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Behaviour of Pile Adjacent to Excavation in Layered Soil

Dr. A.I.Dhatrak[1], S.D.Kulkarni[2]

[1]Associate Professor, Department of Civil engineering, GCOEA Amravati, India
[2]PG Student, Department of civil engineering, GCOEA Amtavati, India

***Abstract*— *Construction of deep basement structure is common thing in urban cities, as land available for construction is limited. As this excavation carried out near the existing building, the major challenge is to minimize the damage to existing building or underground utilities. As pile foundation were used for high rise building, there is concern with lateral ground movement resulting from soil excavation, may adversely affect the nearby pile foundation. This paper aims at investigating the effect of excavation induced movements on the lateral deflection of pile situated near the excavation in multilayered soil.*

Keywords*—*Deep excavation, Pile, Side supported excavation.

I. INTRODUCTION

In dense urban environments where land is scare and building are closely spaced, deep excavation for basement construction and other underground facilities like cut cover tunnels are unavoidable. During deep excavation, there is concern that lateral ground movement resulting from the soil excavation, may adversely affect the nearby pile foundation systems.

II. LITRETURE REVIEW

The H.G.Polus L.T.Chen [1] represented study of finite element and boundary element method for pile response due to excavation educed moment in clay. C.F.Leung Y.K.Chow and R.F.Sen [2] represented a study of centrifuge model tests on instructed deep excavation in dense sand and its influence on an adjacent single pile foundation. A.T.C.Goh, K.S.Wong, C.I.Teh and D.Wen [3] presented the result of an actual full scale instrumented study that was carried out to examine the behavior of existing pile due to the nearby excavation activities of tunnel. D.E.L Ong, C.E. Leung and Y.K.Chow[4] presents study of series of centrifuge model test to investigate the behavior of pile group of various sizes and configuration behind the retaining wall in very soft clay.Elkady T.[5] represented a study of finite element anlysis by ABAQUS to assess the effect of excavation depth, distance of pile from side supported excavation, pile stiffness and wall stiffness. Kulkarni. S.R[6] presents a study of deep basement excavation for 33 stored high rises Tower by Finite element software (Plaxis 2D).

From the litreture review, it is observed that effect of excavation induced soil movement on adjacent pile (clay and sand) were studied by many researchers.As the soil profile in deep excavation consist of different properties of soil, the study of pile response in layered soil is necessary. There is need to study the effect of deep excavation on adjacent pile considering various parameters.

III. METHOD AND MODEL

The finite element method using plaxis 2D software was used to study the behaviour of pile adjacent to deep excavation.Mainly four cases were considered for the analysis viz; without load on pile, with safe load on pile, excavation without support and excavation with support. Material properties for pile, side wall and soil considered for analysis are given in table 1 and table 2 respectively.

Table.1: Pile and side wall properties

Parameter	**Name**	**Layer 1**	**Layer 2**
Material mode	Model	Mohr-Coulomb	Mohr-Coulomb
Unit weight above pheratic lavel (kN/m^3)	ϒunsat	17.6	18.2
Unit weight below pheratic lavel (kN/m^3)	ϒsat	19.39	20.05
Young,s modulus (Mpa)	E	7.5	10.5
Cohesion (kN/m^2)	Cref	20	35
Friction angle (degree)	Ø	17	17.5
Possion ratio	μ	0.1	0.15

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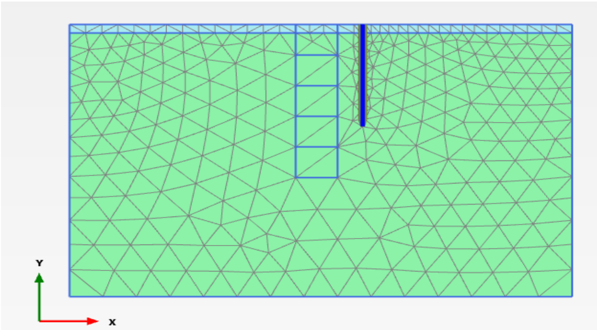
Table.2: Soil Properties

Component	Density (kg/m^3)	Elastic modulus	Poisson's ratio
Pile	24	25	0.15
Wall	25	200	0.30

3.1 Model Preparation**:**

Model for analysis selected by performing number of analysis of different refrences for different size of model. Model selected for analysis gives maximum deflection value. The model consists of three parts; namey soil, pile and wall. Pile and walls are defined by plate element on model. Main features and dimensions of the finite element model is shown in Figure 1.



IV. RESULT AND DISCUSSIONS

For case 1 i.e. No support to excavation and no load on pile.A pile with 300 mm diameter in two layered soil was analyzed using PLAXIS 2D for varying depth of excavation to pile length ratio (H/L). The thickness of upper layer of soil walls h_1 =0.25L. The maximum deflection observed is shown in Figure 2.

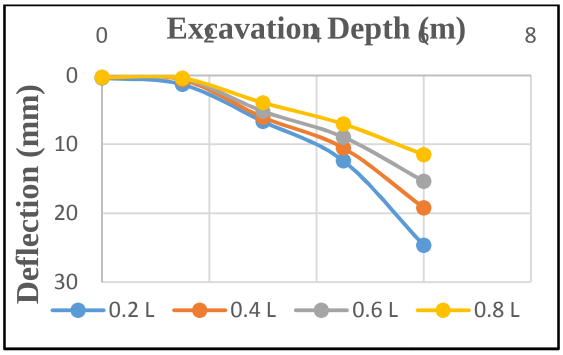


Fig.2: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for 0.25L.

Similarly for h_1=0.5L , 0.75L and L thickness of top week soi, the pile deflections are as shown in figure 3 and 4 respectively.

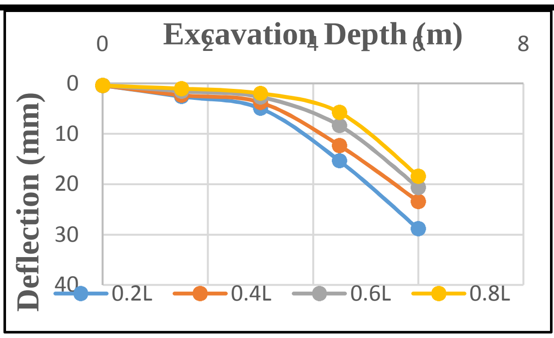


Fig.3: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h_1 =0.5L.

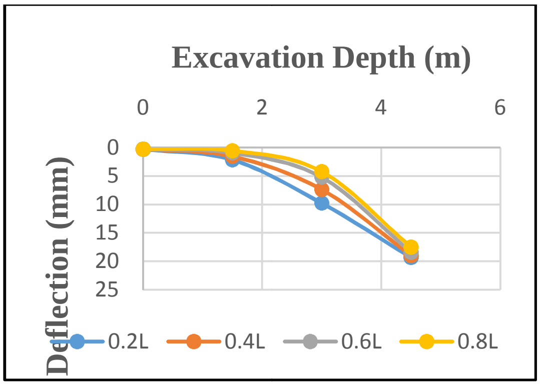


Fig.4: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h_1 =0.75L.

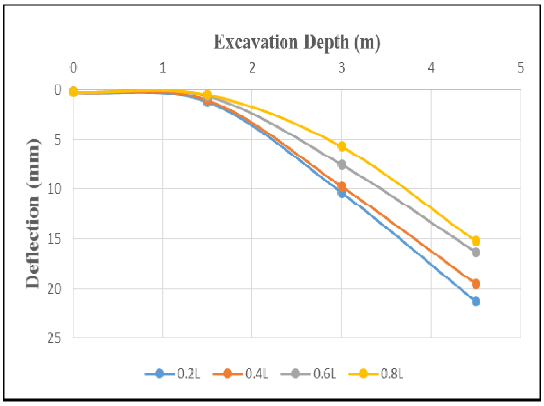


Fig.5: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h_1 =L.

For case 2 i.e No support to excavation and with safe load on pile. Figure 6 shows the deflection of pile for 5 m length of pile with $h_{1=}$ 0.25L.

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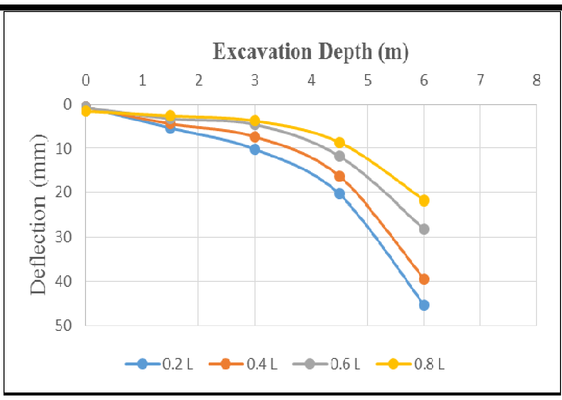

Fig.6: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for 0.25L.

Similarly for h_1=0.5L , 0.75L and L thickness of top week soli, the pile deflections: are as shown in figures 7,8 and 9 respectively.

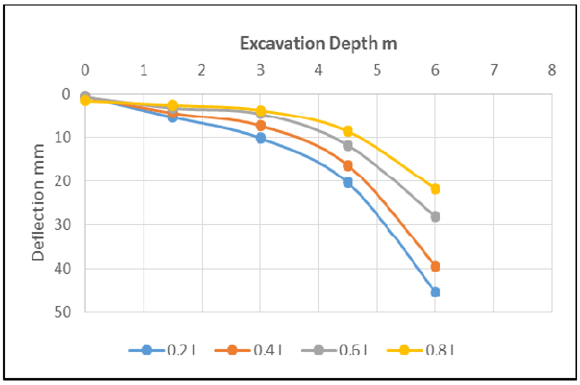

Fig.7: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h_1 =0.5L.

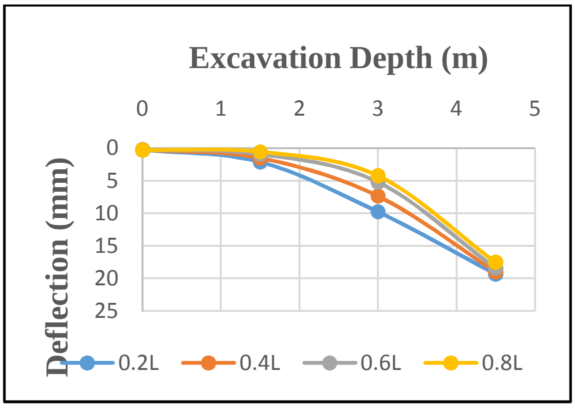

Fig.8: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h_1 =0.75L.

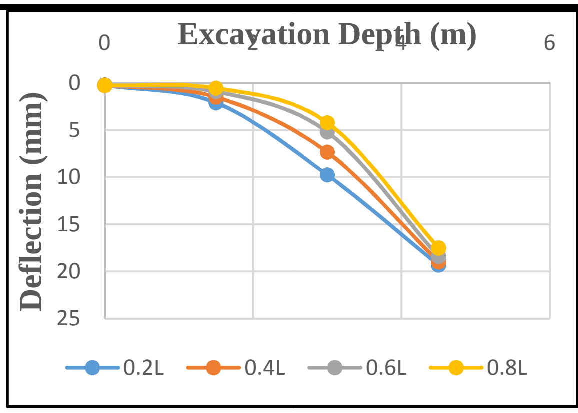

Fig.9: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for L.

For case 3 with support to excavation and no load on pile. Figure 10 shows the deflection of pile for 5 m length of pile with $h_{1=}$ 0.25L.

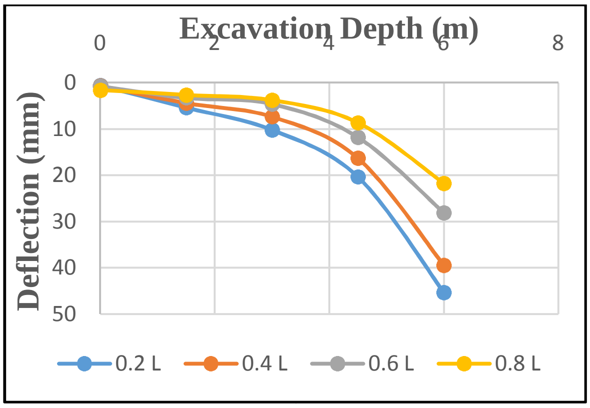

Fig.10: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h1= 0.25L.

Similarly for h_1=0.5L , 0.75L and L thickness of top week soli, the pile deflections are as shown in figures 11,12 and 13 respectively.

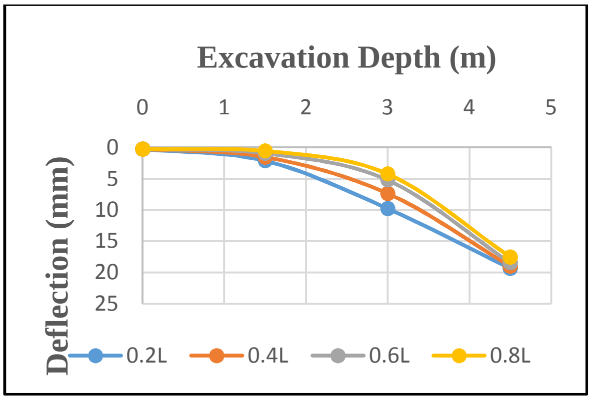

Fig.11: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h1= 0.5L.

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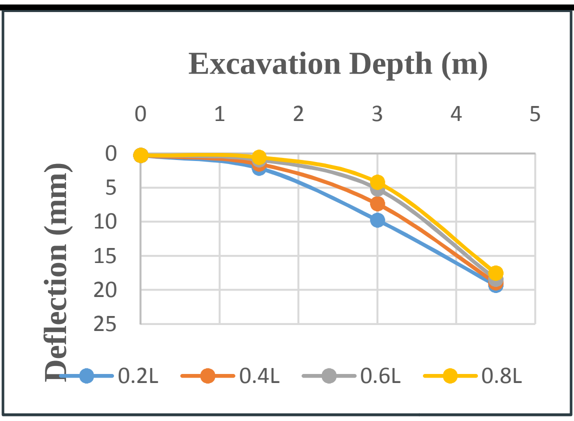

Fig.12: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h1= 0.75L.

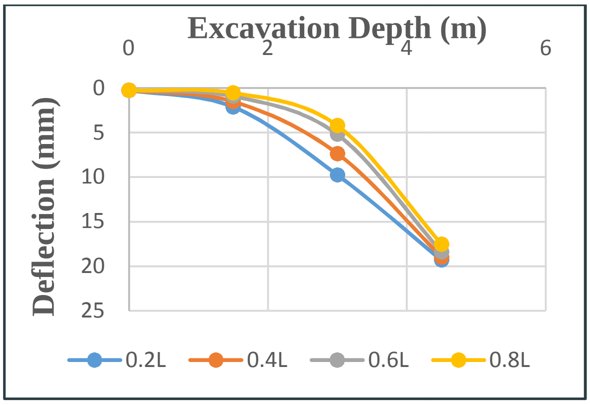

Fig.13: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h1=L.

For case 4 with support to excavation and with safe load on pile. Figure 14 and 15 shows the deflection of pile for 5 m length of pile with $h_{1=}$ 0.25L and 0.5L respectively.

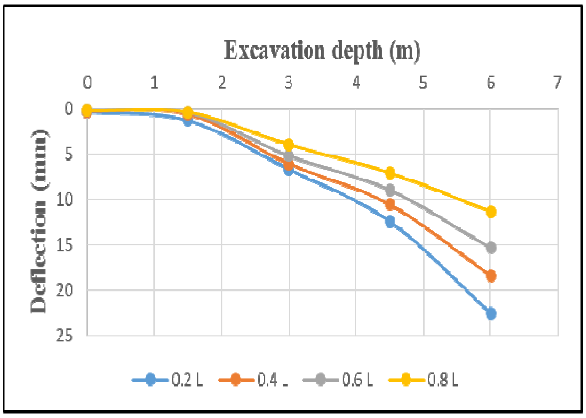

Fig 14: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h1= 0.25L.

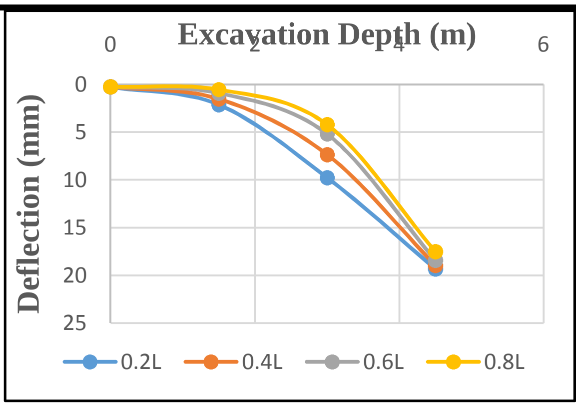

Fig 15: Deflection of pile (300mm) corresponding to excavation depth for 5 m length of pile for h1= 0.5L.

4.1 Discussion of results:

The results obtained for various cases and parameters of pile and soil are sutaibly discussed in following section.

4.1.1 Effect of diameter of pile on deflection of pile.

For no support and no load condititon Deflection for various daimeters were compared as discuss below.

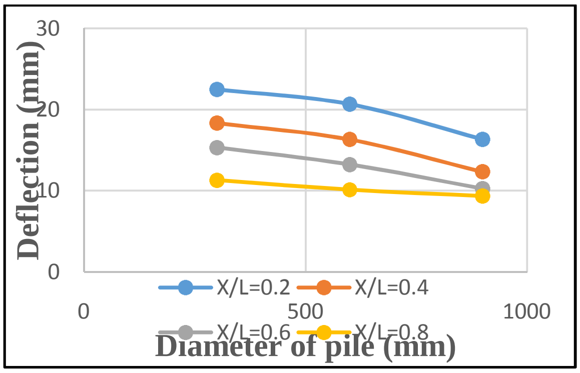

Fig.16: Effect of diameter of pile on deflection of pile.

Significant decrease in deflection of pile is observed with increase in diameter of pile in all cases.

4.1.2 Effect of length of pile on deflection of pile:

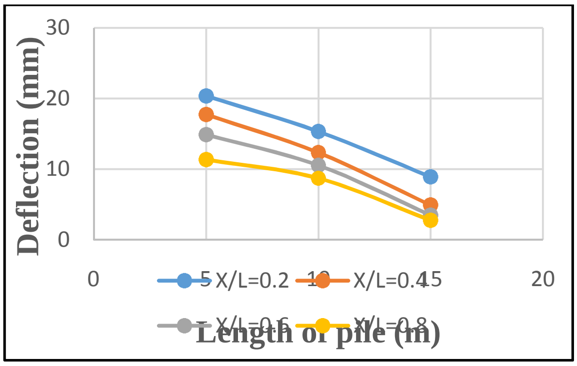

Fig.17:Effect of length of pile on deflection of pile.

Significant decrease in deflection of pile is observed with increase in length of pile in all cases.

4.1.3 Effect of distance of pile from excavation on deflection of pile.

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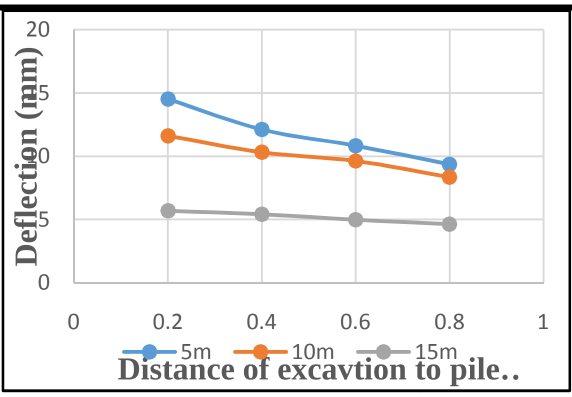

Fig.18: Effect of diameter of pile on deflection of pile.

Significant decrease in deflection was observed as distance of pile from defleciton increases for 5m and 10 m. No markable decrease was observed 15m length of pile.

4.1.4 Effect of increasing top week layer of soil on pile head deflection

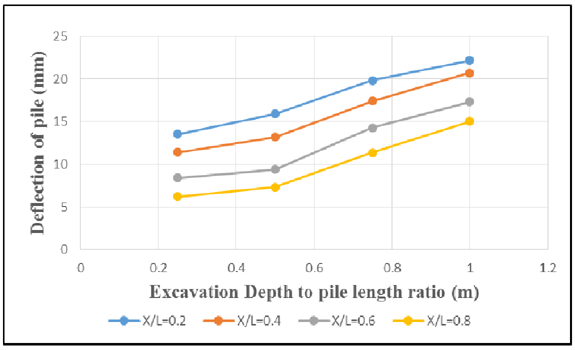

Fig.19: Effect of increasing the depth of top week layer of soil on pile head deflection

V. COCLUSIONS

In the study undertaken, deflections of pile was evaluated for various cases and parameters.The broad conclusions drawn from the study are as follows:

1. As the distance of excavation from pile increases, deflection of pile decreases.
2. As the diameter of pile goes on increasing, decrease in pile head deflection was observed.
3. The depth of collapse of unsupported excavation can be decreased by insertion of pile because pile act as a reinforcing material.
4. As the length of pile increases, there is significant reduction in deflection of pile.
5. By providing support to excavation, remarkable reduction in deflection of pile is observed.
6. As the depth of excavation increases, deflection of pile also increases.
7. As the thickness of top layer of week soil increases, deflection of pile also increases.

REFERENCES

[1] Hong-Bing Zhang and Jin-Jian Chen (2014) 'Displacement Performance and Simple Prediction for Deep Excavations Supported by Contiguous Bored Pile Walls in Soft Clay' Journal of Aerospace Engineering,

[2] Polous H.G and Chen L.T (1997) 'Pile Response due to Excavation induced Lateral Soil Movement'; *Journal of Geotechnical and Geoenvironmental Engineering*,Vol.123,no 2 February,1997.

[3] Leung, C. F., Chow, Y. K., and Shen, R. F (2000): "Behavior of pile subject to excavation-induced soil movement." *Journal of Geotechnical and Geoenvironmental Engineering*, 12611, 947–954.

[4] Goh A.T.C., Wong K.S., Teh C.I. and Wen D. (2003): 'Pile Response Adjacent to Braced Excavation', *"Journal of Geotechnical and Geoenvironmental Eng* 129(4), 383-386.

[5] Ong D.E.L, Leung C.E. and Chow Y.K. (2006): 'Pile behavior due to excavation-induced soil movement in clay I: Stablewall', "Journal of Geotechnical and Geoenvironmental Eng132 (1), 36-44.

[6] Ong D.E.L, Leung C.E. and Chow Y.K. (2009): 'Behavior of Pile Subject to Excavation Induced Soil Movement in Very Soft Clay' *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 135, No. 10, October 1, 2009. ©ASCE, ISSN 1090-0241/2009/10-1462–1474.

[7] Elkady T. (2013): 'Effect of Excavation-induced Movements on Adjacent Piles', Proceedings of the 18th international conference on soil mechanics and geotechnical engineering, Paris (707) 2013.

[8] Kulkarni S. R. (2014) 'Analysis of deep excavation using Plaxis 2D'. Mtech Thesis, Department of Civil Engg, COEP.