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MICRO-PILES

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ABSTRACT : *Micro piles have been used effectively in many applications of ground improvement to increase the bearing capacity and reduce the settlements particularly in strengthening the existing foundations. Advantages of Micro piles are high carrying capacity, less site constraint problem and self sustained operation. This piling system is therefore attractive to both the client and foundation designer. Apart from this the light and compact drilling rigs other ancillary equipment, like grout mixer and grout pumps, is very compact size. Micro installations can penetrate to hundreds of feet in depth; each of the piles can support many tons of load. Micro piles transfer loads through liquefiable soil to competent bearing strata to conform to design requirements. This paper deals with a case study in which micro piles of 100 mm diameter and 4 m long have been used to improve the bearing capacity of foundation soil and in the rehabilitation of the total building foundation system. The micro piles were inserted around the individual footings at inclination of 70° with the horizontal.Micropile technology is a reliable pile system that can withstand large capacity axial or lateral loads with minimal disturbance to the existing structures. They became very popular due to their ability to transfer loads efficiently through skin friction and due to their*
many installations advantages over conventional pile system. Micro piles has the capability of combining micro pile technology with one or more of the other ground improvement techniques to meet unique or complex project requirements cost effectively and efficiently.

I. INTRODUCTION

Since mankind started to design and build structures for different usages and environments, foundation systems to support such structures had to be developed in order to match the architectural and structural needs. With the ever-increasing urban expansions, it is not always possible to find good supporting ground at or close to surface level. Therefore, foundations other than spread footings were designed to transfer compression loads down to a suitable load-bearing stratum. Higher and slender structures subjected to wind and seismic loads need foundations capable to support compression as well as uplift and lateral forces. Instead of large, mass concrete foundations, which require large areas and mass excavations, smaller and deeper drilled shaft or pile foundations became a more economical alternative, in which steel reinforcing systems embedded in concrete and cement grout are the major component. Micro Piles belong in this category of foundation elements. They are very simple but unique in design and construction and are becoming more and more popular.

II. HISTORY OF MICRO PILES

Since its original conception in the 1950's by Dr. Fernando Lizzi, a number of micro pile systems using steel-bar reinforcement / cement grout combinations with or without steel pipe casing, have been developed.

Lizzi's idea was, to produce a foundation system consisting of small pile groups, which form a reinforced soil mass like the root system of a tree. He called these ***PALI RADICE*** or ***"ROOT PILES"*** Further developments using different installation methods and reinforcing systems made it necessary to capture them all under a general heading, first ***"MINI-PILES",*** which was later changed to ***"MICRO PILES".*** With the creation of the International Workshop for Micro piles (IWM), first in North America and later internationally, ***MICRO-PILE*** became a household name in the Geotechnical and foundation industry. They are mainly used as Friction Piles to take tension and / or compression loads

III. OBJECTIVES

- To study an alternate cost effective and economical solution to prevent settlement of existing foundation.
- To study behavior of micro piles as strengthening technique of existing structure.

IV. SCOPE

In recent years, especially in urban areas experiencing a huge growth in redevelopment either by tearing down an existing building and building something new in its place or by upgrading an existing structure a means to cost-effectively stabilize structures has become paramount. Caused by poorly compacted fill, improper drainage, development of sinkholes, or even improper design, settlement can have drastic effects on a structure. If a structure experiences loads for which it was not designed, severe cracking in the floor or walls is likely and doors

or windows may become difficult to operate. Thus it becomes necessary to improve the stability of the ground conditions and thus stabilize the structure.

A generally up to 300mm diameter, drilled and grouted pile with a centrically placed steel reinforcing member consisting of single or multiple bars. They can be placed with relatively small drilling equipment, single or in groups, under limited access and low headroom conditions. They can be installed, for instance as the Titan IBO system, using rotation boring only. This reduces or eliminates the risk of structural damages caused due to vibrations, by otherwise used heavy percussion and pile driving methods, especially inside or in close vicinities of buildings. The reinforcing materials are simply single solid or hollow bars with continuous outside threads (***as shown in figure 2 and 3)***, which can easily be spliced and coupled to any required length. The intent of this presentation is to introduce, to designers and specialized foundation engineering contractors, the different types of reinforcing systems and corrosion protection methods available for drilled and grouted Micro Piles.

V. CONSTRUCTION OF MICRO PILES

V.I Drilling Techniques

The drilling method is selected on the basis of causing minimal disturbance to the ground and nearby sensitive structures and able to achieve the required drilling performance. In all drilling methods, drilling fluid is used as a coolant for the drill bit and as a flushing medium to remove the drill cuttings. Water is the most common drilling fluid compared to other drilling fluid such as drill slurries, polymer, foam and bentonite. Another type of flushing medium is using compressed air, which is commonly used in Malaysia.

Single tube advancement: By this method, the toe of the drill casing is fitted with an open crown or bit, and the casing is advanced into the ground by rotation of the drill head. Water flush is pumped continuously through the casing, which washes debris out and away from the crown.

Rotary duplex: With the rotary duplex technique, drill rod with a suitable drill bit is placed inside the drill casing. It is attached to the same rotary head as the casing, allowing simultaneous rotation and advancement of the combined drill and casing string.

Rotary percussive duplex*:* Rotary percussive duplex systems are a development of rotary duplex methods, whereby the drill rods and casings are simultaneously per cussed, rotated, and advanced. The percussion is provided by a top-drive rotary percussive drill head. This method requires a drill head of substantial rotary and percussive energy.

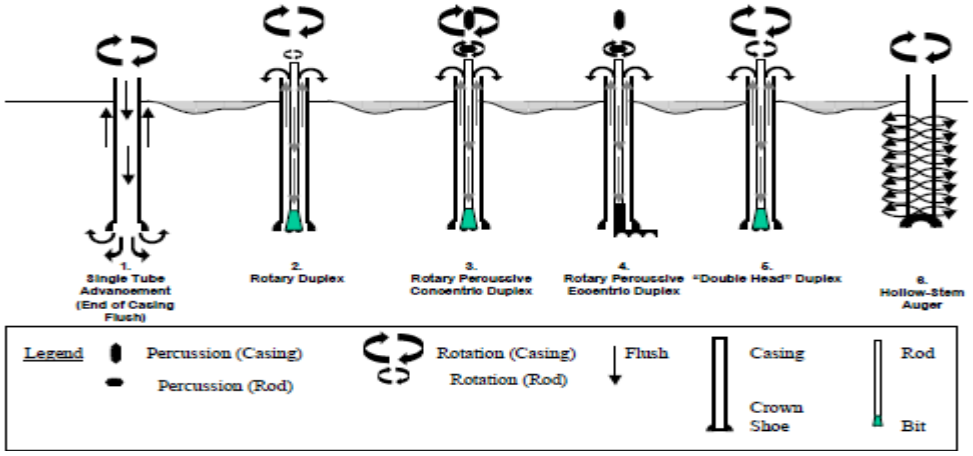

Fig VI.I Schematic representation of the six generic overburden drilling methods

V.II Grouting

Micro pile grouting equipment consists at a minimum of a colloidal high speed, high shear mixer, holding tank with agitation, grout pump capable of reaching pressures of 300 psi, pressure gauges, recirculation lines, qa/qc equipment and log books. The colloidal mixer is a high-shear grout plant that is capable of rapidly mixing neat cement based grout in a few minutes, with a thorough wetting of the individual cement grains. A thorough wetting allows a low water-cement ratio grout to be pumped easily through the grout lines that run from the plant to the pile. Without a colloidal plant, clumps of cement will cling together, clogging injection lines, and ultimately yielding a lower strength grout, because significant amounts of the cement grains are not hydrated. Following a thorough mixing, the grout must be stored in an agitation tank with agitation blades that constantly stir the mixed grout, prolonging separation of the cement from the mix water. With proper admixtures, grout life may be extended easily to a working time of 6 hours, and in some cases, may be suspended indefinitely until the reaction

is re-initiated on demand. A Marsh Cone simplifies optimization of the grout mix design with respect to retarders and fluidifiers. A Marsh Cone time of 11 – 14 seconds is typically considered ideal for pumping into micro pile packer systems

V.III Installation

The micro pile contractor must keep accurate and contemporaneous logs showing detailed installation information. Boring logs are used for planning the pile installation, but in karst' conditions, rock head may vary greatly within a few feet of the boring. In karst, it is conceivable that each pile will be unique in overall length, un-bonded length, depth to rock head and sequencing of adequate bearing stratum .The pile installation log is the only record of the verification of the pile design dimensions and compositions having been achieved. The pile installation log is also generates the pay items for the project, such as drilled footage in soil as well as rock, and amount of grout consumed. The contractor must be able to verify through his logs that the design requirement of a given amount of rock has been encountered in order to substantiate that a pile of the design capacity has been installed.

VI. CONCLUSION

The paper describes the bearing capacity of the foundation soil is improved using micro piles. Non-linear finite element analysis is carried out to examine the applicability and level of improvement obtained in the field. Densification of soil surrounding the micro piles and the frictional resistance between the micro piles and the foundation were given due consideration in the analysis. The results s

Micro piles can be installed in low overhead clearance (less than 3.5 m), in all types of soils and ground condition. Minimal disturbance is caused during construction. Inclined micro piles can be easily constructed. They are able to resist axial and lateral loads. Only small volumes of earth to be excavated due to small diameter. . Little disturbance is caused during drilling through an existing structure due to their small diameters. They can be drilled with boring machines that do not cause much noise.

Their high flexibility during seismic conditions. How that the methodology used was effective in obtaining the desired level of improvement.

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