Micro-piling Design and Construction at Fern club, Amanora, Pune

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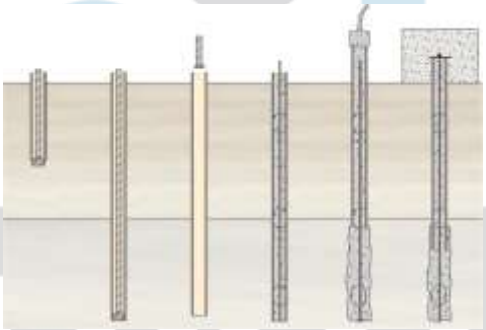
***Abstract*: Micropiles have been used mainly as foundation support elements to resist static and seismic loads, and to a lesser extent, as in-situ reinforcements to provide stabilization of slopes and excavations. Many of these applications are for transportation structures. This contains sufficient information on the geotechnical and structural design of micropiles for foundation support and for slope stabilization. Information is also provided on inspection and load testing procedures, cost data, and contracting methods to facilitate the safe use of micropiles.**

***Index Terms*: Core -cuts, Casing, Depth, Costing**

I. INTRODUCTION

This micro pile is a small-diameter of 300 mm, drilled and grouted non-displacement pile that is reinforced with 32 mm bar diameter . A micro pile is constructed by drilling a borehole, placing steel reinforcement, and grouting the hole as illustrated in Figure 1-1. Micro piles can withstand relatively significant axial loads and moderate lateral loads, and may be considered a substitute for conventional driven piles or drilled shafts or as one component in a composite soil/pile mass, depending upon the design concept employed. Micro piles are installed by methods that cause minimal disturbance to adjacent structures, soil, and the environment. They can be installed where access is restrictive and in all soil types and ground conditions. Micro piles can be installed at any angle below the horizontal using the same type of equipment used for the installation of ground anchors and for grouting projects.



II. PROCESS OF MICRO-PILING

III. **Steel Pipe Casing:** With the trend towards micro piles that can support higher loads at low displacements and for the requirement to sustain lateral loads, steel-pipe reinforcement has become more common. Pipe reinforcement can provide significant steel area for support of high loading and contribution to the micro pile stiffness, while providing high shear and reasonable bending capacity to resist the lateral loads.

Pipe reinforcement is placed by either using the drill casing as permanent reinforcement, or by placing a smaller diameter permanent pipe inside the drill casing. Use of the drill casing for full-length reinforcement is typical only for micro piles founded in rock, where extraction of the casing for pressure grouting is not necessary. The length of the pipe sections used is dictated by the length of the drill mast and by the available overhead clearance. Casing sections are typically joined by a threaded connection, which is machined into the pipe. The reduced area of the threaded joint should be considered in the structural design of the pile, particularly for the capacity in tension and bending. Methods exist for reinforcement of the threaded joints that can provide a strength equivalent to the full casing section

1. CONTRACTOR SET UP

- Review Drawings, Specifications, and Micro pile Work Plan
- Review Contractor schedule
- Inform Contractor of conformance testing requirements and frequency
- Discuss anticipated ground conditions and potential problems with Contractor
- Check overall condition of Contractor equipment

- Verify that drill hole locations are consistent with Drawings
- Review Contractor material storage area

2. DRILLING

- Prepare soil/excavation logs for each hole (confirm length of bond zone)
- Confirm stability of each hole and record specific methods used to maintain hole stability
- Verify final depth of hole
- If temporary casing is used, record casing type and length
- Record observations made during drilling
- Check tolerances (e.g., alignment of hole, angle of drilling machine)

3. REINFORCEMENT

- Verify bar size, length, and condition just prior to insertion into the drill hole
- Verify size and condition of bar couplers
- Verify installation (i.e., bar should be easily pushed to bottom of hole without interference)
- Verify location of centralizers (if required)

4. GROUTING

- Verify hole cleanliness
- Observe dry cement for indications of hydration
- Verify water/cement ratio and grout mix design
- Verify that all grouting equipment (pumps, gauges, hoses, etc.) are in good working order
- Record grout volumes and grout pressures for each micro pile
- Observe quality of grout at ground surface (i.e., when hole is full of grout)
- Collect grout samples / perform required conformance testing
- Verify pay quantities
- Record load test data
- Report unacceptable load test results to Engineer
- Complete required forms (micro pile installation logs, grout records, etc.)

Economics of Micro piles

The lineal cost of micro piles usually exceeds that of conventional piling systems. Access, micro piles will likely not be a competitive solution.

Care should be taken to clearly define the true final cost of a solution based on micro piles. Cost analysis should be based on all related costs for the entire project and not just the unit cost of the piling system. As with other pile systems, it would be beneficial to consider micro pile costs in terms of Rs/kN of axial capacity when evaluating deep foundation alternatives. Micro pile costs are associated with:

- right-of-way acquisition;
- right-of-way agreements;
- utility realignment;
- excavation, shoring and backfill requirements;
- footing construction;
- hazardous material handling;
- dewatering;
- erosion control;
- access restrictions;
- ground improvement; and
- Owner and neighbor disruption.

IV. ADVANTAGE OF MICRO PILING :

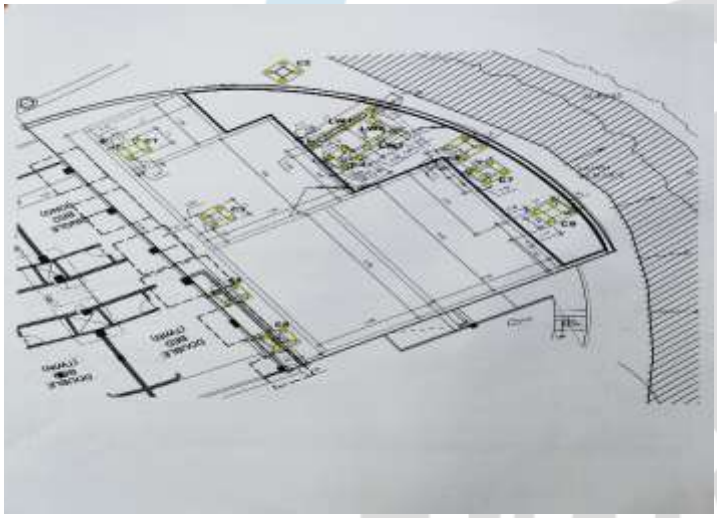
The main advantage of a micro pile is its ability to work in very congested and low height areas and on any soil surface irrespective of its type. Micro piles are best suited for piling, retrofitting & underpinning works, slope protection, soil stabilization, etc.

V. MATERIALS USED FOR MICRO PILING :

Micro pile System & Accessories for Shoring and Piling Works
Dywidag bar with 32 mm ø and locking nut
Micro pile plate thickness 40 mm ø
Cement grout mixture (per batch):
2 bags cement = 100 kg
50 liters water = 50 kg
50 to 80 liters of sweet water depends on the ambient temperature
W/C ratio = 0.50
Design compressive strength of the grout at 28 days = 30 N/mm²

No of piles=45 piles
Total time required for completing the task=1.5 month with all necessary strength
Estimated Budget=20-30 lakh (Including back propping, debris removing)

I. DRAWINGS:



1.2 Plan

II. ACTUAL EXECUTION AT SITE PICTURES:

2. Pilling

3.RCC Cutout done complicated area

4. RCC Cutout



Methodology

Micro piles are installed in order to reduce the bending moment and thereby reduce deflection on the wall top. Loads on each pile and its dimensioning are made as elaborated in the design.

Generally, the sequence of installation of micro piles involves the following activities:

- Drilling of boreholes by rotary drilling (Klemm machine)
- Supply and mixing of cement mortar(RMC)
- Installation of 50 mm ø Dywidag Bar
- Grouting of drill holes
- Testing of micro piles (1 preliminary test on non-working pile & 1 proof load test on working piles)

Working Platform

Drilling of the micro piles will be carried out from the level approx.10m from ground surface as the Dth crawler machine is allowed to stand on the slab level drawings .The working platform shall be prepared to allow the unhampered and continuous movement of the drilling machines. The working platform shall be maintained in a dry and stable condition.

Construction Sequence

Drilling of Boreholes

From the working platform level, the anchor drilling machines, KLEMM machine and/or UBW drilling rig, will drill the micro pile boreholes. All drilling works shall be performed from a dry and stable working platform and in a manner that effect on adjacent structures, foundation, and services, if any, shall be minimized.

The boreholes will be pre-cored through the capping beam with reservation pipe sleeves.

Where micro piles are to be drilled in the capping beam, sleeve pipes shall be pre-installed in the capping beam to the required inclination. The boom of the anchor drilling rig will be adjusted to the required inclination for the drilling process.

The drill bits are attached to drill rods required for the drilling. Drilling will be supported by water flushing technique. In steps of 80 cm, the drilling rods will be extended until the length of the micro pile is reached i.e 15 mtr.

In the event that soil conditions as described in the borehole logs are differing from those encountered on site, the Engineer will be notified accordingly and adjustment of drilling tools and flushing technique as well as parameters of anchorage will be re-considered. The process is to be understood that the first drilling rod is provided with teeth and drill head for loosening the materials, while water is pumped simultaneously through the drilling rods for transportation of the loosened material. The loosened material, mixed with water, will flush out along the side of the rods at the cored location. A trench should be prepared to contain the drilling water.

A. Rebar Installation
When the required depth/length of micro pile is reached, the machine is de-coupled from the drilling rod. The Dywidag bars (with a plastic spacer to maintain the centricity) are then inserted into the rods over its full required length. Approx. 1.5-2.0m of the rebar is exposed outside the ground (projected/free length) for the tensioning purposes.

B. Application/Injection of Grout
Grouting
When the anchor tendons are installed, again the KLEMM machine is coupled to the rods and a grout mixture (water-cement mix) is pumped via the rotary drive over the full length of the rods. While the grout is being pumped into the borehole, the drilling rods are also simultaneously being extracted in steps of 80 cm accordingly, the void around the anchor tendons is filled with grout.

C. Sequence of Micro pile Drilling/Installation
The above steps are to be followed for all micro piles taking into consideration that no drilling is to be done for 2 piles next to each other. Micro pile drilling will be performed in a staggered way (i.e. installing one micro pile and leaving the pile next to it then installation of the subsequent pile. The micro pile in the middle between 2 installed previously shall be drilled after a minimum of 24 hours).
V.2.5

D. Protection of Micro pile Heads
After the testing of reinforcing bar (for PTP only), the rebar will be cut and the head will be applied with grease for protection from the weather elements.
V.3

E. Micro piling Records, Drilling, Testing & Tensioning
The frequency of tests shall be in accordance with the requirements of IFC Drawings.
Drilling of Micro pile shall be carried out as per approved shop drawings.
One preliminary test on the non-working pile (200% x Working Load)
One proof load test on the working pile (150% x Working Load)
Three grout cubes for each micro pile will be tested for its compressive strength (1 for 7 days & 2 for 28 days)
Working Load = 297 KN (Type 17) and 418 KN (Type 18)
The Engineer shall be given at least 24 hrs notice before the installation of micro piles and tension test.
Tension Test Report
Tension test will be recorded for every 1 minute, at 10%, 100%, 150% & 200% of working load prior to off-loading (see Appendix E).
where: WL = Working Load