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Analysis of Laterally Loaded Pile by Experimental Approach

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ABSTRACT

This paper study the lateral behavior pile. The pile foundation commonly used to support load that are sufficiently heavy and laterally loaded structure. The laterally loaded pile shows initially linear deflection forwarded by curvilinear behavior. The pile is tested for sand soil and the properties of sand is evaluated in laboratory. In this work, we are performing test on circular cast iron pile deeply embedded in sand. The load versus deflection graph has forwad period upto many periods to get trend of failure.
Keywords: Pile Foundation, Sand, Dial Gauge, Load, Sieve Analysis.

I. INTRODUCTION

Generally, high vertical loads and small lateral loads are carried by pile foundation. Pile foundation is provided where soil bearing capacity is low and loads are high. Vertical piles are provided for sustaining the high axial loads and small lateral loads. Lateral loads play vital role in offshore structures and it can be 30% of the vertical load, whereas in case of onshore structures it is around 10-15%. It can be applied by wind, waves or both in offshore structures. In case of onshore structures lateral load can be applied by means of earth pressure in retaining wall, traffic loading on a bridge pier etc. During floods high lateral loads are applied by means of trees, soil and other material flowing through water. In such case where lateral loads increases batter piles are preferred because of their high resistance towards lateral loads. So while designing the foundation for these types of structures the effect of lateral loads should never be under estimated. Small scale model tests are generally preferred because full scale model test turns out to be costly and time taking. However, in small scale model test number of parameters can vary according to the researcher’s requirement. The objective of this study is to compare the efficacy of the vertical piles with batter piles. The “p-y” method is one of the most popular and widely used approaches for understanding the behavior of laterally loaded piles. This is a subgrade reaction technique, where p is the mobilized soil resistance and y is the deflection of the pile. The p-y method for sands was developed by Reese, Cox and Koop (1974). The p-y approach has been used by various researchers in different soils i.e. sands (Reese et al., 1974; Wessel ink et al., 1988), silts (e.g., Reese and Van Impe, 2001) and clays (e.g., Matlock, 1970; Reese and Welch, 1975). Most of the studies were performed under monotonic lateral loads. Initially the method was proposed for single piles but later it has also been used for the pile groups using the p- multiplier concept. The software used for the study is LPILE which works on the principal of finite difference method. The program use p-y curve method for solving laterally loaded pile problems

II. METHODS AND MATERIAL

Model tests were conducted in the laboratory to determine the pile behavior under lateral loading condition. The results of the tests were then compared with the results of PLAXIS software. The piles were properly scaled out so that its behavior can be used on the field. Tests were conducted on single piles in sand.

Sand

Locally available sand was used as a foundation for the tests. The intrinsic properties of used sand are reported in Table. The sand bed was prepared using rainfall technique. The falling height of the sand from the container was kept constant throughout the experiment. The average dry density of the sand was 16.5 kN/m^3. The interface was developed between the pile material and sand, so the angle was calculated using direct shear test. The sand was classified as poorly graded sand (SP) according to unified soil classification system (USCS).

Model Pile

The piles were modeled using scaling laws proposed by Wood et al (2002). The scaling factor for the pile was 1/16. Mild steel piles having an outer diameter 20 mm and internal diameter 18 mm were used. The piles with different slenderness ratios were adopted i.e. 18, 28, and 38 to understand the behavior of short, intermediate and long piles at a relative density of 60%. The bottom of the pile section was made conical (60 angle) which helps in smooth driving of piles and also prevents entering of sand into the pile.

Pile Caps

Pile caps were also made up of the same material as used for piles i.e. mild steel. Since, the tests were not only conducted on vertical piles, the pile caps were also fabricated with different angles such as 15, 25, and 35. The pile caps having size of 90 x 90 x 35 mm and weight 7.45 N were placed and the piles were then inserted.

Model Tank

The tank was first modeled according to the piles and pile caps and then fabricated accordingly. The maximum length of the pile was 760 mm and Outer diameter 20 mm. According to (Matlock and Rao) to avoid the boundary effect minimum distance from the periphery of the pile to the tank should be 8 to 10 times the diameter of the pile for lateral loads. So, the size of the tank was kept as 1.1 x 1.1 x 1m and was made of mild steel sheet of thickness 2 mm. Lateral load arrangement was provided on the tank.

Test setup and loading arrangement

Static lateral load tests were conducted on vertical and batter piles using the test setup as shown in figure 1. Dead loads were used for applying static lateral loads on the piles. Static lateral load was applied by means of GI wire, one end of which is connected to the pile cap and other end goes from pulley to the loading frame. Weights were added and displacement of the pile was measured using Dial gauge. The applied load was measured using the load cell.

Filling of tank and Pile Installation

Rainfall technique was used for filling of the tank. Sand was poured in tank from a height of 450 mm and was kept constant for all tests. Sand was filled in layers of 50 mm and was leveled after each layer. Initially sand was poured up to a depth of 300 mm from the bottom of tank. The relative density for each test was kept 60%. A marginal variation of 2% in the density was observed. The density of the sand was checked by placing cylindrical containers of known volume at different places in the tank. Pile was inserted in the pile cap and was placed in position where load can be applied. Same technique was used for filling the remaining portion of a tank. The top 50 mm of the pile was kept above the sand bed so that the wire remains horizontal while applying load.

III. RESULTS AND DISCUSSION

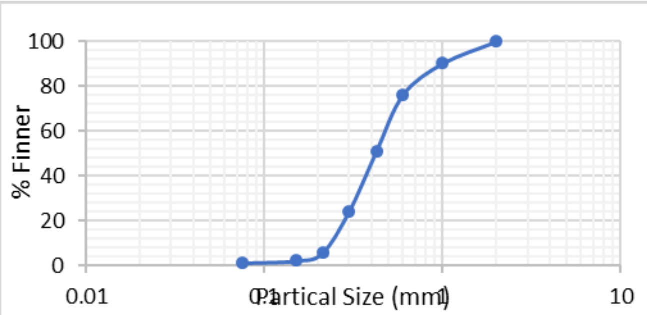
The various test were conducted on the sand that we had used.

The index property of Sand Indian Standard

Table 1

Property	Values
Unit weight (kN/m³) min	15.02
Specific gravity (G)	2.64
Coefficient of uniformity, Cu	1.91
Coefficient of curvature, Cc	1.24
D10	0.24
D30	0.37
D60	0.46

Sieve Analysis results

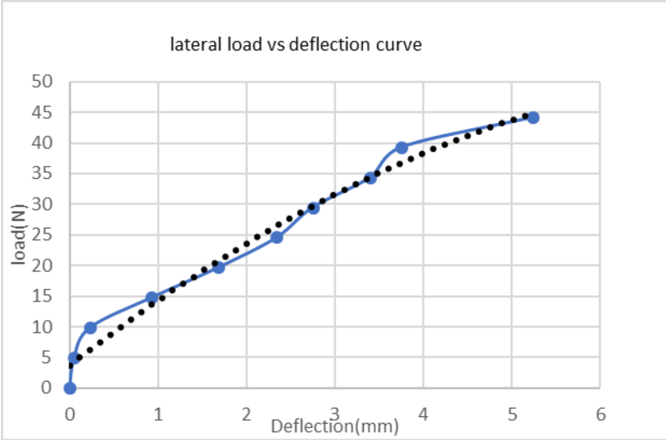


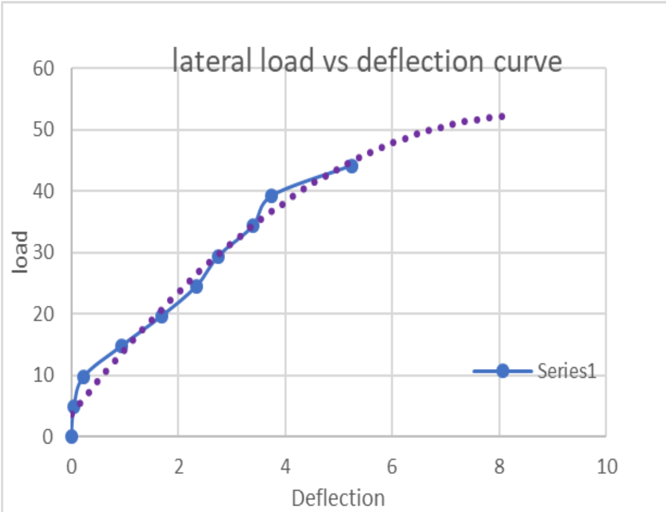
Results of pile testing against lateral load

Pile Diameter - 25cm
Pile Length - 60cm

Table 2

Sr. No.	Load (kg)	Load (N)	Deflection (Division on gauge)	Deflection (mm)
1	0	0	0	0
2	0.5	4.90	0	0
3	1	9.81	23	0.23
4	1.5	14.75	92	0.93
5	2.0	19.62	168	1.68
6	2.5	24.52	234	2.34
7	3.0	29.43	275	2.75
8	3.5	34.335	340	3.4
9	4.0	39.24	375	3.75
10	4.5	44.145	524	5.24





IV. CONCLUSION

The laterally loaded pile shows the load versus lateral deflection straightforward nature. The initial linear portion of graph is followed by non linear behavior. The slope of load versus deflection reduces as load increase this behavior will help to find out lateral load carrying capacity of pile.

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