International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Micro Piling for Retrofitting of Structures-Case Studies

Mahipal Burdak[1], Amita[2]

[1]Structural Consultant Engineer, Dara Construction Company Jodhpur, Rajasthan, India

[2]Assistant Engineer, PHED, Jodhpur Rajasthan, India

Abstract: ***Piles are used to transfer the load of the super structure to the hard bearing strata below ground surface. To resist the horizontal load, for work over water eg. Jetties or bridge piers, a soil is not having adequate bearing capacity pile foundation is beneficial. In some difficult geotechnical condition instead of piles, Micro piles are very useful. They are used due to its flexibility and ductility in seismic condition. Micro piles are drilled, having a diameter less than 300mm. They are grouted by neat cement grout. They also increase the bearing capacity and reduce the settlement of the soil. Many historical structures which are not built according to code and the structures and which are damaged during earthquake need to retrofit. For seismic retrofitting of the structure and underpinning works Micro piles are very much useful.***

Keywords: micro pile, bearing capacity, settlement & retrofitting

1. Introduction

Pile foundations are the part of the structure which transfers the load of the super structure to the hard bearing strata below ground surface and which resist vertical, lateral and uplift load. Pile foundations are beneficial where soil is not having adequate bearing capacity, to resist the horizontal load, for work over water eg. Jetties or bridge piers are cheaper than any other compared ground improvement costs. Piles are used for the support of bridges, buildings, docks and other structures. Mainly the materials used for pilling are wood, steel and concrete. But some difficult geotechnical condition and particularly for seismic retrofitting of structure or bridge foundation micro piling are best compare to pile foundation.

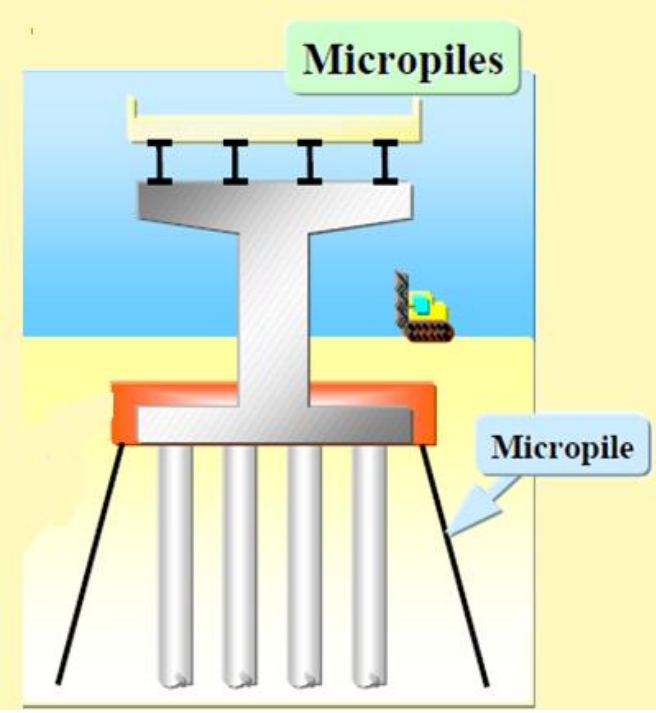

Figure 1: (a) Retrofitting by Micro pile

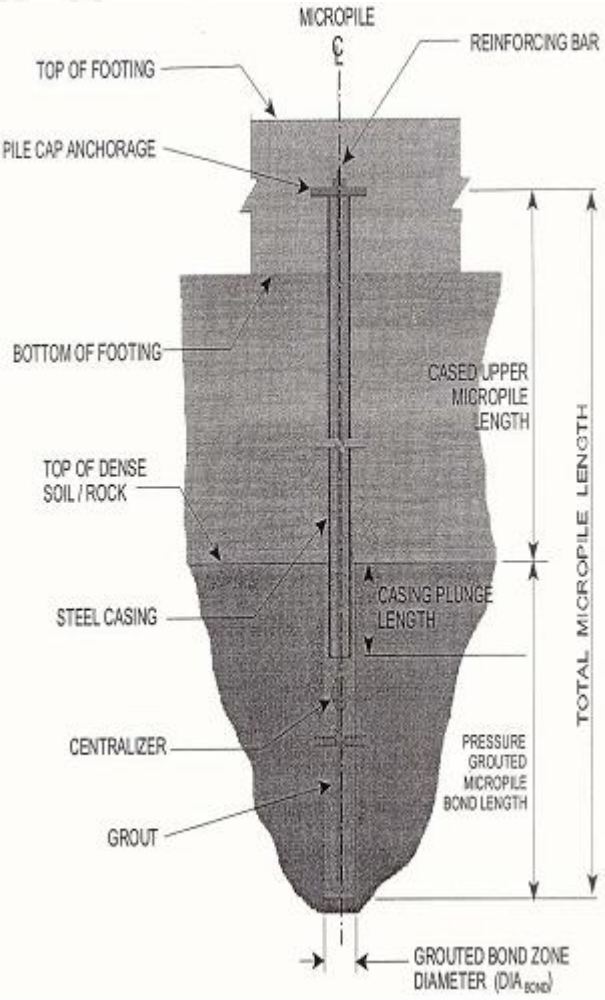

Figure 1: (b) Details of Micro pile

2. History of Micro pile

The concept of Micro pile has been developed in the early 1950's in Italy when innovative and reliable methods of under pinning historic buildings and monuments were being sought in that war-damaged country. In the past, Micro piles

were not used much because of the drilling and flushing process which might takes minutes or hour to complete. Dr. Fernando Lizzi is well known as the inventor of micro piles in the form of the root pile or palo-radice, which was used extensively in Europe for the restoration of various structures and monuments. By the mid 1970's a number of US had developed their own variants of the technology. There was slow growth of the technology in the time period between the mid 1970's and the mid 1980's .But Nowadays Micro piles or mini piles are gaining greater popularity and getting wider acceptance due to its small size and only small dimension of equipment is needed for construction. They are also called as pile radices or root piles or needle piles or mini piles.

3. Applications and advantages of Micro pile

Micro piles are reinforced piles having small diameter ranging from 90mm to 250mm, grouted in place with neat cement (Fig 1-a and Fig.1-b). Micro piles can be used to drill through any type of soils, boulders and hard materials. When there is a difficult geotechnical condition then also Micro piles are very much useful. It is installed without risking the stability of structure. In seismic areas due to its flexibility and ductility used as foundation support of new structures as well as for seismic retrofitting structure which have been affected seismic damage. Inclined Micro piles are more suitable with inclination between 0 to 25° than vertical Micro pile.

4. Case Studies

In many applications of ground improvement, Micro piles have been used effectively to increase the bearing capacity and reduce the settlements.

In a metropolitan city in India a two storeyed building rectangular in plan was constructed on a (loose sandy soil) whose soil properties like cohesion and friction angle can be taken as c=0 and φ= 25°and the bulk density (γb) is in the range of 17 kN/m^3. Considering that the safe bearing pressure of the soil is 120 kN/m^2 and the foundations were designed to carry expected column load of 600 kN and individual column footings of size 2.5 m × 2.0 m were proposed (Fig. 2-a).
For making up the difference in level a compacted soil whose bulk density is 20 kN/m^3 is placed upto a height of 6.5m, which resulted in a further loading of 130 kN/m^2 on the foundation. As a result, plinth beam (at the foundation level) and tie beams at the middle level showed considerable distress in the form of cracks when the filling was nearing completion. Foundations supporting columns tilted out of line and further construction was difficult.

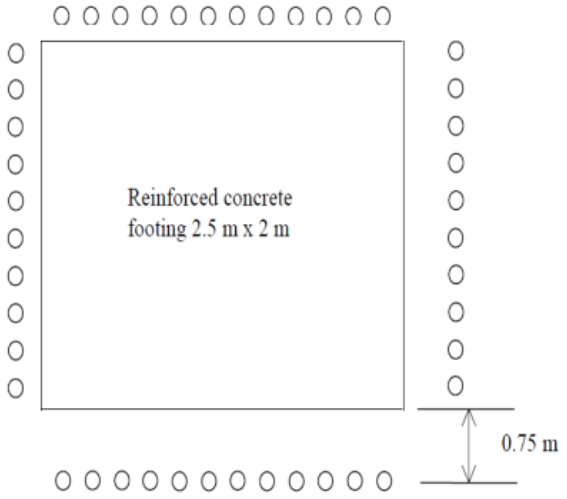

Figure 2: (a) Plan of a building strengthen by Micro piles

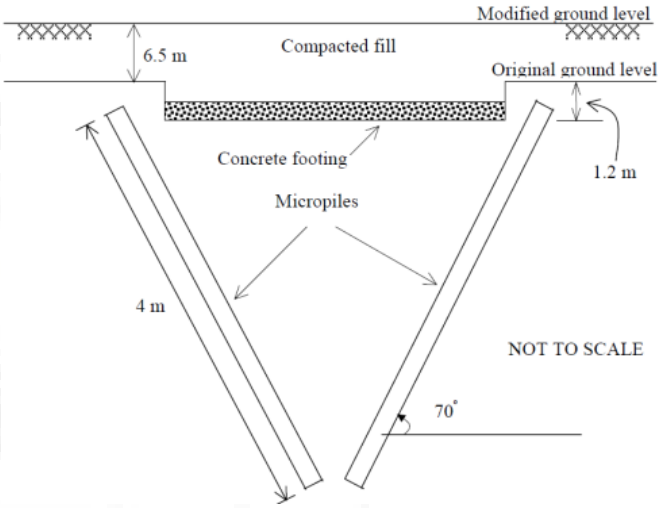

Figure 2: (b) Sectional view of footing strength by Micro piles

After soil investigation it seen that the actual safe bearing capacity is 70 kN/m^2 while initially it was considered higher. So micropiling has been chosen to restore the foundations and columns having 100 mm diameter and 4 m long were inserted around the individual footings at inclination of 70°with the horizontal as shown in Fig. 2-b.

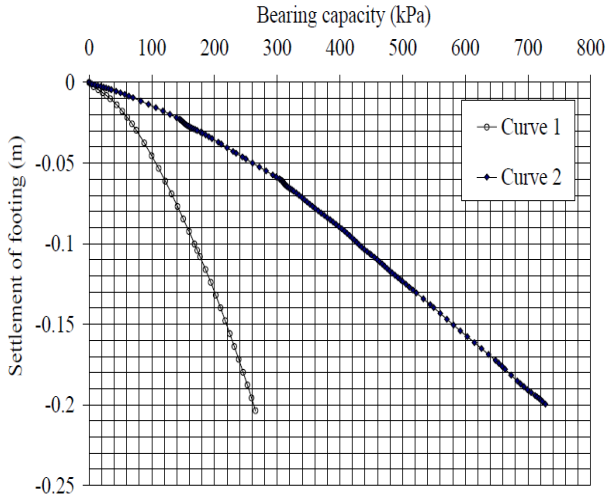

Figure 3: Load-settlement curves with and without micro piling

Fig.3 shows the load settlement curve without and with micro piling. In curve 1 without micro piling the values of bearing pressure at 25mm settlement is 66.8 kPa while in curve 2 with micro piling at 25mm settlement the value of bearing capacity is 70 kPa. But if settlement is 50mm the bearing capacity of soil is increased about 60% with inserting Micro piles.

In a second case in a Damietta Bridge on a river Nile the first two piers and an abutment are found on very soft clay with shallow foundation and that is the main cause for differential settlement. Due to this differential settlement wide gap are seen on a bridge as shown in Fig. 4. So after using the technique of micro piling the bridge piers foundation are retrofitted and no further differential settlement is reported.

Figure 4: Wide gap due to differential settlement in Damietta bridge

In one another case the existing control tower at King County International Airport in Seattle, Washington, was severely damaged during the Nisqually Earthquake in 2001.The existing tower was found on timber piles on a liquefiable soils. For retrofitting of foundation, again micro piling techniques introduced and the loose liquefiable soil were densified.

5. Conclusion

From above case studies it is concluded that Micro piles are the cheapest option for ground improvement technique. They are used in any difficult geotechnical conditions and particularly for retrofitting of structures. They reduce the settlement and improve the bearing capacity of the soil.

References

[1] G.L. Sivakumar Babu, B. R.Srinivasa Murthy, D.S. N. Murthy, M.S. Nataraj
[2] Micro piles Design and Construction Guidelines,(2000) US Department of Transportation, FHWA, report number FHWA – SA – 97 – 070.
[3] Usama A. Morsy (2002)" Repair of Damietta bridge foundation usning Micro piles". Annual Conference of the Canadian Society for Civil Engineering
[4] Dominic M. Parmantier ,Tom A. Armour, Bill J. Perkins, Jim A. Sexton, (2004)"Foundation Seismic Retrofit of Boeing Field Control Tower" ASCE pp. 278-288.