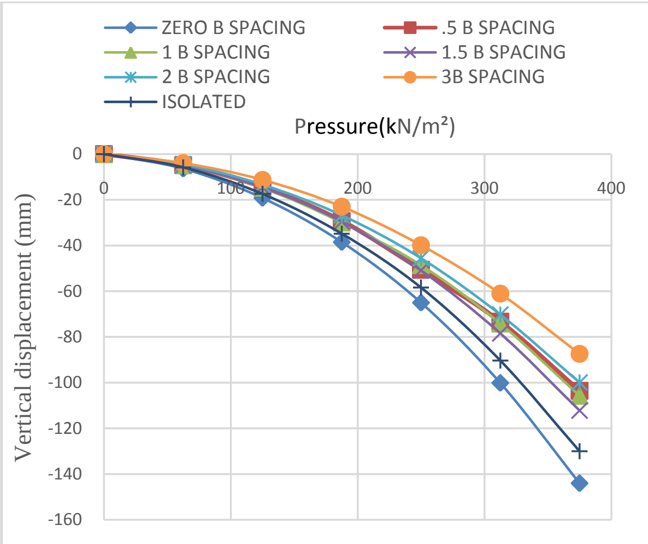
The MIDAS 3D was used to determine UBC for different conditions and the load settlement curve for different spacing of footing (S/B) are shown in Fig. 3. The load settlement curve shows that the load carryingcapacity decreases as the spacing between adjoining footings increases.



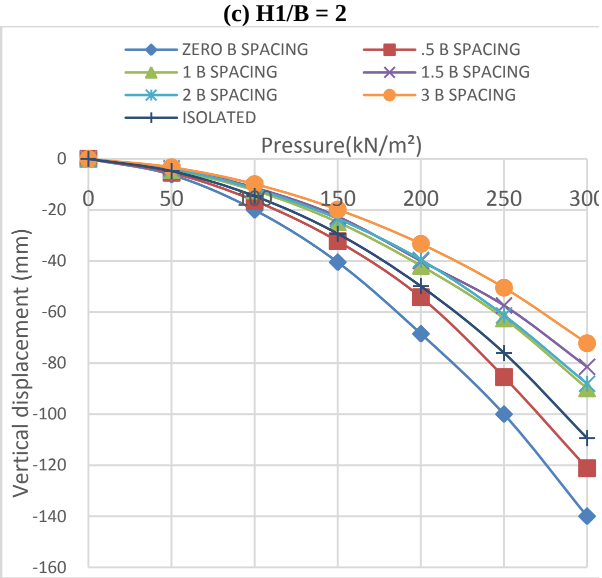
(a) H1/B = 0.5



(b) H1/B = 1



(c) H1/B = 2



(d) H1/B = 3

Fig.3: Load Settlement Curve for Different Values of H1/ B

The ultimate bearing capacity (UBC) was obtained from shear criteria by plotting the tangents on load settlement curves. Aldo, from the load settlement curves, the load corresponds to 50 mm settlement was obtained for each case. The bearing capacity obtained from shear criteria and settlement criteria from load settlement curves for different soil layer thickness (H1/B)and spacing of footings (S/B)are shown in Fig. 4 and Fig. 5 respectively.It can be seen that for different thickness of weak layer the bearing capacity from shear failure is maximum when footings are spaced at 1.5 times width of footing, while settlement criteria it is at spacing equal to width of footing.

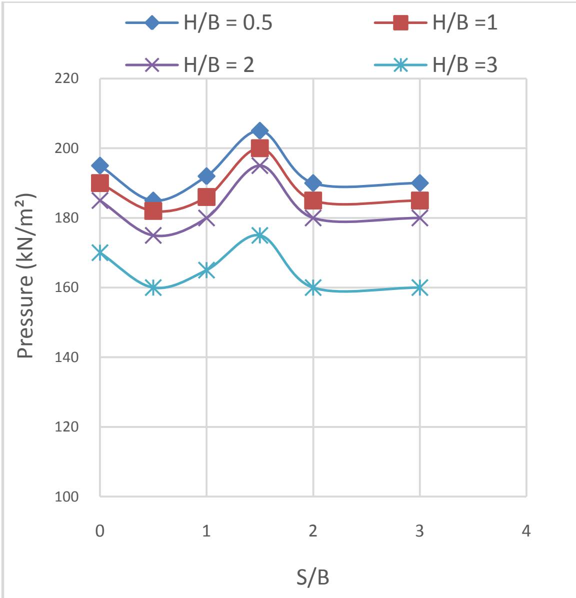


Fig. 4: Variation in Bearing Pressure with Respect to S/B

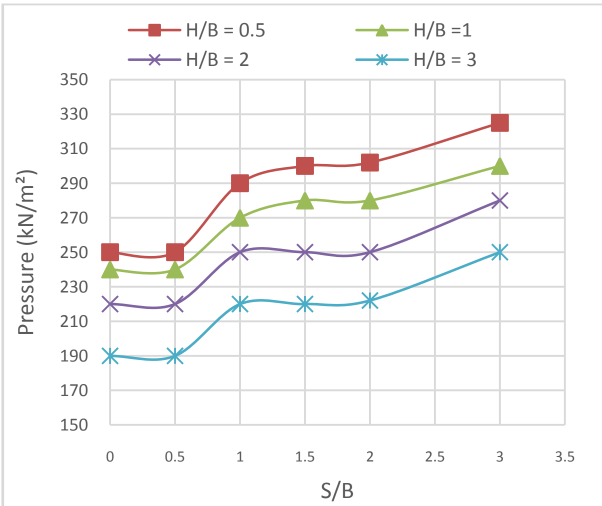


Fig. 5:Variation in Bearing Pressure at 50 mm Settlement with Respect to S/B

VII.CONCLUSIONS

The analysis of soil model wascarried out to determine the ultimate bearing capacity and bearing capacity of closely placed square footings resting on a single as well as a two-layer sand bed using MIDAS 3D.The study investigated the effect of depth of top weak layer,effect of spacing between the footings on bearing capacity. The study concluded that:

- Ultimate bearing pressure varies with respect to spacing of footing due to influence of interference effect.
- The bearing capacity decreases as the depth of top weak layer increases, for interference of two square footings on layered soil.
- The bearing capacity decreases as spacing between the footings increases.
- The variation of UBC with respect shear criteria and settlement was found maximum at different spacing.
- From shear criteria, the UBC is maximumat spacing of 1.5 times the width of footing for layered soil.
- From settlement point of view, the UBC is increases with increase in spacing for layered soil.

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