Effect of Depth on Pile Cap Performance

[1] Prof. Nilesh Bhopale, [2] Prasanna Varhade, [3] Jayesh Deshmukh, Pratham Thokal[4], Samaksh Chandure[5], Prathmesh Kubade[6]

[1]Asst. Prof., Department of Civil Engineering, P. R. Pote Patil Edu & W T ,GoI College of Engineering & Management, Amravati

bhopalenp@gmail.com

[2345]6 U. G. Student, Department of Civil Engineering, P. R. Pote Patil Edu & W T ,GoI College of Engineering & Management, Amravati

***Abstract*: Pile cap is a region with small length to depth ratio. Pile cap design by beam method gives a very lower value of pile cap depth which generally cannot be used practically and the Reynolds chart gives an empirical formula about pile cap depth which is uneconomical in some cases. This work presents a analysis about the behavior of pile caps supported by 4 piles subjected to axial loading. Pile cap were designed for certain theoretical ultimate loads. These piles cap were analyzed using staad- pro software. Loads were applied at the center of pile cap. This study includes the numerical analysis of the pile caps with varying depth..**

Keywords*- Pile cap, *Depth, Staad-Pro

I. INTRODUCTION

A reinforced concrete slab or block which interconnects a group of piles and acts as a medium to transmit the load from wall or column to the Piles is called a Pile Cap. The Pile cap should normally be rigid so as to distribute the forces equally on the piles of a group. In general it is designed like a footing on soil but with the difference that instead of uniform reaction from the soil, the reactions in this case are concentrated either point loads or distributed. As per IS 2911 (Part I/ Sec 3) -2010, the pile cap may be designed by assuming that the load from column is dispersed at 45˚ from the top of the cap up to the mid depth of the pile cap from the base of the column or pedestal. The reaction from piles may also be taken to be distributed at 45˚ from the edge of the pile, up to the mid depth of the pile cap. On this basis the maximum bending moment and shear forces should be worked out at critical sections [2].

Whittle and Beattie has developed through computer program the relationship between dimension of pile cap and the size of the pile. The minimum spacing of piles permitted from soil mechanics depends on the type and end conditions. CP 2004 requires a minimum centre- to –centre spacing of twice the diameter of the piles for end bearing and three times the diameter for friction piles. IS 2911 part1, sections 1 and 2 recommended a minimum spacing of two and half times the diameter of the pile for both driven cast in situ and bored cast in situ piles. For accommodating deviations in driving of piles, the size of the pile cap is made 300 mm more than the outer- to outer distance of the exterior piles. (150 mm on either side). The plan dimension of the pile cap is based on the fact that the actual final position of piles can be in construction up to 100 mm out of line from the theoretical centre lines. Pile caps should be made very large to accommodate these deviations. In practice, pile caps are extended as much as 150 mm beyond the outer face of the piles [2].

II. LITERATURE REVIEW

Pile cap design by beam method gives a very lower value of pile cap depth which generally cannot be used practically. And the Reynolds chart gives an empirical formula about pile cap depth which is uneconomical in some cases. But in strut & tie model the depth is quite sufficient which can be practically used by the designer [3].

Shear failure is an important failure mode for pile caps, civil engineering structures in reinforced concrete, often used as substructures for bridges. However, while relatively thin slabs, such as flat slabs for office buildings, have been subjected to intense research in the past, there is a lack of generic models for thicker structures today and building codes are still based on less appropriate empirical or semi-empirical models. For this reason, the design of pile caps for shear failures, and punching failure in particular,often results in dense reinforced structures. A rational approach to shear failures in three-dimensional structures is needed to provide a safe and efficient design of pile caps. In order to comprehend the complex cracking and failure process in pile caps, the different shear transfer mechanisms of forces in structural concrete, as well as shear and punching failures of flexural elements are described in this thesis. [1].

Shear failures are characterized by a local shattering of the shear links in the material that weakens the structure up to a point where it cannot transfer the load to the supports. Shear failure mechanisms in reinforced concrete usually consist of the unconstrained relative sliding of two parts of the structure. Punching is a localized shear failure mode that occurs in structural elements with bending moments and shear transfer of forces in two directions, like in slabs or in pile caps. The punching failure mechanism consists of the separation of a concrete cone from the slab under a concentrated load or over a concentrated support reaction. The geometry of the punching cone is linked to the particular shear and moment distribution that occurs in the vicinity of a concentrated load [1].

III. ANALYSIS OF PILE CAP

A load of 6000 kN is applied at the top of pile cap as in the form of column reaction and self-weights is added. Pile of 450 mm diameter was provided. Shape of the pile cap was square one. The depth of pile cap was varied and shear stress was observed for different depths in staad pro V8i.

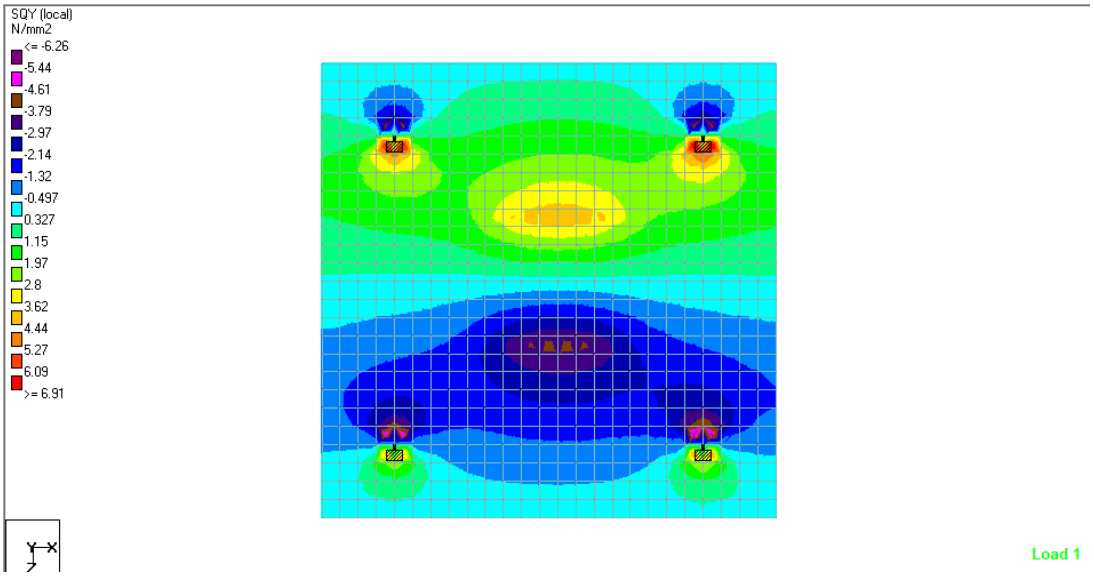

Fig1: Depth of pile cap 750 mm

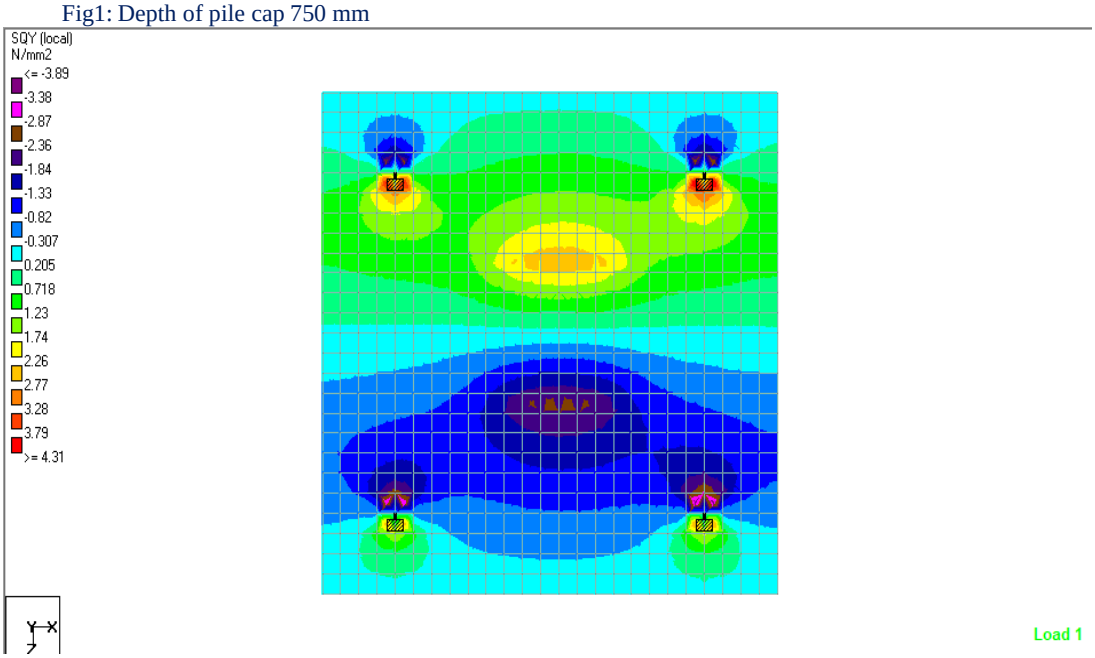

Fig 2: Depth of pile cap 1200 mm

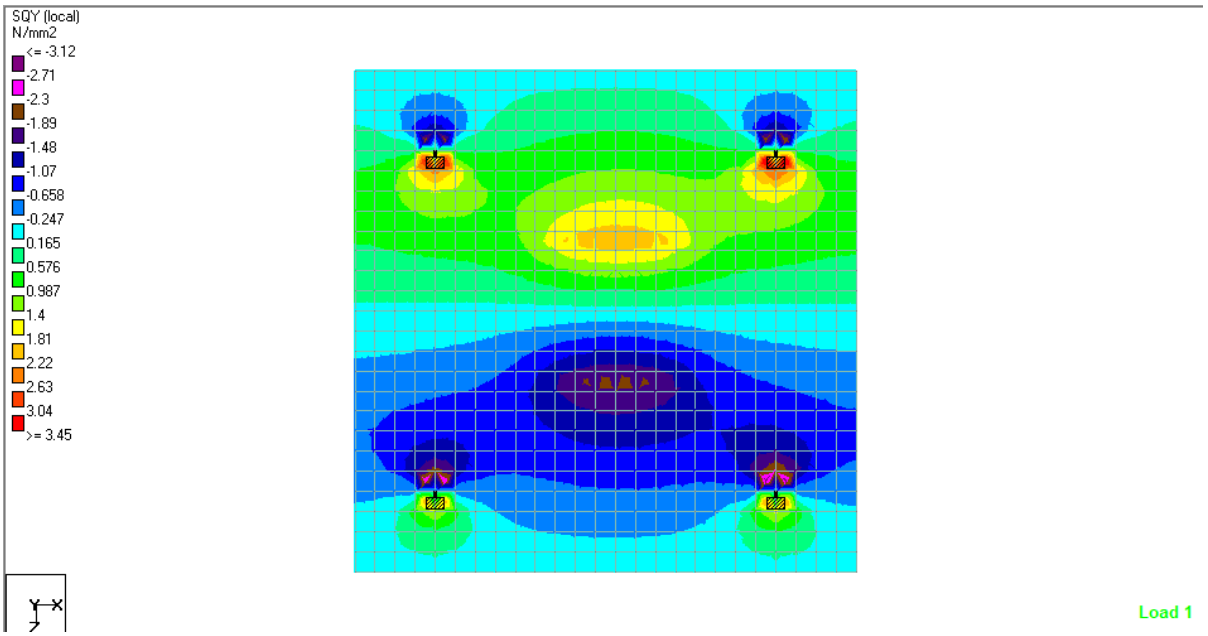

Fig 2: Depth of pile cap 1500 mm

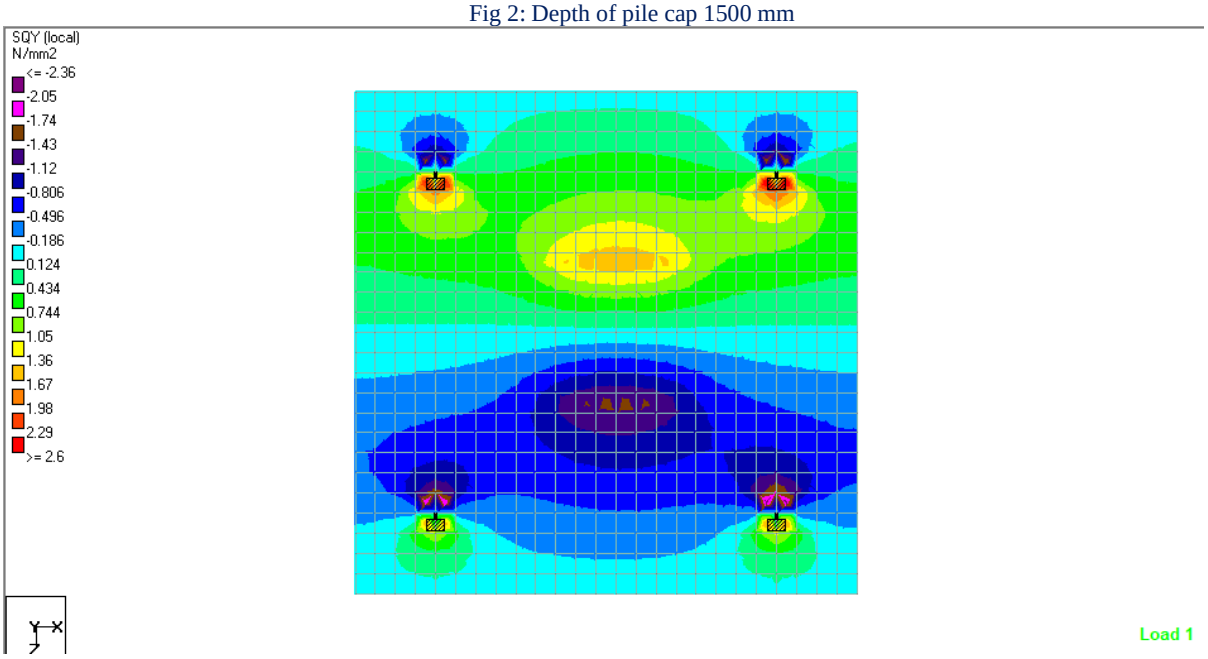

Fig 2: Depth of pile cap 2000 mm

IV. RESULT

The depth of the pile cap is varied in the analysis. It was observed from the above analysis that as the depth of pile cap is varying the shear stress is reduced. The shear stress gets reduced as the distance from the column is increased.

Depth of pile cap (mm)	750	1200	1500	2000
Maximum Shear Stress (N/mm^2)	6.26	3.89	3.12	2.36

REFERENCES

[1] Gautier Chantelot, Alexandre Mathern, "Strut-and-tie modelling of reinforced concrete pile caps ",Department of Civil and Environmental Engineering Division of Structural Engineering Concrete Structures CHALMERS UNIVERSITY OF TECHNOLOGY Göteborg, Sweden 2010

[2] website google "*https://www.scribd.com/document/212610665/Two-Pile-Group"*

[3] A. B. M. Golam Rabbany, Samiul Islam, Md. Hasan-Uz-Zaman, "Pile Cap Performances in Different Consequences", Architecture Research 2018, 8(2): 51-61

[4] website google "*https://www.thestructuralworld.com/2018/07/20/pile-cap-design/"*

[5] IS 2911 (Part 1/Sec 3), "Indian Standard DESIGN AND CONSTRUCTION OF PILE FOUNDATIONS — CODE OF PRACTICE" 2010