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Response of Pile Group against Cyclic Lateral Loads

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ABSTRACT: The destructive earthquakes, environment prevalent in ocean demands the supporting structures here piles to be designed against cyclic latereal loading by wave action, wind action and seismic action due to this kind of loadings especially cyclic lateral loadings causes the foundations to reach its most critical condition by inducing large deformations, decrease in strength, bearing capacity and stiffness of soil. The effect of cyclic lateral loads on group piles is understood by carrying experiment using model test set-up and the cyclic lateral loading effect is established using hydraulic rams this paper presents the observations and conclusions drawn from them.

KEYWORDS: Pile group, Cyclic lateral load, Soil, pile test, response.

I. INTRODUCTION

The study on pile groups and their response has been subjected to several studies in the past decades. Cyclic lateral force is the most critical state in the soil foundations. It is mainly due to seismic loading. The Primary objective of the research reported herein was to observe the mechanism of lateral loading in pile groups and to advance the state of design-level practice for laterally loaded group of piles, with a special focus on extreme Event loading by utilizing and improving upon the current concepts that were described in The previous journals. Design and performance of pile group foundations under lateral loading conditions, such as ship or ice impacts and earthquakes is the key concern of civil engineers. Piles can reach deeper bedrock and strong soil to provide sufficient resistance. Many previous studies have led to sufficient data and understanding of the axial response of pile groups to dynamic loads but the predictions of response of pile group against lateral response remains questionable from many decades. The reason for this may the complexity in the behavior of the soil against Lateral loads such as wind loads, seismic loads and offshore waves loading. And more specifically in the events of lateral cyclic loads the soil behavior is most unpredictable and it depends mostly on the structure, type of soil and the system pile foundation used at a specific site. The predominant criteria of group action of piles against cyclic lateral loads is pile-soil interaction, spacing of piles, number of piles etc... The document herein reports the behavior of soil mass and pile group against cyclic lateral loads and relevant conclusions drawn from the experiment. The experiment on pile group is carried out by A model set-up utilizing Hydraulic rams.

II. RELATED WORK

Robb Eric S. Moss (1998) investigated on model group of piles and observed non linear increment of maximum bending moment with increase of cycles and presented normalized curves which represent some dimensionless quantities

Kevin J. Bentley (1999) presented some empirical methods like Winkler and some scientific approaches like finite element methods to analyze behavior of pile foundations thoroughly and also presented clear-cut information about Soil-Structure Interaction

D.A. Brown (2001) Developed a better way of understanding the soil is modeled, including the effects of pile-soil-pile interaction in soft ground

Federation of Piling Specialists (2006) provides handbook which guides on issues related to enable perfect planning and execution of pile tests thereby increasing accuracy.



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S. Basack (2010) have done considerable investigations on vertical pile group subjected to horizontal cyclic load in soft clay. From his experiments, it was observed that the ultimate cyclic load capacity of pile groups and the other degradation factors decreased with number of cycles.

Spyros Giannakos, Nikos Gerolymos (2012) prepared a soil model for the static and cyclic loading conditions response of piles which are embedded in cohesionless soil was presented. And it is Materialized into a threedimensional finite element code, the model predictions were compared with experimental results of a single pile in dry sand,

III. PROPOSED METHODOLOGY AND DISCUSSIONS

EQUIPMENT AND INSTRUMENTATION:

The Major equipment and instruments used in our test are:

- 1. A model test facility
- 2. Large steel tank
- 3. Model pile group
- 4. Strain gauge
- 5. Hydraulic rams
- 6. Pile cap
- 7. Test -ring

The model test facility consists of large steel tank, approximately 4 m by 1 m in top view and 1.5 m high. This tank was lined with a geo-fabric membrane. Soft clay was placed into the tank in slurry form and then consolidated using hydraulic rams pushing on steel plates overlaid on the clay was consolidated upto an average undrained shear strength of 60 kPa. The important note in the test is the clay was maintained in a saturated state throughout the testing. The pile group is composed of five piles arranged linearly as shown in Fig.1 A pile cap is placed over them. The spacing of the pile is 4d. The piles are fabricated from aluminum pipes with diameter 40mm and thickness of walls is 10 mm. 12 pairs of Strain guage load cells were attached on the pile to measure load distribution between each pile and also the hydraulic rams were mounted on the pile cap such that they are horizontal to the plane .Apart from that a digital setup which gives real time values of load, slope and deflection of pile cap, bending stresses and maximum stress in each pile.



Fig.1 Model test set-up

Testing

The test is conducted on the pile group and the model set-up is shown in the above figure. The pile group was laterally



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loaded from 0 to 2000 N and back to zero in approximately 1 min and the cyclic lateral load effect is established using hydraulic ram ,the arrangement is as shown in the Fig.1 . The system records the readings, continuously for each cycle .The readings are observed and the results and conclusions are drawn those are given in the following chapters.

Risk factors and safety considerations

Safety must be always considered in the planning and execution of tests on pile groups, which includes the following

- Preparation of soil
- Maintenance of Test Area
- Lighting
- Load application limits
- Site operative instructions

The table below gives the risk level is related type of works.

Table 1 Risk level of works

Characteristics of work	Risk level	Pile testing strategy
Unknown ground conditions.	High	Both preliminary and model pile tests are required. 1 preliminary pile test per 3piles. 1 model pile test per 5 piles.
No previous test pile data. Limited experience of piling in similar ground.	Medium	Both preliminary and model pile tests are required. 1 preliminary pile test per 1 piles. 1 model pile test per 5 piles.

IV. EXPERIMENTAL RESULTS



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Fig.3 Variation of deflection with lateral cyclic load

The expected maximum bending moment and deflection in the aluminum pile can then be predicted. These results are only valid for similar soft clay.

The variation of deflection of pile top is quite linear and predictable when tested on soft clay the results may not be same when tested on other soils.

V. CONCLUSION

The research project is to improve design of deep foundations on soft clays which can tolerate cyclic lateral loads by using model testing in which the response of pile group to cyclic lateral loads. The primary phases of the testing have been completed and the response of pile group against bending moment and deflections are Non linear and unpredictable former but after considerable cycles let us say about 1000 they seem to be predictable and on the whole the results are promising that we can design a full fledged pile group which can resist major cyclic lateral loads on further investigations.

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BIOGRAPHY



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