International Journal of Engineering Applied Sciences and Technology, 2022
Vol. 7, Issue 1, ISSN No. 2455-2143, Pages 211-216
Published Online May 2022 in IJEAST (http://www.ijeast.com)

SETTLEMENT ANALYSIS OF PILE FOUNDATION USING PLAXIS 3D

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Abstract: **In recent years, there are many construction projects which are constructed on the soft soil. Because of the characteristics Sentimental or soft soil, the structures which are built on that are subject to differential settlements. Foundation is one among the methods for reducing differential settlement. To reduce the settlements to a suitable amount, the piles are added. In this project, the aim is to analyze the settlements of the pile foundation by increasing the number piles, as the pile foundation, under the same loading, with or without considering the water table below the top surface. The numerical analysis has been done by finite element method using PLAXIS 3D by considering the varied number of piles. As a result, the addition in the number of piles could reduce the settlement. It is necessary to think about the optimum number of piles in pile foundation system supported the allowable settlements, for its economical design. This analysis has been undertaken to study the behavior of pile foundation under different number of piles. This analysis has been done using PLAXIS 3D software.**

Keywords: PLAXIS 3D, Settlements, Pile Foundation.

I. INTRODUCTION

1.1 General

Foundation may be a structural part of a building on which a building stands. Foundation transmits and distributes its own load and imposed loads to the soil in such the way that the load bearing capacity of the “foundation bed” isn't exceeded. When the soil at shallow depth isn't capable of supporting a structure, deep foundations are required to transfer loads to deeper strata. If a firm stratum is so deep that it cannot be reached by open excavation, the deep foundation are adopted.

1.2 Objectives

- Increase shear strength
- Decrease permeability
- Control undesirable volume changes
- Increases stability of slope

1.3 Need of Pile

Insufficient bearing capacity of the soil for bearing a structure will demand for the pile foundation. The pile foundation will be chosen based on the Soil Condition, Types of Loads acting on the Foundation, Bottom layers of the soil, Site Conditions, Operational conditions.

When the plan of the structure isn't regular the load distribution also won't be uniform in nature. Employing a shallow foundation in these cases will lead to the differential settlement. In order to eliminate differential settlement and such a cases, the pile foundation becomes necessary. Pile foundation is critical for areas where the structure surrounding has chances for erosion. This might not be resisted by the shallow foundation. Pile foundation is needed near drainage and the canal lines. The adjacent soil are often confined by means of pile foundation.

II. METHODOLOGY

2.1 Finite Element Method

The finite element method (FEM) is a numerical method for finding fairly accurate solutions of partial differential equations as well as integral equations. The solution approach is based either on eliminating the differential equation completely (steady state problems), or rendering the PDE into an approximating system of ordinary differential equations, which are then numerically integrated using standard techniques such as Euler's method. For carrying out elasto-plastic analysis in this project, commercially available geotechnical software PLAXIS 3D is being used which uses Finite Element Analysis (FEA) for simulation of model.

2.1.1Plaxis 3D

PLAXIS 3D is a powerful user-friendly finite element package intended for two dimensional analysis of deformation and stability in geotechnical engineering and rock mechanics. It is used worldwide by top engineering companies and institutions in the civil engineering and geotechnical engineering industries. Applications range from excavation, embankment and foundation to tunneling, mining and reservoir geo- mechanics. PLAXIS is equipped with broad range of advanced feature in model a diverse range of geotechnical problems, all from within a single integrated software package.

2.2 Soil Layer and Structural Elements

Current model of this problem consist of a piles having diameter 40cm and 50m which is ultimately loaded to 500kN, 1000kN and 1500kN each. The pile is placed at the centre of excavation with the depth of 1.2m.The subsoil is divided into 4 layers.

2.3 Procedure used for Simulation and Analysis of Project:

Following work done in the software expresses the procedure adopted for the simulation of each model having unique position of pile:

2.3.1 Analysis of Pilein Plaxis 3D

Step 1: In this step, it’s the dimension of influence area

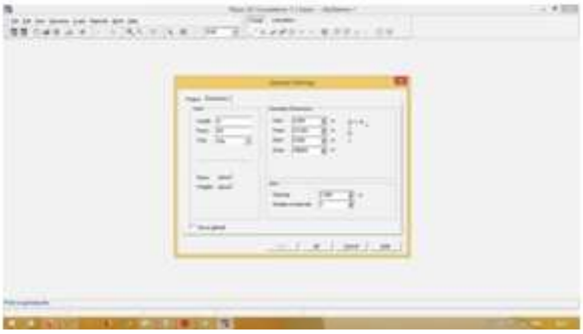


Figure 2.1: Select dimension of influence area

STEP 2: Select plate command to insert pile of given dimensions.

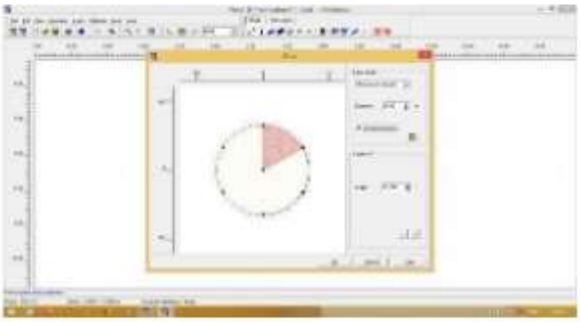


Figure2.2: Pile in influenced area

STEP 3: After making complete geometry of pile, next step to assign soil property to model

Figure2.3: Assign properties to structural element (pile)

STEP-4: After giving input to soil layer, there properties were assigned

Figure2.4: Material property assigning to soil

STEP 5: Next step is to assign load at pile nodal point

STEP 6: Mesh is Generated

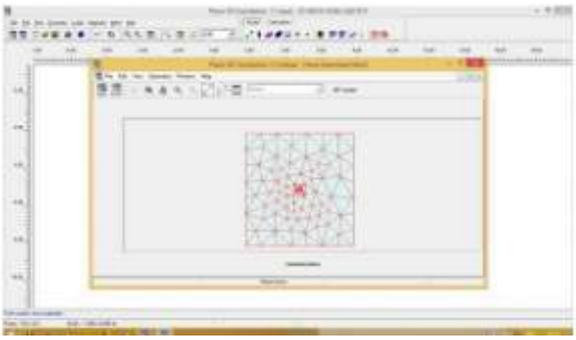


Figure2.6: Generation of mesh

STEP6:Ground water table is assigned.

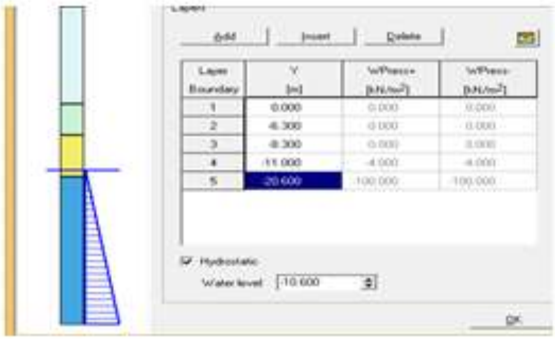
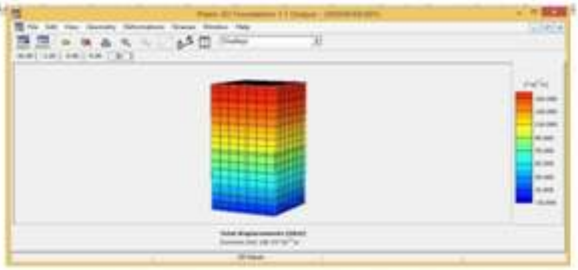


Figure2.6: Generation ground water table

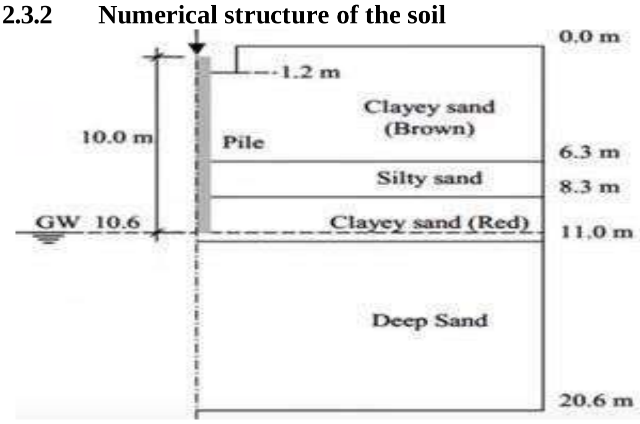
STEP 7: Point load and Output calculation

Fig 2.7 Point load and output calculation

STEP 8: Settlement of deformed pile



2.3.2 Numerical structure of the soil



2.4 Settlement and displacement analysis

2.4.1 For 40cm dia.Pile:

a) 500 kN Loading

Fig- Total displacement

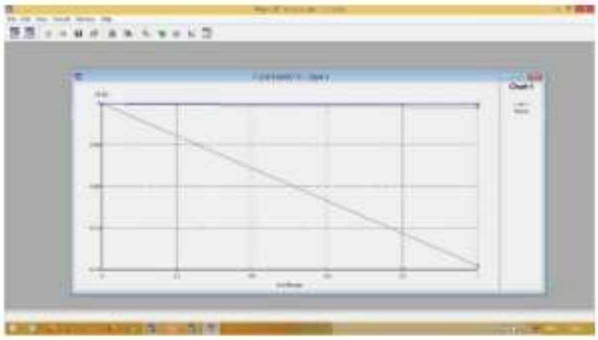


Fig- Load-Displacement curve

b) 1000kN Loading:

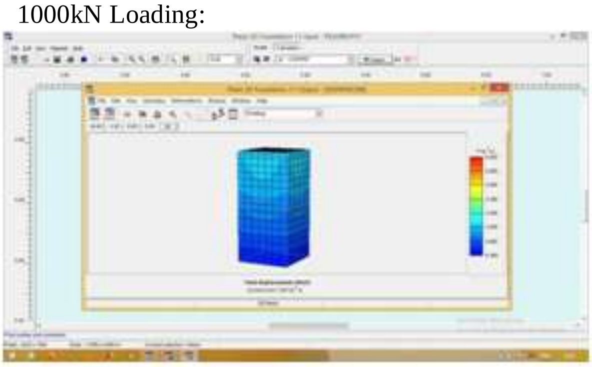


Fig- Total displacement

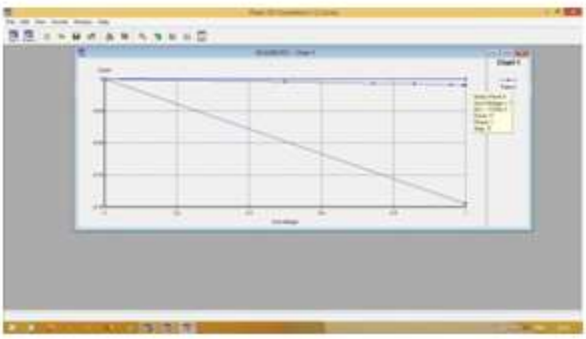


Fig-Load-Displacement curve

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c) 1500kN Loading:

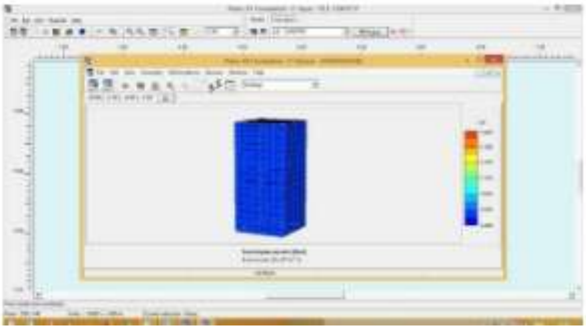

Fig- Total displacement

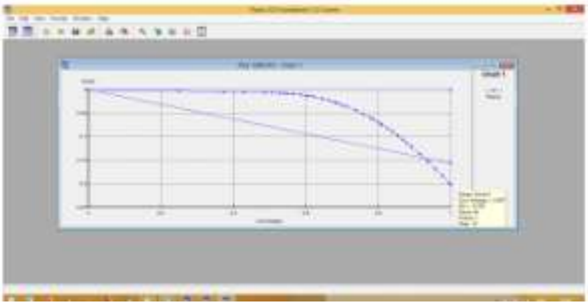

Fig- Load-Displacement curve

TABLE 1: values observed from load- displacement curve (40cm dia.)

LOAD(kN)	DISPLACEMENT (mm)
1. 500kN	3.56mm
2. 1000kN	7.88mm
3. 1500kN	201.05mm

2.4.2 For 40cm dia.Pile:

a) 500kN Loading

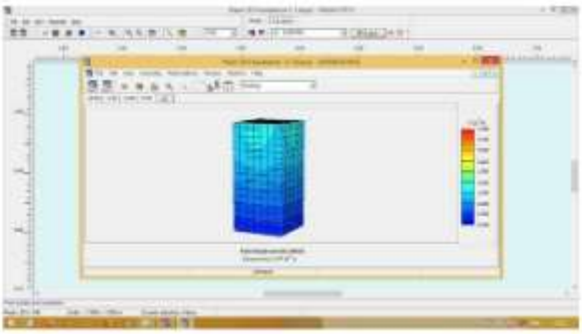

Fig- Total displacement

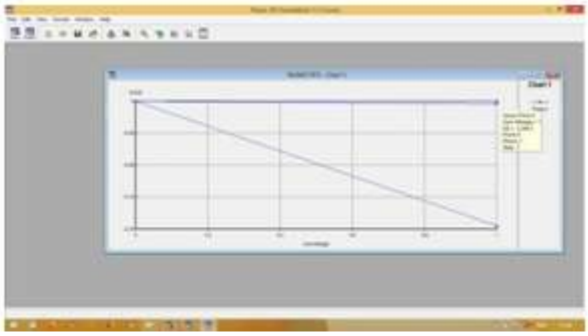

Fig-Load-Displacement curve

b) 1000kN Loading:

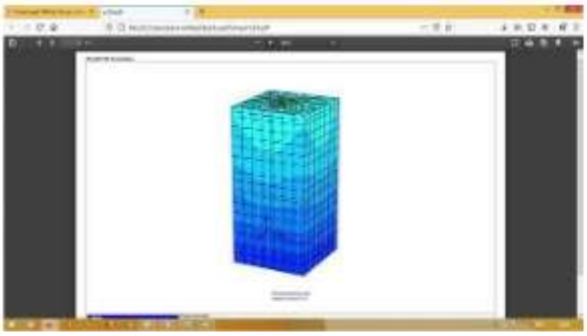

Fig- Total displacement

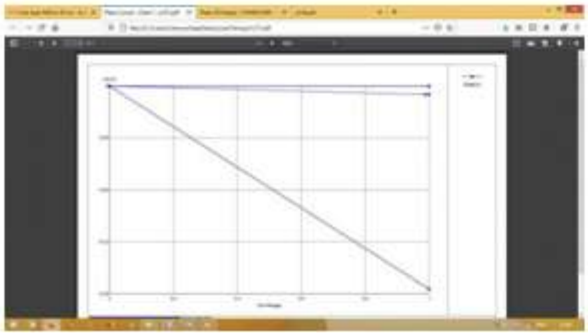

Fig-Load-Displacement curve

c) 1500kN Loading.

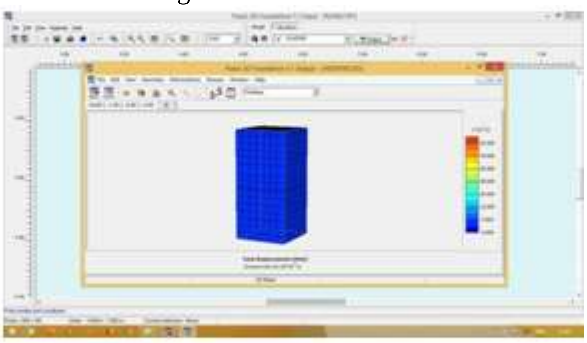

Fig- Total displacement

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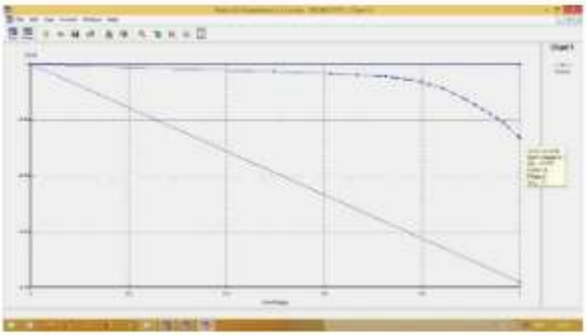

Fig- Load-Displacement curve

TABLE 2: values observed from load-displacement curve(50cmdia.)

LOAD(kN)	DISPLACEMENT (mm)
1. 500kN	3.24mm
2. 1000kN	6.62mm
3. 1500kN	53.18mm

III. RESULTS AND DISCUSSION

1. The present work was carried out to study the load-settlement behavior of model pile on sand. The length of the pile, diameter of the pile was kept constant for all the trial. Load varied as 500kN, 1000kN, 1500kN.
2. Discussions were made on the effect of load on the pile as well as settlement of the pile. Increasing amount of settlement is taking place as increased the prescribed load for this analysis.

Fig - Load- Settlement graph for 40cm dia.pile

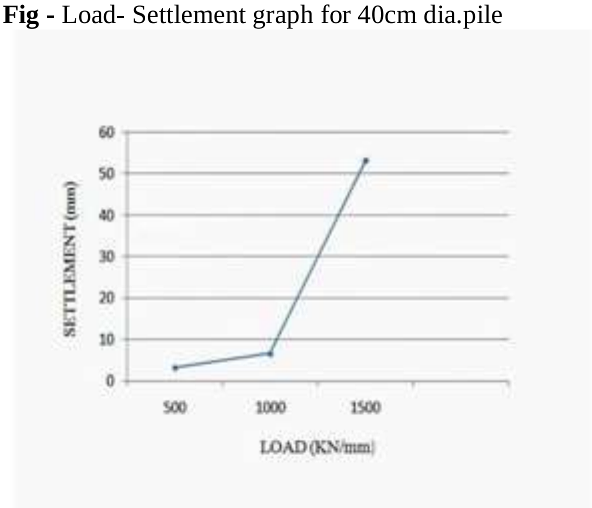

Fig - Load- Settlement graph for 50cm dia.pile

From the above graph, it was found that as load increases, settlement increases and if load goes higher then settlement goes on increasing further.

IV. CONCLUSION

4.1 General

1. For 40cm dia. Pile, as increased the load from 500kN to 1000kN, settlement is increased about 7.88mm. Load is applied upto1500kN, settlement is 201.05mm which is not within allowable settlement limit. For 50cm dia. Pile, as increased the load from 500kN to 1000kN, settlement is increased about 6.62mm. Load is applied upto1500kN; settlement is 53.18mm which is not within allowable settlement limit.
2. The addition of small number of piles increases the ultimate load of pile, and this enhancement effect increases with increase in number of piles as well as with increase in l/d ratio. For the piles to be within allowable settlement limit, group of piles or single piles of greater diameter can be used, as greater the diameter, lesser is the settlement.
3. From above study it can be concluded that the Numerical analysis of piles by using software like PLAXIS are more economical and accurate. In this computer age use of software like PLAXIS give better and faster results and approach analysis represents actual soil conditions.

4.2 Scope of Future Study

1. Piles of different diameter with different sizes are considerably used in order to reduce the total and differential settlement.
2. Different arrangements of piles alongside raft are often utilized in order to induce the most effective combination of less pile with high bearing capacity and ultimately reduces the costing of piling.
3. By providing group of pile system at a critical location, the differential settlement can be reduced.
4. Geo-foam instead of soil can be used as it gives better results for particular structures and should be investigated for economy.

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