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Numerical Analysis and comparison of Micropile's Pressure Bearing Capacity With the new Microbulb system on clay in Shiraz, Iran

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ABSTRACT: In recent decades, the implementation of micro piles have been increased extensively in large project constructions because of the unique advantages of this method compared to concrete piles.The results of centrifuge tests and numerical analysis show that efficiency and importance of micropiles can be considered as an effective functional solution. This research is designed to use a numerical modeling using finite elemet software Plaxis 3d Foundation v1.6 and also the FHWA code for a comparative study between micropiles and microbulbs . then the effective factors was analysed in order to choose the better method for between these two methods(micropile and microbulb). The results showed that the new microbulb system is an appropriate solution for improvement of mechanical properties of the soil ,increase of bearing capacity and settlement decrease.
Keywords: micropile, microbulb, bearing capacity,Plaxis 3d Foundation

INTRODUCTION

Using micropiles in foundations was effectively began in 1950 in order to improve withstanding of static and dynamic loads . steel micropile with less than 300mm diameter is drilled into the desired depth of ground and then grout which includes cement, water and various additive injects into the micropiles. Grout with pressure between 5 to 25 bar will be injects considering the depth and the material of the ground. micropiles are effectively apply in foundations to resist them against decrease of settlement, to improve the mechanical properties of the soil and to increase baring .

Micropiles like other structural and geotechnical elements have two different structural and geotechnical bearing capacities. Geotechnical bearing capacity of micropile is mainly caused by parietal friction and cement joints due to the injection of cement grout around the micropile. Structural bearing capacity of piles is applied by increasing of their cross section while the bearing capacity of micropiles is mainly caused by steel elements within the micropiles. The steel elements emrace approximately half of the boreholes[1].

Bearing capacity of micropile contains a wide range based on the relations mentioned in the major references.

These relations contains different results of bearing according to soil type and the method of application. The sugessted numbers for factor of safety for the calculation of loading capacity of micropiles are mentined in FWHA code[2].

Background history of micropiles

Lizzi used micropiles for the first time as a method in 1950 in Italy. He used this mehod for reparing the foundations of historical buildings and also the memorial buildings which were damaged during the world wide two. This technology was spread very fast in the world ,and some countries such as England,germany and north America started to use this method in 1962,1965 and 1973. China's first attempt of using this technology was in 1980 in order to protect the deviation of Hu-Qiu tower which was built in the year 959.

Lizzi and Plumele (1984) showed that use of micropiles creates a reinforced soil system with adhesion and will result in increasing of the soil mechanical parameters.In 1973 FHWA supported a comprehensive investigation in relation to micropiles. The research group using the international research background ,the

laboratory results and the designed methods presented a comprehensive guide about how to impellent micropiles[3].

Microbulb

Microbulb structure sharing all effective properties of the micropiles, have a number of differences with them. These differences cause changes which lead to an increse of loading capacity and a decrease of movement and settlement.Generally the process is as follow, injection applies with the specified biometric pressure, the grout moves trough the holes of microbulb body and enters into a rubber membrane layer,then the grout enters the second membrane layer and stands between the two membrane layers. It should be mentioned that the membrane layer has been tighten with steel clamps. The grout is not allowed to pass the second layer and the second layer which has elastic quality starts to swell. Then a bulb forms which overthrows and compress the soil around itself. After that some bulb shaped grout forms. These bulbs have effects on increase of compression bearing capacity ,tensional bearding capacity and decrease of settlement.

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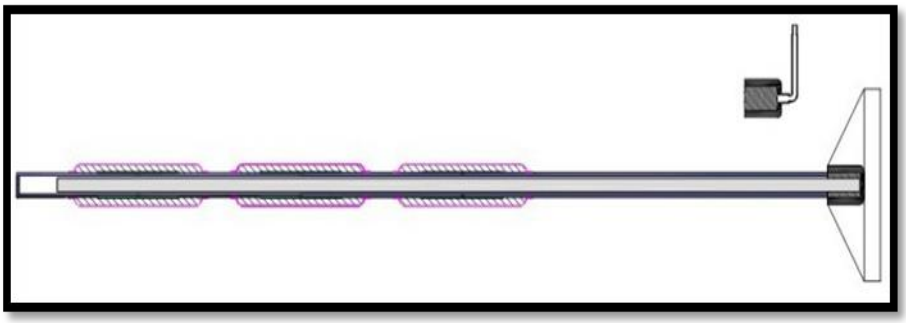

Figure1.Microbulb

Numerical modeling

A three dimension model of Plaxis 3d foundation v1.6 was used in order to examine the micropile system. The Plaxis program development began in 1987 at the University of Delft in the Netherlands.44444 The three-dimensional Plaxis program uses specifically for review and analysis of piles and offshore foundations. 555555 The soil model in this study ,was prepared in dementions of 1 m, 1.5 m and height of 1.2 m .the length and diameter of the micropile was considered respectively 1 meter and 1 inch. Figure 2 shows the modeled micropile in soil profile.

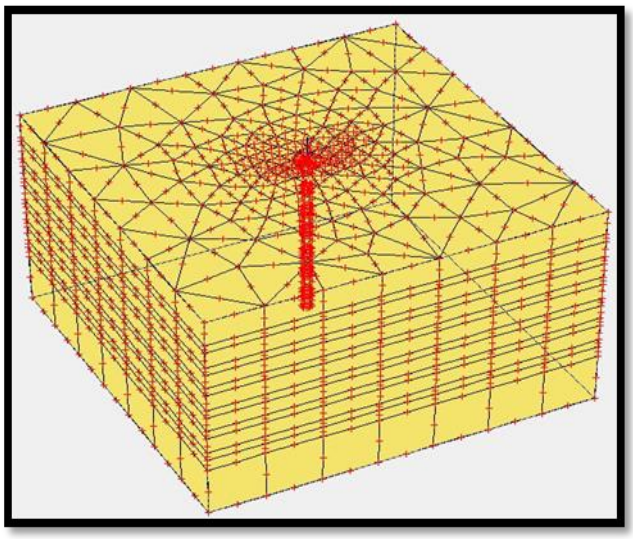

Figure 2.Microbulb Mesh

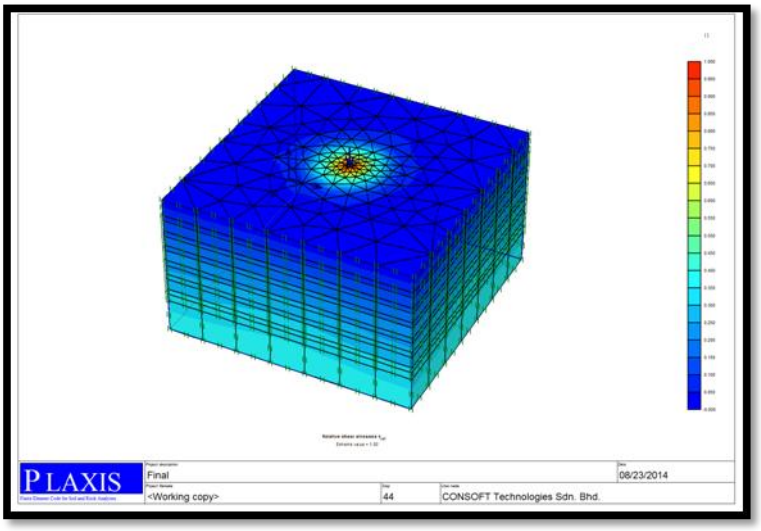

Figure 3.Modeled Microbulb in soil profile

The microbulb was modeled with 1meter length and the diameter of 9 cm. In this analysis, the Mohr-Coulomb behavioral model was used for the soil ,and the EL linear elastic model for the micropile element. Table 1 shows , geotechnical parameters, soil properties, micropile and micro bulb.

Table 1. geotechnical parameters, soil properties, micropile, microbulb

Material	Soil (Clay)	Micro Pile	Micro Bulb	Vertical Beam
γ(KN/m^2)	16.00	24.00	24.00	78.50
E(KN/m^2)	85300	200000	200000	20700
N	0.35	0.3	0.3	—
C(KN/m^2)	14.00	—	—	—
Ø	24	—	—	—

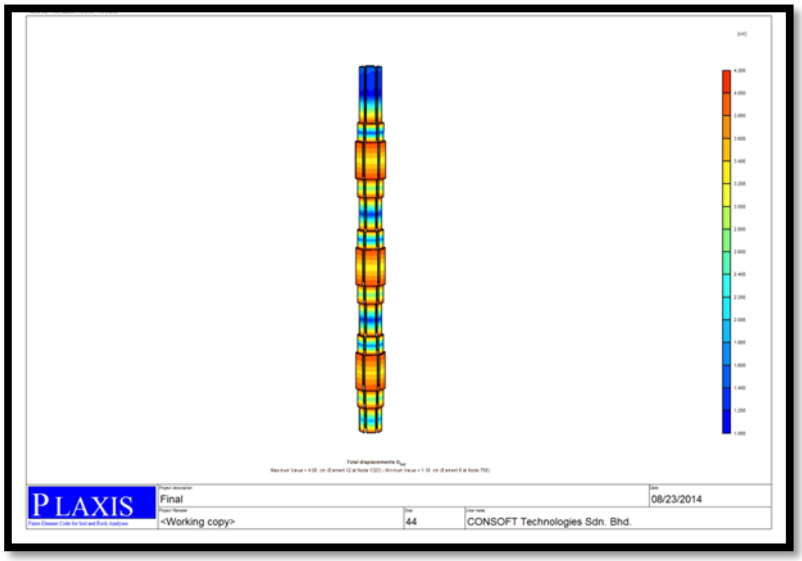

Figure 4.modeled micropile in soil profile

The program operation

By selecting the desired mechanical properties suitable for the soil,and by doing the numerical analysis of the loading capacity diagram of micropile and microbulb after the deformations ,the loading diagram was drawn.Figure 5 shows the overall movement counters of modeled microbulb in soil profile.

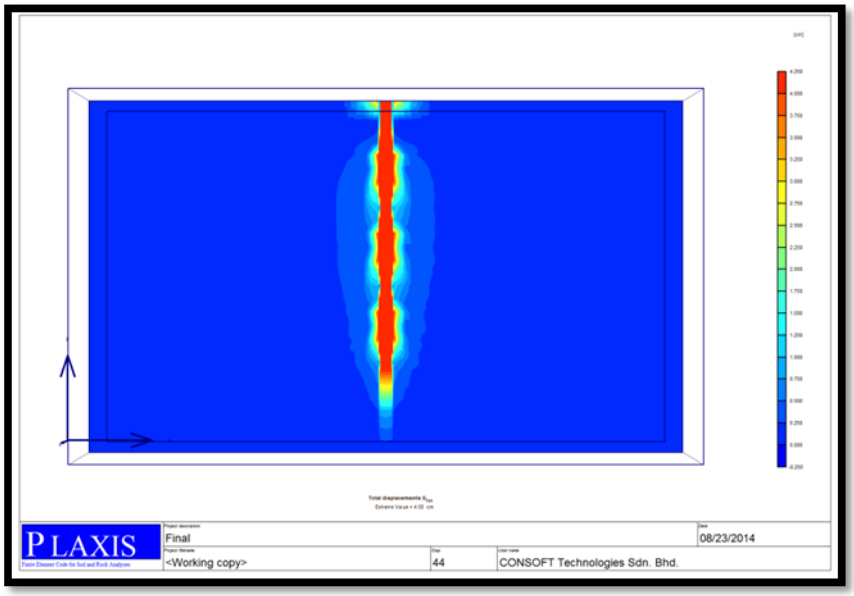

Figure 5. the overall movement counters of modeled microbulb in soil profile

Results review and the comparison between loading capacity of micropile and microbulb

Having finished the calculation process, the diagrams for loading on micropile and microbulb are shown in 6,7,and 8 figures.

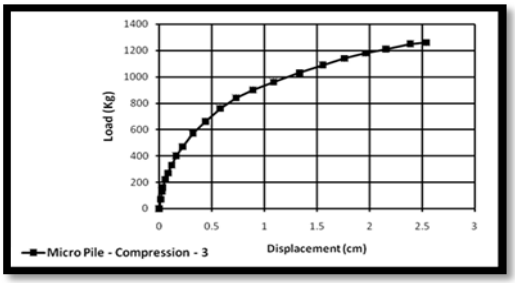

Figure 6.Load diagram –movement for micropile in compression test

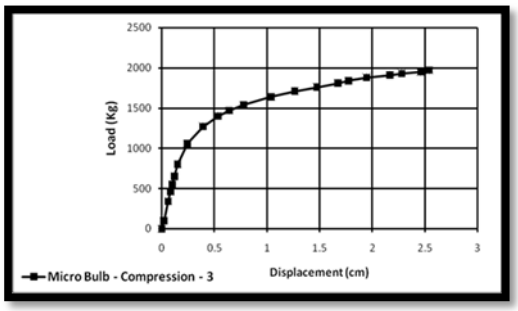

Figure 7.Load diagram-movement for microbulb in compression test

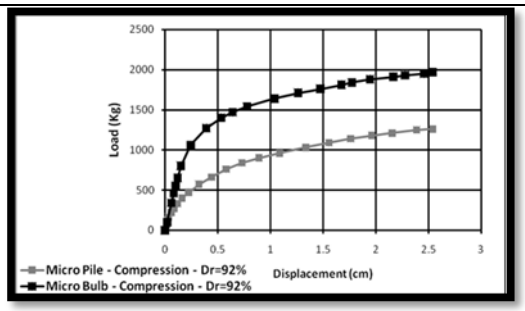

Figure 8.Load diagram- comparison of movement for micropile and microbulb in compression test

CONCLUSION

A comparison between micropile and microbulb shows that for a fixed movement of 1 inch, microbulb has a higher compression bearing capacity and it differs from 60 percent to 90 percent considering the soil compaction. The microbulb system ,considering the swelling of the bulbs helps the lateral compaction of soil in addition to increase of bearing capacity and decrease of settlement And helps the improvement of soil around itself.

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