International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 01 | Jan 2021 www.irjet.net p-ISSN: 2395-0072

LOAD CARRYING CAPACITY OF UNDER-REAMED PILES: A REVIEW

Ritu Bala[1], Parveen Kaur[2], Abhilash Thakur[3]

[1]M.Tech Scholar, Civil engineering, Sant Baba Bhag Singh University, Village Khiala, Padhiana, Punjab.
[2,3] Assistant Professor, , Civil engineering, Sant Baba Bhag Singh University, Village Khiala, Padhiana, Punjab.

Abstract - *In deep foundations, under-reamed piles are useful methods to improve the bearing power. Their roots have several swollen bases. They are ideal for soils that, because of seasonal moisture fluctuations, are frequently prone to major ground movements. In the implementation of these piles, group structure is also a productive parameter. Under-reamed piles are bored cast in-situ concrete piles with one or more bulbs created by enlarging the pile stem. They are used to improve compressive pile tip strength and tensile pile bearing power, so they have advantages over uniform diameter piles. The bulbs may be supplied where substantial bearing or anchorage is accessible at desired depths. In this article, traditional methods for measuring the load bearing potential of the under-reamed pile are compared and the most efficient and accurate approach is found.*

***Key words**: Under-reamed piles; Driven; Contact with soil structure; Ability for load carrying.*

1. INTRODUCTION

Foundations are the most essential aspect of any system. A house, highway or a dam may be the structure. It is said to be a structure's foot. When planning the foundations, one must be extremely cautious for it is very difficult to modify them once installed. The foundation can be an extended base of a wall or a pier, including the supporting land or subsoil.

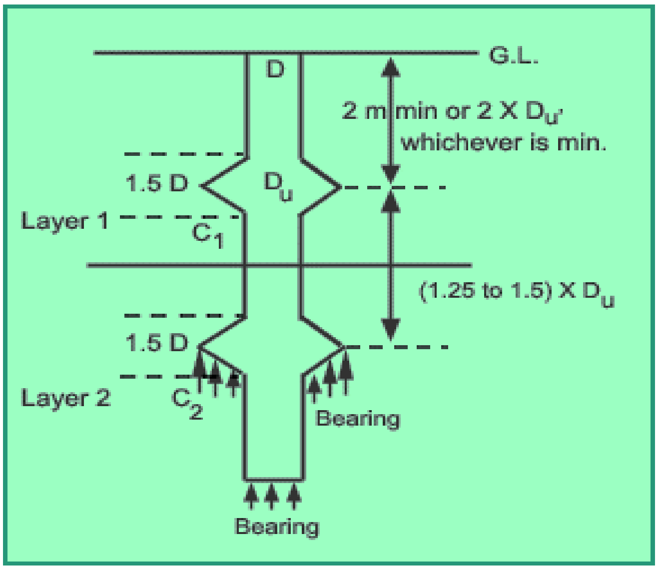

Figure 1 Structural diagram of under reamed pile

If the base stands directly on the hard subsoil, it is considered to be a 'Natural Base' and it is called 'Artificial Foundation' when any artificial arrangements are made in the form of concrete framework, piles, raft, etc.[1-2] The design of the under-reamed pile- beam is identical to that of belled piers. Under-reamed piles have been thoroughly studied and planned for use under Indian conditions by the Central Building Research Institute, Roorkee (CBRI).

A bored cast-in-place concrete stack with a few bulbs or sub-reams in its lower section is the under-reamed stack. The bulbs are created by the reaming tool. The batteries underneath are usually 20 cm to 50 centimetres in diameter and the cell diameter is between 2 to 3 times larger. Base piles are about 3 m to 8 m in length. Piles can be sized between 2 m and 4 m. The bottom piles can also be used with a high water table for sandy soils.

1.1 Advantages and Disadvantages of Under-Reamed Piles

Table 1 Advantage and Disadvantages of Under-Reamed Piles

S.no	Advantages	Disadvantages
1.	This reduces the vertical settlement and even the settlement of discrepancies.	Under-Reamed Piles are not ideal for waterlogged soil at a depth where the composition of the soil varies with a climatic condition, since they pick up load by friction.
2.	It is used because, due to moisture variation or the abundant nature of the soil, the soil begins to expand and shrink.	During building, these piles require stringent quality control and regular monitoring.[4]
3.	The value of having under-reams or bulbs is that the bearing and uplift capacities are improved.	The Under Reamed Piles are most commonly powered manually by a hand-operated pump.
4.	The load bearing capacity of the Under-Reamed Pile is increased when the number of bulbs is raised from one to two. In Under-Reamed Stacks, the supply	It is also very necessary to preserve the pile plumb, since if they are not in the plumb, the entire load transfer process will

	of bulbs is of particular benefit in avoiding uplift and they can be used as anchors.[6]	shift.

1.2 Properties

By following stacks or a greater diameter or by extending the length of the batteries or by creating more lamps, the load size under reamed piles may be increased. Usually, one or two bulbs can be found under the ream pile. If two or more bulbs are supplied at the root, the lamp is known as a multi-amp. There are 1.25 to 1.50 times the diameter of a filament in the longitudinal space between two lamps.[8]

A summary of the study of the various methods of assessing the load carrying capacity of the non-expansive layer under-reamed piles surrounding the swelling soil. For heavy structures where the lateral load working on the pile is treated as marginal, the piles under vertical load are often used[11]. The application of the pile is a must where the plies are under uplift load for systems where lateral load has meaning. For the stability and protection of the building, these piles are very useful and the advantages and disadvantages under reamed pile is shown in table 1. By skin friction, these piles bear the load. Depending on the uplift resistance to be borne by the piles for the stabilization of the system, the piles can be supplied as an individual unit or they can be supplied as a group.

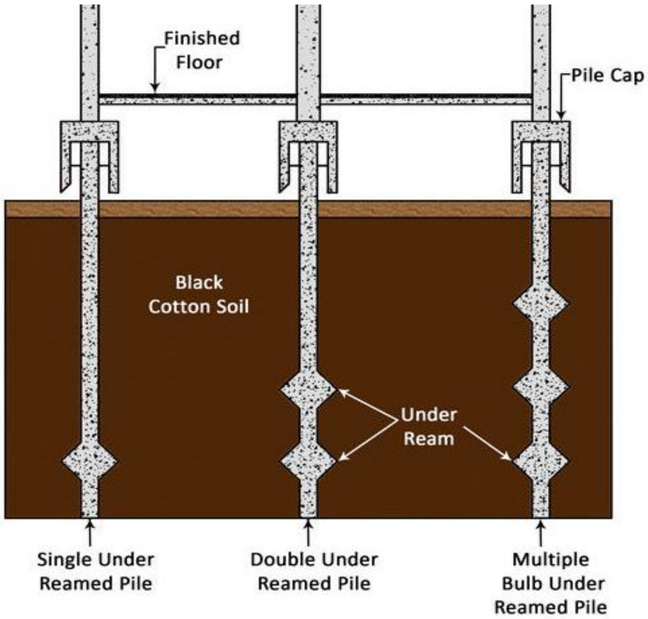

Figure 2 pile with bulb underground

The present paper seeks to analyse a single and group several piles of varying cross - sections by numerical simulation technique in order to describe its load carrying capacity and to clarify its behaviour[26]. The pile foundations are used to carry and transfer the construction load to the supporting field placed some distance below the ground floor, which is also known as the structural elements. The main components of the base are really the pile cap and the piles. Piles of long, slender members transfer the strain from the shallow soil of lower load towards deeper soil or rock of high load potential[13,19]. They are often used to resist uplifting forces in normal soil conditions or to resist lateral forces in weak soil conditions.

Most of the piles are made of timber, steel and concrete, the three major types of material. Normally, piles are guided, drilled or jacked into the earth and attached to pile caps. A analysis of related previous studies reveals that not much research has been done to describe the uplift potential in cohesion less soil, a problem frequently encountered in the field, based on a variety of laboratory model findings, several researchers documented the uplift response of piles in cohesion less soil[20,21,22]. The paper observed that the overall uplift capability depends on less soil, the depth ratio of embedment and soil thickness ratio of the relative undrained/drained shear power of cohesion.

2. LITERATURE REVIEW

Pile foundations are typically used to sustain super structural compressive loads. Any buildings, such as high chimneys, transmission towers and jetty structures, are vulnerable to wind-imposed overturning loads. In such situations, to withstand uplift forces that are far greater than the weight of the structure itself, piles are required. In addition to the wind, wave forces and line stress are hit by coastal systems and transmission line poles. Via friction between the pile shaft and the underlying soil, straight shafted piles maintain their resistance to uplift[7,9]. The bottom of the piles may be strengthened by under-reaming or belling down.

Majer, et al. one of the first scholars, assumed that a vertical slip surface above the anchor is the loss mechanism. The uplift power, according to him, is efficiently the total soil load just above anchor and the shear resistance around the perimeter of the vertical slip surface.

Balla et al. studied with various hypotheses that a tangential curve was the sliding surface above small model anchors. The shallow foundation fault board, according to Balla. The tangent to the contact surface has been almost spherical in height, at an average of 90 (450-β /2) to the horizontal, in thick sand. Through taking on a circular course of failure, he achieved a fair connection between the hypothesis and the outcomes of full scale flawed experiments.

Mac Donald, et al. had conducted the model test on the sand. The diameter of the shaped cylinders was roughly 1,75 times its base diameter. Mac Donald's hypothesis assumed that the shallow case was not working is conically angled with an angle of inclination equal to half the internal friction angle. In the meanwhile, a deep failure case with a cylinder diameter of 1.75 times the base diameter was believed to be cylindrical. Sutherland, proposed a correlation between the unit uplift ratio and the footing depth to width ratio.

This observational non-dimensional relationship helped Sutherland predict the overall behaviour. Spence, B.E. Spence, investigated a hypothesis under which shear was only mobilized partly to the level of the ground on a cylindrical surface. The ratio of height and base diameter of the cylinder was constant with the ratio of depth to base diameter, taking maximum soil suction and weight into consideration. In the field testing on belled piers, Downs and Chieurzzi hold to the notion that the lifting power stems from the weight of the soil in a cone inverted over the bell, plus a pier self-weight. Meyerhof and Adams, based on their discovery in the laboratory model experiments, proposed a pyramid-shaped slip surface above the anchor.

Hooper et al. examined the behavior of the piled-up raft base in central London, supporting a tower block. The field observations carried out over the span of several years and the findings of a detailed finite element analysis are discussed. The investigation is carried out on the basis of a consistent raft load distribution.

The approximate proportion of load taken by piles and rafts is 60 percent and 40 percent at the end of the construction, based on field calculations. In order to increase the load transmitted by piles and to minimize the contact pressure from rafting, the long-term effect of the consolidation was found.

Potts and Martins considered the mobilization of shear stress on a rough pile shaft in typically consolidated clay in terms of effective stress acting on the clay. Predictions of stress shifts occurring in the soil are described next to the loading pile shaft and are well consistent with certain experimental results. The angle of the slip-surface of the reverse cone is equal to the vertical model¨,where the angle of friction indicated by Clemence and Harvey, who have carried out a range of laboratory models and anchor field experiments, have developed design maps to assess the anchor resistance.

Ovesen proposed a relationship for plate anchor elevation based on centrifugal model experiments. Sutherland performed a series of laboratory model experiments on anchors. On the basis of these measurements he concluded that the vertical slip angle of the reversed surface cone is influenced by the angle of friction of the earth and the relative thickness. Rowe and Davis could use a finite element analysis and elastic plastic model to assess the uplifting potential of horizontal anchors. Vermeer and Sutjiadi noted that the angle of friction between Murray and Geddes was similar to the angle of the soil.

The improvement in the base angle and diameter ratio, according to Dickin and Leung, results in a decrease in the net lifting capability and loss displacement. In a study on clay and silty soils, Gupta and Sandaram found that soil humidity around the bulb is almost liquid.

3. CONCLUSIONS

All soil shrinks on drying till the shrinkage limit is reached. They also swell if water is available to them when they are dry. In addition, there are special soil called expansive soils in which this problem is very prominent. Because of expansive nature soils, they do noticeable damages to buildings.

Under-Reamed Piles are bored cast-in-situ concrete piles having one or more number of bulbs formed by enlarging the piles stem. The piles are best suited in soils where considerable ground movements occur due to seasonal variation, filled up grounds or in soft soil level.

REFERENCES

[1] "Axial Load Tests on bored piles and pile groups in cemented sands", Journal of geotechnical and geo environmental engineering, 766-773.

[2] Arora, K.R., (2011), "Soil Mechanics and Foundation Engineering", Standard Publishers Distributors, Delhi.Brinkgreve,

[3] Braja M. Das (1983) "Principfles of Foundation Engineering", seventh edition, Global engineering publication..

[4] C. Y. Lee (2007) "Settlement and Load Distribution Analysis of Under-reamed piles", ARPN journal of engineering applied science, Vol. 2, No. 4, 35-40.

[5] Chattopadhyay and Pise, P.J. (1986), "Uplift Capacity of Pile in Sand", Journal of the Geotechnical Engineering Division ASCE. 112. No. 9 paper No. 20919.

[6] Clemence, C.P. and Brumund, W.F. (1975), "Large Scale Model Test of Drilled Piers in Sand", Journal of the Geotechnical Engineering Division ASCE. 101. GT.6.paper No. 11369.

[7] Das, B. M. (1983), "A Procedure for Estimation of Uplift Capacity of Rough Piles", Journal of Soil and Foundation Division ASCE. 109. No.3. pp. 122-126.

[8] Das, B. M. and Seeley, G. R. (1975), "Uplift capacity of buried model pile in Sand", Journal of the Geotechnical Engineering Division ASCE. 101. No. 20. pp. 1091-1094.

[9] Das, B.M., (1983), "Principles of Foundation Engineering", seventh edition, Global engineering publication.

[10] Dickin, E.A. and Leung, C.F. (1990), "Performance of Pile with Enlarge Base Subject Uplift Force", Canadian Geotechnical Journal. 27. pp. 546-556.

[11] Dickin, E.A. and Leung, C.F. (1992), "The Influence of Foundation Geometry on the Uplift Behaviour of Pile with Enlarge Bases", Canadian Geotechnical Journal. 29. pp. 498-505.

[12] Dilip Kumar Maharaj, J. Gayatri and D. Jayanthi (2004) "Uplift Capacity of Pile by finite element method", Electronic Journal of Geotechical Engineeing (EJGE), Vol 8, Bundle D.

[13] Fleming, K., Weltman, A., Randolph, M., and Elson, K., (2009), "Piling Engineering", 3rd Edition, Taylor and Francis Publication, 398 pages.

[14] Gupta, S., and Sundaram, R., (1986), "For which soil conditions are Under-reamed pile foundations superior to other foundations system", Expert paper, proc IGC, Vol II, pp. 131-133.

[15] Hamed Niroumand, Khairul anuar Kassim, et al. (2012) "Uplift Capacity of Enlarged Base Piles in Sand", Electronic Journal of Geotechnical Engineering (EJGE), Vol. 17, Bund R, P. 2721- 2737.

[16] IS:2911 (Part III)- 1980. Code of Practice for Design and Construction of Pile Foundation part III Under-reamed Pile.

[17] Joseph, E. B. (1996), "Foundation Analysis and Design", McGraw-Hill International Editions.

[18] K. Watanabe, H. Sei, T. Nishiyama and Y. Ishii (2011) "Static Axial Reciprocal Load Test of Cast-In-Place nodular concrete pile and nodular diaphragm wall", Geotechnical Engineering Journal of the SEAGS & AGSSEA, Vol 42, No. 2, 11-19.

[19] Krishna, M.N.E., (1992) "A case study of under-reamed pile foundation in expensive soil", (1) Journal Cu Vul.73q Nov. 1992P.P. 113-117.

[20] Kurian, N.P., and Srilakshmi, G., (2010), "Studies on Geometrical Features of Under-reamed piles by the finite element method", Journal of Karunya University, Volume 2, No.1.

[21] Lee, C.Y., (2007), "Settlement and Load Distribution Analysis of Under-reamed piles", ARPN journal of engineering applied science, Vol. 2, No. 4, 35-40.

[22] Meyerhof, G. G. and Adams (1968), "The Ultimate Uplift Capacity of Foundations", Canadian Geotechnical Journal. 5. No. 4. Nov. pp. 225-244.

[23] Mosher, R. L., and Dawkins, W.P. (2000), "Theoretical Manual for Pile Foundations", US Army Corps of Engineers, Engineer Research and Development Center, 92 pages. Esmael, N.F., (2001),

[24] Nabil F. Esmael (2001) "Axial Load Tests on bored piles and pile groups in cemented sands", Journal of geotechnical and geoenvironmental engineering, 766-773.

[25] Nainan P. Kurian and G. Srilakshmi (2010) "Studies on Geometrical Features of Underreamed piles by the finite element method", Journal of Karunya University, Volume 2, No.1

[26] R.B.J., et al. (2006), "Plaxis 3D Foundation manual, Version 1.5", Delft University of Technology & PLAXIS bv, The Netherlands.

BIOGRAPHIES

Ritu Bala is pursuing M.Tech in Civil engineering at Sant Baba Bhag Singh University. Area of interest is utilization of various waste in concrete.

Parveen Kaur, is working as an assistant professor . She has 5 year teaching experiences the area of interest is application of waste foundry sand as partial replacement of fine aggregate in concrete.

Abhilash thakur, working as an assistant professor he has 3 years teaching and 3years industries experiences, the area of interest is effect of partial replacement of sand by iron slag in concrete as strength development.