BEHAVIOUR OF PILED RAFT BY NONLINEAR FINITE ELEMENT METHOD

By

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ABSTRACT

Nonlinear finite element analysis has been performed to understand the behaviour of piled raft under plane strain condition. The soil has been idealized by Extended Drucker-Prager yield criterion. The raft and piles have been considered as linear elastic material. Four nodedisparametric finite elements has been used for discretization. The number of nodes are 243 and number of elements is 208. At all loading intensity the settlement of raft is more than piled rafts. For piled raft having pile of length to diameter ratio equal to 10 settles more than other piles of piled raft. For piled rafts having pile of length to diameter ratio of 20 settle more than piled raft having pile length to diameter ratio equal to 30. The load settlement curve for raft and piled rafts are nonlinear. When the thickness (T) is 0.5 m, the settlements of raft and piled raft both decreases. The raft undergoes maximum settlement followed by piled raft having piles of length to diameter equal to 10,20 and 30. When the thickness (T) is 1.0 m, the settlements of raft and piled raft both decreases than at thickness (T)= 0.50 m. Similarrly at thickness equal to 2.0, the settlement of raft and piled raft decreases than at thickness 1.0 m. The axial load is maximum at the top and minimum at the bottom at all loading intensity. The axial load increases with increase in loading intensity. The axial load distribution curve is nonlinear. This nonlinearity is maximum at loading intensity equal to 60 kN/m^2. The axial load is greater for all loading intensity for L/d ratio 20 than L/d=10. Similarly the axial load is greater for all loading intensity for L/d ratio 30 than L/d=20.

Intex term-: Raft, Piled Raft, Finite Element, Thickness, Length, Diameter, Axial Load, Loading Intensity, Discretization.

INTRODUCTION

Piled raft is a new foundation which takes load partly through piles and remaining through raft which is in contact of ground. Thus it is cheaper to pile foundation and it undergoes lesser settlement than raft foundation.Based on literature reviewi it has been found that few references only report elasto-plastic analysis (Liu and Novak (1991),Trochanis et.al (1991), Potersu and Minalache (1985) mostly using Drucker-Prager yield criterion to idealise soil behaviour. Field measurements as reported by Hooper(1973),Cooke(1986),Schwab et.al(1991), Franke (1991),Poulos(1994) and Yamashita et.al.(1994) give useful information for load transfer and settlement behaviour of piled raft.

FINITE ELEMENT METHOD

In finite element method plane strain condition has been considered. The raft pile and soil have been discretised as four nodedisoparametric elements. The soil has been idelised as Extended Drucker-Prager yield criterion. The raft and pile have been idelised as linear elastic material. The length to diameter ratio of pile varied are 10,20 and 30. The Thickness of raft varied are 0.10 m, 0.5 m, 1.0 m and 2.0 m. The number of nodes in the discretized mesh is 243 and number of elements equal to 208. Being symmetrical only half portion has been analysed. At the centre and at the end only vertical movement is allowed. At bottom no degree of freedom is allowed.

RESULTS AND DISCUSSIONS

Fig.1 shows the comparison of settlement of raft and piled rafts of thickness equal to 0.10

The length to diameter ratio varied are 10, 20 and 30. At all loading intensity the settlement of raft is more than piles. For piled raft having pile of length to diameter ratio equal to 10 settles more than other piles of piled rfat. For piled rafts having pile of length to diameter ratio of 20 settle more than piled raft having pile equal to 30. The load settlement curve is nonlinear.

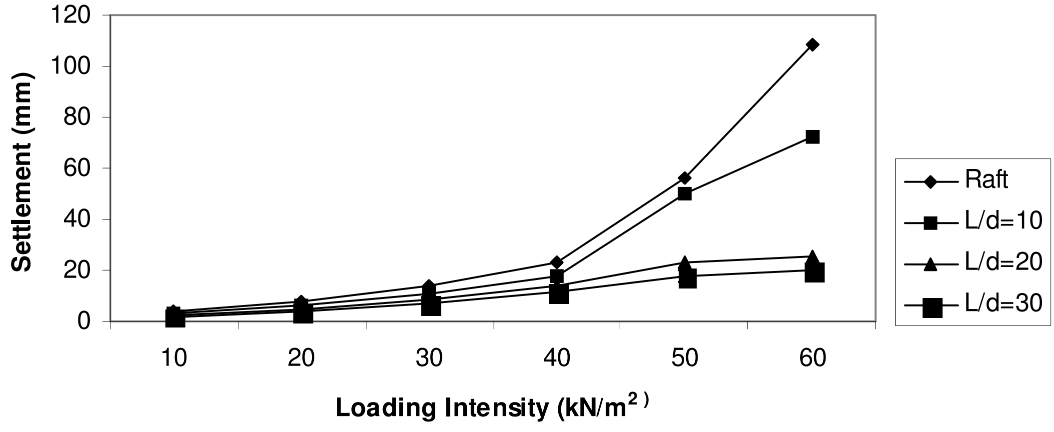

Fig.1 Comparison of Settlement, Th=0.10 m)

Fig.2 shows the load settlement curve for raft and piled raft. The raft undergoes more settlement than the piled rafts. The load settlement curve for raft and piled rafts are nonlinear. When the thickness (T) is 0.5 m, the settlements of raft and piled raft both decreases. In Fig.2 the raft undergoes maximum settlement followed by piled raft having pile of length to diameter equal to 10,20 and 30.

Fig,.3 shows the comparison of settlement for raft and piled rafts. For all loading intensity the raft has more settlement than piled raft. The piled raft having pile of length to diameter ratio 10, 20 and 30 have lesser settlement respectively. The curves are nonlinear. In the initial portion ie loading intensity upto 30 raft and piled rafts show almost same settlement.

Fig.4 shows the loading intensity vs settlement curve for raft and piled raft. The nature of settlement is similar to that described by Fig.3. The overall settlement of raft and piled rafts are less than the overall settlement of rafts and piled rafts of Fig.3.

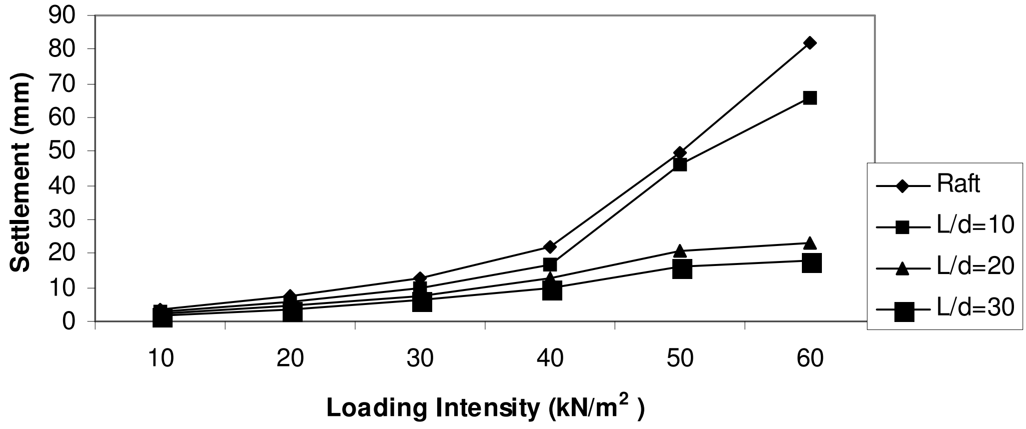

Fig.2 Comparison of Settlement (Th=0.50 m)

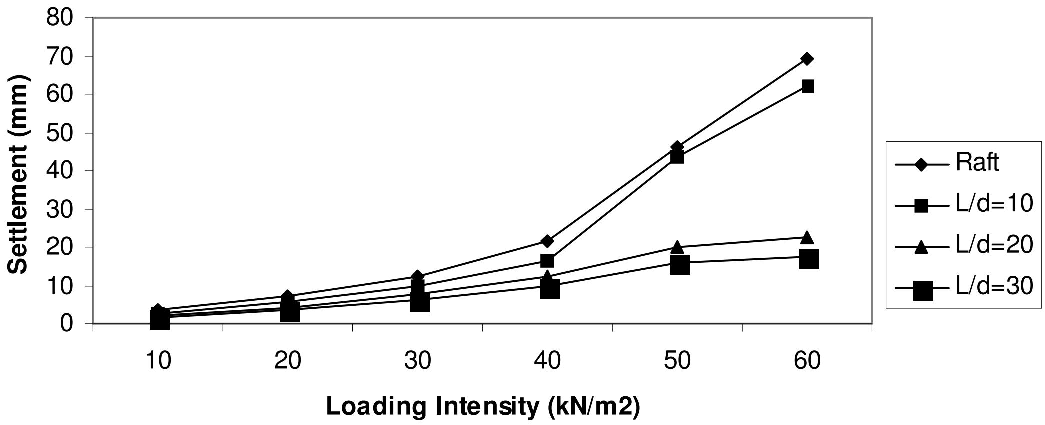

Fig.3 Compasison of Settlement (Th=1.0 m)

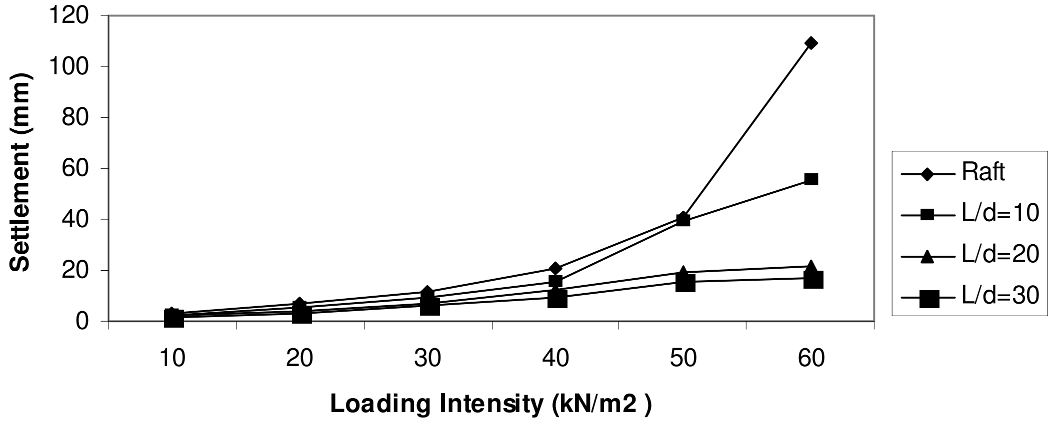

Fig.4 Comparison of Settlement (Th=2.0 m)

Fig.5 shows the axial load distribution for pile of length to diameter ratio equal to 10 for various loading intensity. The axial load is maximum at the top and minimum at the bottom. The axial load increases with increase in loading intensity. The axial load distribution curve is nonlinear. This nonlinearity is maximum at loading intensity equal to 60 kN/m^2.

Fig.6 shows the axial load distribution for length of pile to diameter ratio equal to 20. The axial load for all loading intensity is maximum at top and minimum at bottom. The axial load is greater for all loading intensity for L/d ratio 20 (Fig.6) than L/d=10 (Fig.5). The nature of curve is nonlinear.

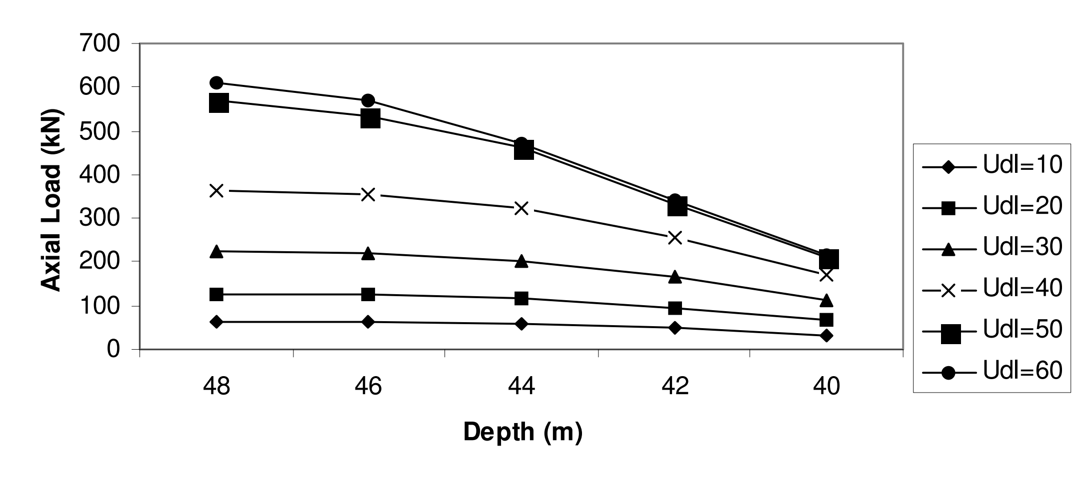

Fig.5 Axial Load Distribution (L/d=10)

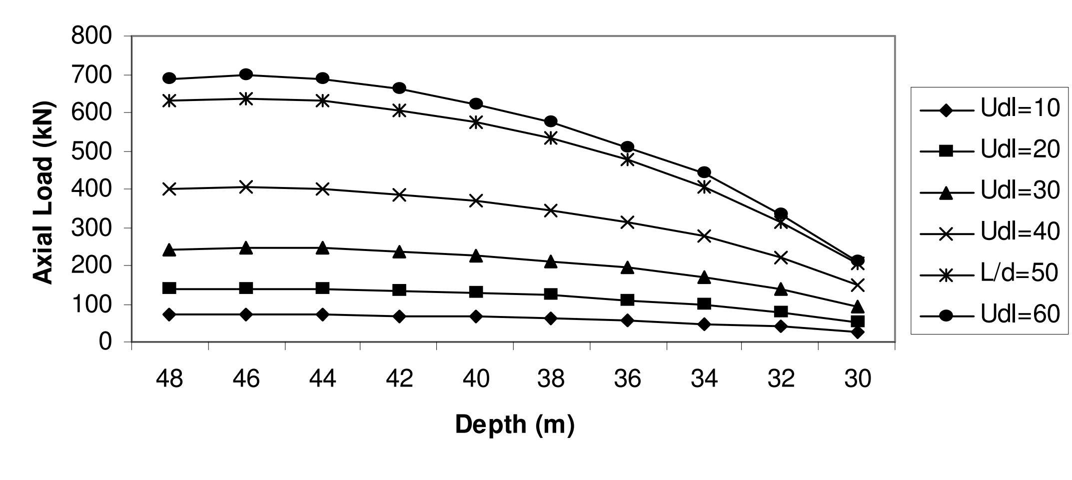

Fig.6 Axial Load Distribution (L/d=20)

Fig.7 shows the axial load distribution between depth vs axial load for different loading intensity for L/d ratio equal to30. The axial load distribution is maximum in the top of pile and minimum at bottom of pile. With increase in loading intensity the axial load increases at all depths. The axial load is greater for all loading intensity for L/d ratio 30 (Fig.7) than L/d=20 (Fig.6). The nature of curve is nonlinear.

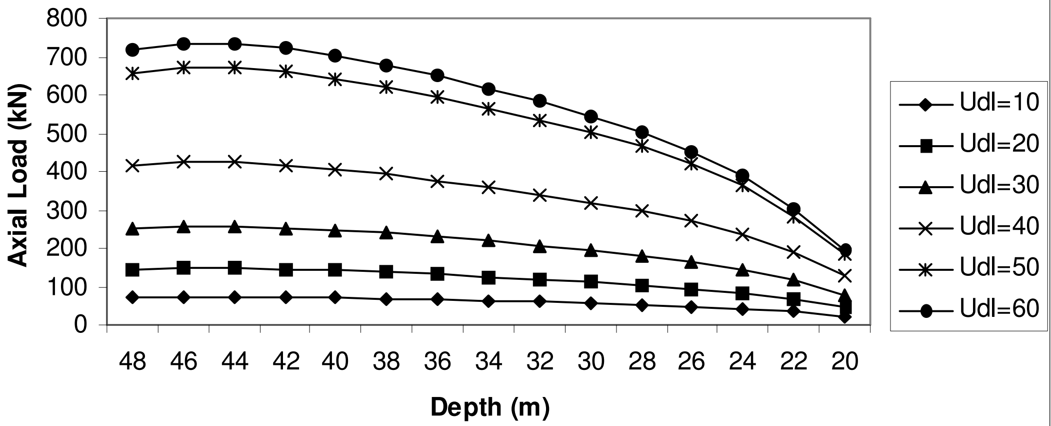

Fig.7 Axial Load Distribution (L/d=30)

CONCLUSIONS

At all loading intensity the settlement of raft is more than piled rafts. For piled raft having pile of length to diameter ratio equal to 10 settles more than other piles of piled raft. For piled rafts having pile of length to diameter ratio of 20 settle more than piled raft having pile length to diameter ratio equal to 30.The raft undergoes more settlement than the piled rafts. The load settlement curve for raft and piled rafts are nonlinear. When the thickness (T) is 0.5 m, the settlements of raft and piled raft both decreases. The raft undergoes maximum settlement followed by piled raft having pile of length to diameter equal to 10,20 and 30. When the thickness (T) is 1.0 m, the settlements of raft and piled raft both decreases than at thickness (T)= 0.50 m.Similarrly at thickness equal to 2.0, the settlement of raft and piled raft decreases than at thickness 1.0 m. The axial load is maximum at the top and minimum at the bottom at all loading intensity. The axial load increases with increase in loading intensity. The axial load distribution curve is nonlinear. This nonlinearity is maximum at loading intensity equal to 60 kN/m^2. The axial load is greater for all loading intensity for L/d ratio 20 than L/d=10. Similarly the axial load is greater for all loading intensity for L/d ratio 30 than L/d=20.

REFERENCES

[1].Cooke, R.W.(1986) Piled raft foundations on stiff clay-a contribution to design philosophy, Geotechnique, 36(2),169-203.
[2].Franke,E.(1991) Measurement beneath piled rafts, key note lecture to the ENPC-Conference on Deep Foundations, Paris, 1-28.
[3].Hooper, J.A.(1973) Observations on the behaviour of a piled raft foundation in London clay,Proceeding of Institution of Civil Engineers, 55(2),855-877.
[4].Liu, W. and M.Novak (1991) Soil-pile-cap static interaction analysis by finite and infinite elements, Canadian Geotechnical Journal,771-783.
[5].Poterasu, V.F. and N.Mihalache (1985) FEM and BEM in elasto-plastic problem for soil-structure interaction.InternationalConference.Finiteelementsin Computational Mechanics, Bombay, India, December, 2-6.
[6].Poulos, H.G.(1994) Alternative design strategies for piled raft foundation. 3rd International Conference on Deep Foundation Practice incorporating PILETALK,Singapore.
[7].Schwab, H.H., N.Gundling and B. Lutz (1991) Monitoring pile raft soil interaction. Proc. Of Symposiumon Field Measurements in Geotechnics, Sorum, Balkema, Rotterdam,117-127.
[8].Trochanis,A.M., J.BielakandP.Christiano(1991) Three-dimensional nonlinear study of piles, Journal of Geotechnical engineering, ASCE, 117 (3), 429-447.
[9].Yamashita, K., M.Kakurai and T.Yamada (1994) Investigation of a piled raft foundation on stiff cly. XIII International Conference on Soil Mechanics and Foundation Engineering, New Delhi, India, 543-546.