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"STUDY OF MICRO-PILES SUBJECTED TO LATERAL LOADING AND OBLIQUE PULL" REVIEW

Deepak Hooda[1], Anupam Mittal[2]

Master of Technology Scholar Department of Civil Engineering, NIT Kurukshetra, (India)

Professor, Department of Civil Engineering, NIT Kurukshetra, (India)

ABSTRACT

Micro-pile is another type of pile which acts as a supporting structure to transfer the load from building to the ground. As the name implies, Micro-pile is small diameter pile constructed by the drilling process and is often keyed to the rock. Capacity varies depending on the micropile size and sub-surface profile. Vertical piles are used in foundations to take normally vertical loads and small lateral loads. When the horizontal load exceeds the permissible bearing capacity of vertical piles in that situation piles with inclination are provided along with vertical piles. Mainly the micro piles are used for two purposes as structural reinforcement and in-situ reinforcement.

This paper will give the idea about the effect of inclination, length to diameter ratio on the load capacity of micro piles.

Key words: Micro-pile, L/D ratio, Lateral load, Load capacity

I. INTRODUCTION

Micro-pile is another type of pile which acts as a supporting structure to transfer the load from building to the ground. As the name implies, Micro-pile is small diameter piles constructed by the drilling process and are often keyed to the rock. Micro-pile also known as minipile is deep foundation element constructed using high strength, small diameter steel casing or threaded bar. Capacities vary depending on the micropile size and subsurface profile. There is various diameter of micropile can be found in the market ranging from 100mm to 250mm length between 2 to 3m and 300 to 1000 KN in compressive or tensile service load , although far greater depths and much higher loads are not uncommon.

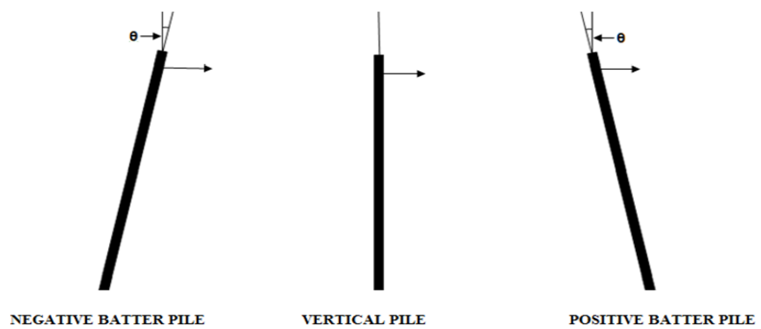

Figure1: Vertical and batter piles

Vertical piles are used in foundations to take normally vertical loads and small lateral loads. When the horizontal load exceeds the permissible bearing capacity of vertical piles in that situation batter piles are used in combination with vertical piles. Batter piles are also called inclined piles. The degree of batter is the angle made by the pile with the vertical. If the lateral load acts on the pile in the direction of batter, it is called an in-batter or negative batter pile. If the lateral load acts in the direction opposite to that of the batter, it is called an out-batter or positive batter pile. Mainly micro piles are used for two purpose namely structural support and in situ reinforcement. As structural support it can be used for underpinning of distressed historical monuments, seismic retrofit mainly in congested and low headroom areas resisting uplift dynamic loads. As in situ reinforcement it can be used for slope stabilization, for arresting structural settlement, excavation support in congested areas and as retaining structures. Micropiles are used for retrofitting and rehabilitating existing foundations due to their ease of installation. Micropiles are also used to increase the overall capacity and to reduce deflections of existing foundations subjected to compression and uplift forces. Micropiles can be advantageous for construction in seismic areas, mainly due to their flexibility, ductility and capacity to withstand extension forces. Micropiles are also used to support the foundations of both new structures and existing structures which have suffered seismic damages.

Strengthening of foundations of existing buildings in earthquake prone megacities and addition of new floors to existing buildings due to sky- high land values in big cities, usually need excavation and temporary support system below the foundation level. This is difficult not only due to limited head room and access in congested area but also for the risk of collapse of the structure during the excavation process itself. Moreover, underground spaces need to be utilized for alternate modes of transport. Micropiles may be used economically in such situations. Micropiles are small diameter (less than 300 mm) grouted drilled pile. The grout is either placed or injected under pressure (grouting pressures above 0.8 to 1 Mpa). It consists of a continuously threaded hollow reinforcing tendon as a load carrying steel member together with a grout body of furnace (Portland) cement which allows transfer of tension and compression forces mainly from the friction of the threaded tendon via the grout body into the surrounding soil. Due to high pressure grouting there is insignificant shrinkage between the pile and the soil. The penetration of the fluid part of the cement mix into the surrounding soil creates a transitory zone between the body of the micropile and the soil leading to a strong grout/ground bond. Due to this reason ultimate load carrying capacity of micropile is higher than anticipated capacity based on conventional bearing capacity theory.

Micropiles are typically used for structural support. It is usually installed for bridge and building foundations supports and seismic retrofits. Another main application of micropile is soil reinforcement e.g. slope stabilization/earth retention projects. The basic philosophy of micropile design differs little from that required for any other type of pile. The system must be capable of sustaining the anticipated loading conditions with the pile components operating at safe stress level and with resulting displacements falling within acceptable limits. For conventional piling systems, the large cross sectional area results in high structural capacity and stiffness, hence the design is normally governed by the geotechnical load carrying capacity. Due to the micro piles small cross sectional area the micropile design is more frequently governed by structural and stiffness considerations.

The emphasis on structural pile design is further increased by the high grout to ground bond capacities that can be attained using pressure grouting techniques.

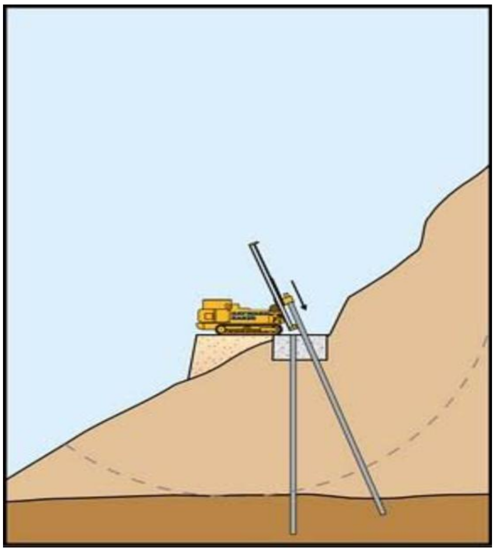

Figure2. In-Situ Reinforcement

II. BRIEF REVIEW OF LITERATURE

Micropile technology, application and soil micropile interaction are reported in literature by various research workers. [Schlosser and Juran(1979), Lizzi(1983), Soliman and Munkoph(1988), O Neill and Pierry(1989), Ting and Nithiraj(2000), Bruce et. al. (1995) completed a major study of micropile technology that was funded by FHWA. Benslimane et. al. (1998) reported about a series of centrifugal tests conducted on micropile group and network system embedded in loose to medium dense dry sand. Seismic retrofitting by micropile method was described by Nishitani et. al. (2002), Yamana et. al. (1990) conducted lateral and vertical load test on micro-piles.

In India too the use of micro-piles was found effective. Deshmukh and Ganpule (1990) in their paper highlighted the salient features of design, construction and performance of micro piles in Bombay region. Nayak and Ketkar (1992) reported that Asia Foundation Consultancy (AFCONS) in Mumbai have underpinned eleven structures in a single complex using micro piles of 150mm diameter . O Neill M.W.R.F Pierry(1989) reported about behavior of micropile in Beaumont clay in Houseton. Dideck (in 1989) presented a case history of construction of minipiles to support an intake tower at fault zone near Mukakuning dam. Benslimane, Hanjuran, Sherif Hanna, Drabkin(1998) reported about a series of centrifugal test conducted on micropile group and network system embedded in loose to medium dense dry sand.

Systematic investigation on the qualitative and quantitative influence of parameters such as embedment length to diameter ratio, spacing and soil friction angle on ultimate horizontal resistance are practically scanty. Research work is necessary to understand the behavior of single and group of micro-piles subjected to horizontal loads. Piles are commonly used to transfer vertical forces, arising primarily from gravity. Examples of structures where piles are commonly used as foundations are tall buildings, bridges, offshore platforms,

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defense structures, dams and dock structures, transmission towers, earth retaining structures, wharfs and jetties. However, in all these structures, it is not only the axial force that the piles carry; often the piles are subjected to lateral forces and moments. In fact, there are some structures where the primary function of piles is to transfer lateral loads to the ground. Wind gusts are the most common cause of lateral force (and/or moment) that a pile has to support. The other major cause of lateral force is seismic activity. The horizontal shaking of the ground during earthquakes generates lateral forces that the piles have to withstand. Certain buildings are also acted upon by lateral earth pressures, which transmit lateral forces to the foundations. That apart, depending on the type of structure a pile supports, there can be different causes of lateral forces.

Experimental procedure

MODEL PILES & PILE CAP

The present work consists of a model experimental study on single micropile having different L/D ratio installed in sand beds. The micro piles were subjected to lateral loading conditions. Influence of embedment length to diameter ratio (L/D), influence of relative density on the ultimate lateral load, mode of failure of the piles and influence of relative density were investigated. Investigation on single and group of micro piles having different L/D ratio subjected to lateral loads were also done.

III. MEASUREMENT OF LOAD AND DEFLECTION

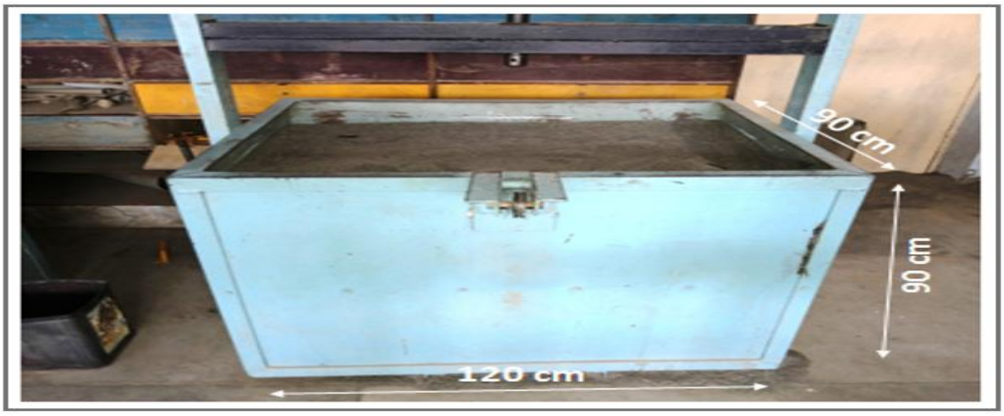
The tank used in test with pulley arrangement for applying lateral load is shown in Figure below. The dimension of the testing tank was kept large enough to avoid the boundary effect. The testing tank used was rectangular and had a length 120cm, width 90cm, height 90cm.Thickness of G.I. Sheet of testing tank was 4mm. The soil was filled up to 80 cm height from bottom of testing tank.

After driving required number of piles at the required spacing and inclination, the top of pile group was connected by pile cap. Now the free end of wire was attached gently to hook of the pile cap. The other end was attached to hanger and the wire passed over the pulley was attached at the outer part of the testing tank. A dial gauge was attached to the bottom of the hanger to note down the horizontal deflection of the pile group. Before the application of load reading on the dial gauge were noted. This is the initial reading and note down the readings after every application of load. The difference of these reading gave the horizontal deflection of pile or group of piles. The load on the hanger was increased in steps (2 kg each time for test series 1 to 14 and 4 kg each time for test series 15 to 18).

The increment of the load was applied up to the point till total horizontal deflection of group of piles exceeded 10-15 mm. After this, load was brought back to zero in similar steps. Correspondingly readings of dial gauges were noted. The reading of dial gauge was noted only after it had attained a constant value.

Properties of Sand

S. No.	Property	Value
1.	Effective Size	0.130mm
2.	Uniformity Coefficient	2.00
3.	Coefficient of Curvature	3 .98
4.	IS Classification	SP
5.	Mean Specific Gravity	2.68
6.	Minimum Dry Density	1.45gm/cc
7.	Maximum Dry Density	1.70gm/cc
8.	Minimum Void Ratio	0.55
9.	Maximum Void Ratio	0.81



TESTING TANK

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