INTERACTION BETWEEN TWO CAP HAVING ONE PILE IN EACH BY NONLINEAR FINITE ELEMENT METHOD

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ABSTRACT

The two piled cap foundations have been placed at a distance from each other. Both the piled cap foundations are under the application of uniformly distributed and both piled cap are under three dimensional condition. The cap pile and soil have been discretized into eight noded isoparametric elements. The cap and pile have been considered as linear elastic medium while the soil has been idealized as extended Drucker-Prager yield criterion. Full Newton Raphson method has been used to solve the nonlinear finite element equation. The parameters varied are the length of pile, distance between two piled caps and uniformly distribution load.. The settlement of cap for all spacings remains the same upto 80 kN/m^2. After loading intensity equal to 80 kN/m^2, the settlement for spacing 0.50 m is maximum and for spacing equal to 1.5 is minimum. For piled cap having pile length to diameter ratio equal to 10,20 and 30 at smaller spacing interaction is more and hence the pile cap settles more. At larger spacing interaction is less and hence the pile cap settles less. The settlement is maximum for pile cap and it reduces with increase in length to diameter ratio of pile. The axial load is maximum at top of pile and then it decreases with depth and is minimum at bottom element of pile. This is true for all length to diameter ratio of pile. The axial load distribution is more at spacing 0.50 metre and minimum at spacing equal to 1.5 metre. For pile with length to diameter ratio 20 for all loading intensities the axial load is maximum in the top pile element and minimum in the bottom element. The axial load distribution is nonlinear. At loading intensity 100 and 120 kN/m^2 both the curves show approximately same axial load distribution. For no interaction the piled caps should be placed at a distance greater than 1.5 metre.

Keywords : Piled cap, Uniformly Distributed Load, Extended Drucker-Prager, Full Newton Raphson,, Parameters, Settlement

1.1 INTRODUCTION

In a soil-foundation-structure interaction problem the behaviour of foundation depends on the behaviour of soil and structure and the behaviour of structure depends on the behaviour of foundation and soil. Soil-structure-interaction in a single integral system has been reported in literature by Duiker et.al (2009), Hararika and Nath (2010),. Khodair and Abdel-Mohti(2014), Majid, and Cunnell(1976), Maryam Mardfekri at al. 2013), Nanda (1994), Nasri and Magnan(1997), Sreelakshmi et.al. (2016) and Sreelakshmi et.al (2008) The interaction between two integral systems has not been reported in literature. This means that interaction between two separate piled cap foundations have not been reported in the literature. The present research work concentrates on interaction between two piled cap foundations on soil.

1.2 FINITE ELEMENT ANALYSIS

The two piled cap foundations have been placed at a distance from each other. Both the piled cap foundations are under the application of uniformly distributed load and both piled cap are under three dimensional condition. The cap pile and soil have been discretized into eight noded isoparametric elements. The cap and pile have been considered as linear elastic medium while the soil has been idealized as extended Drucker-Prager yield criterion. Full Newton Raphson method has been used to solve the nonlinear finite element equation. The parameters varied are the length of pile, distance between two piled caps and uniformly distribution load..

RESULTS AND DISCUSSIONS

Fig.1 shows the uniformly distributed load (udl) vs settlement curve for cap to cap interaction for various spacing between the caps. The settlement for all spacings remains the same upto 80 kN/M^2. After udl equal to 80 kN/m^2, the settlement for spacing 0.50 m is maximum and for spacing equal to 1.5 is minimum. This shows that at smaller spacing caps interact more than at larger spacing.

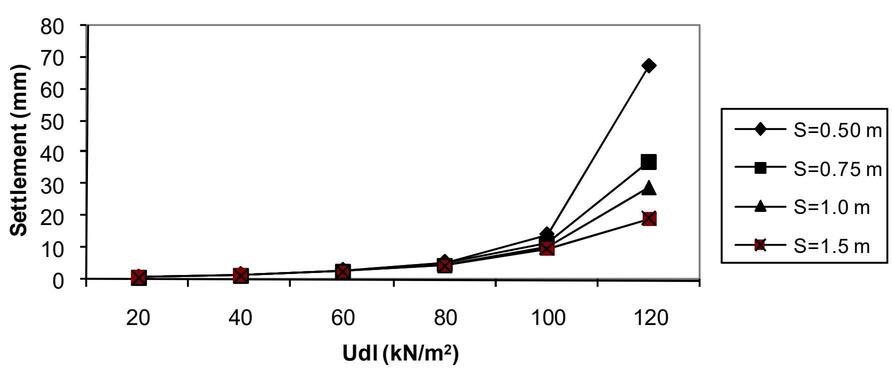

Fig.1 Udl vs Settlement Curve (Cap)

Fig.2 shows the udl vs settlement curve for various spacing between the caps with pile of length to diameter ratio 10. The settelement is same upto 80 kN/m^2 for all spacing between caps upto 80 kN/m^2. At smaller spacing interaction is more and hence the pile cap settles more. At larger spacing interaction is less and hence the pile cap settles less.

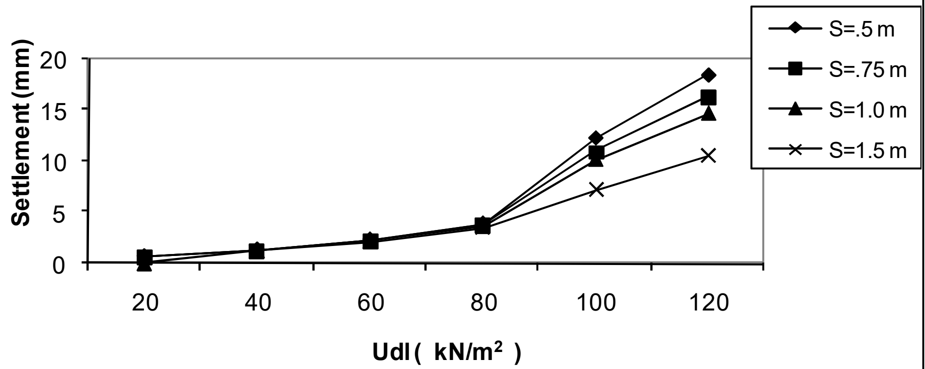

Fig.2 Udl vs Settlement Curve (L/d=10)

Fig.3 shows the udl vs settlement curve for various spacing between the caps with pile of length to diameter ratio equal to 20. The settlement is same for all spacings upto 80 kN/m^2 . After that the settlement is maximum at spacing 0.5 m and minimum at spacing equal to 1.5 m. This is because the cap with pile interacts more at smaller spacing than at larger spacing. The overall settlement is less in pile of length to diameter ratio 20 than length to diameter ratio 10.

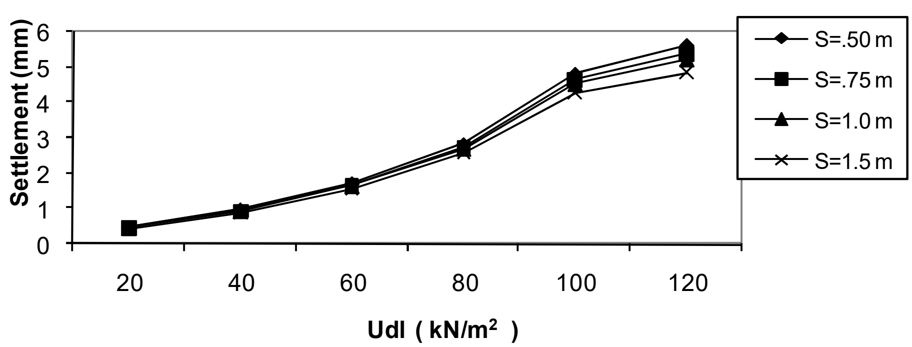

Fig.3 Udl vs Settlement Curve (L/d=20)

At length to diameter ratio 30 the interaction between cap with pile is minimum. This is because at length to diameter ratio 30 pile cap with pile interacts less than the pile of length to diameter ratio of pile equal to 20.

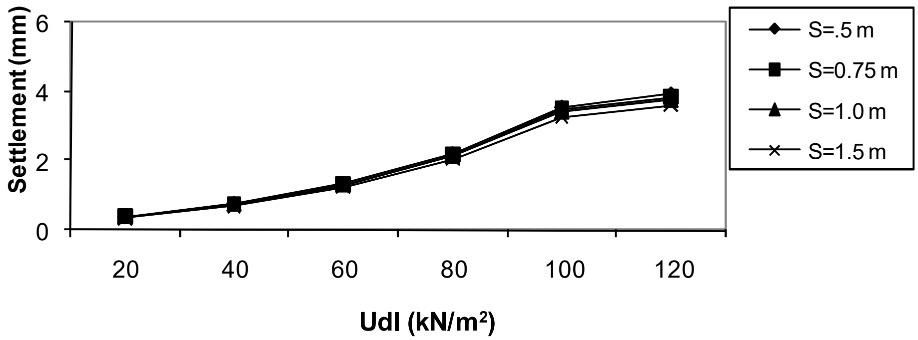

Fig.4 Udl vs Settlement Curve (L/d=30)

Fig.5 shows the spacing vs settlement curve for cap and cap with pile of various length to diameter ratio equal to 10,20 and 30. The settlement is maximum for pile cap and minimum for cap with pile of length to diameter ratio of 30. This is because at smaller spacing the cap interacts more and with increase in length to diameter ratio the cap with pile interacts less.

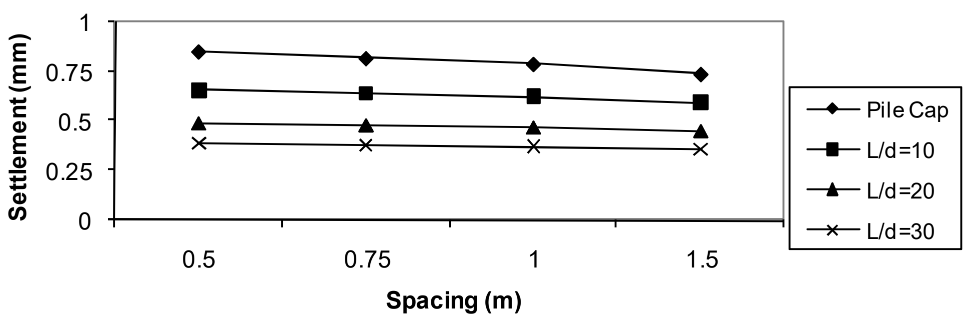

Fig.5 Spacing vs Settlement Curve (Udl=20 kN/m^2)

Fig.6 shows the spacing vs settlement curve for udl equal to 60 kN/m^2. The explanation is same as Fig.5. The overall settlement is more for udl equal to 60 kN/m^2 than at udl equal to 20 kN/m^2.

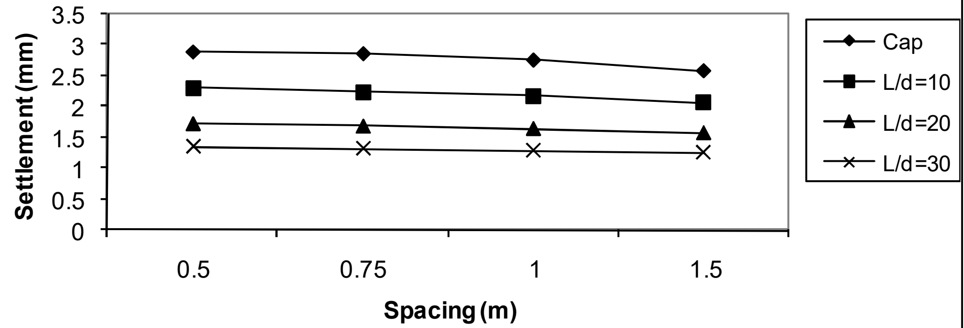

Fig.6 Spacing vs Settlement Curve (Udl=60 kN/m^2)

Fig.7 shows the spacing vs settlement curve for udl equal to 120 kN/m^2. The settlement of cap and cap with pile for various length to diameter ratio decreases with increase in spacing. This is because at smaller spacing the interaction is more than at larger spacing.

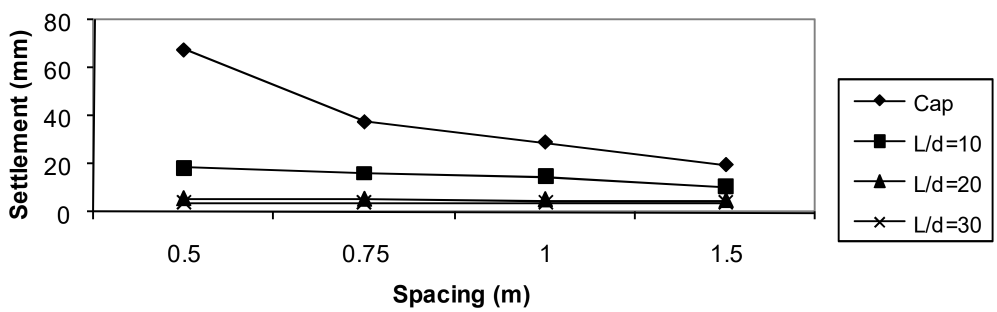

Fig.7 Spacing vs Settlement Curve (Udl=120 kN/m^2)

Fig8 shows the axial load distribution curve for various spacing for cap with pile of length to diameter ratio equal to 10 and udl equal to 20 kN/m^{2}. The axial load is maximum at top of pile and then it decreases with depth and is minimum at bottom element of pile. The axial load distribution is more at spacing 0.50 metre and minimum at spacing equal to 1.5 metre. This is because pile interacts more at smaller spacing.

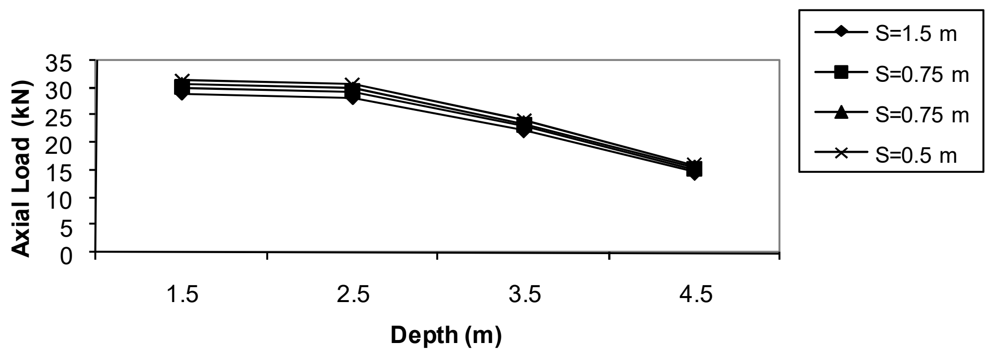

Fig.8 Axial Load Distribution (L/d=10, Udl=20 kN/m^2)

Fig.9 shows the axial load distribution of pile for two spacings for length to diameter ratio equal to 10 and udl equal to 60 kN/m^{2}. The axial load for spacing 0.50 metre is more than at spacing 1.5 metre throughout the depth of pile. This is because pile interacts more at smaller spacing than at higher spacing.

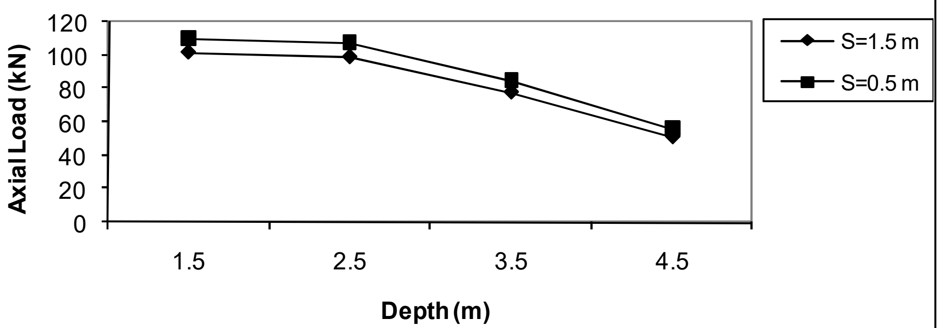

Fig.9 Axial Load Distribution (L/d=10, Udl=60 kN/m^2)

Fig.10 shows the axial load distributionin pile of length to diameter ratio 20. The axial load is maximum at top element and minimum in pile element at bottom. The axial load is greater at spacing 0.50 metre than at spacing 1.5 metere throughout the depth.The axial load for pile of length to diameter 20 is greater than axial load for pile for L/d equal to 10 for same loading intensity.

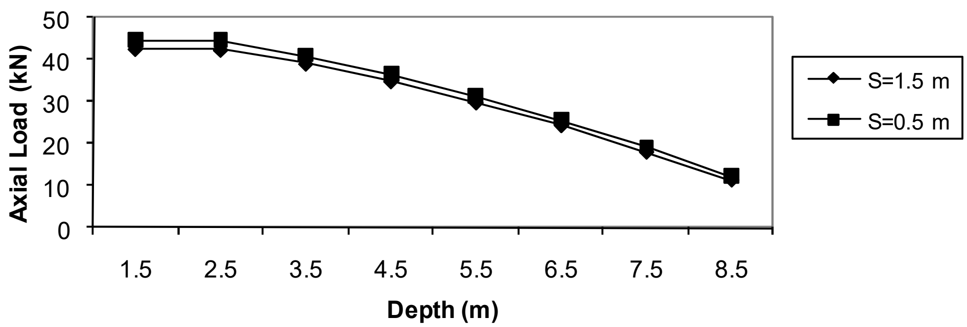

Fig.10 Axial Load Distribution (L/d=20, Udl=20 kN/m^2)

Fig.11 shows the axial load distribution for udl equal to 60 kN/m^2. The axial load distribution for udl equal to 60 kN/m^2 is greater than the axial load for udl equal to 20 kN/m^2(Fig.10) throughout the length of pile of L/d equal to 20.

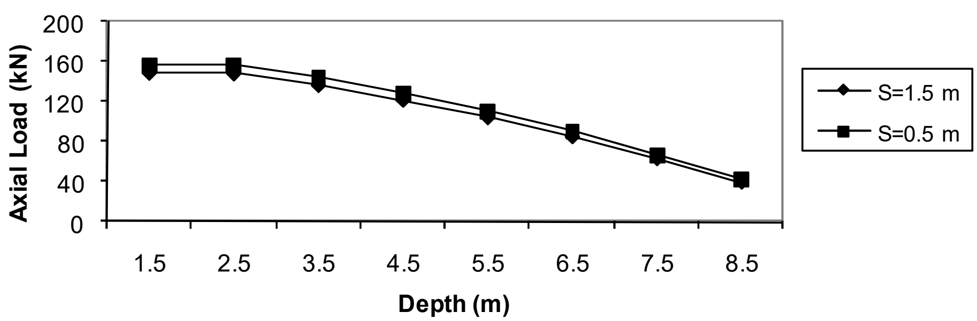

Fig.11 Axial Load Distribution (L/d=20, Udl=60 kN/m^2)

Fig.12 shows the axial load distribution for pile of length to diameter L/d equal to 20. The axial load distribution is greater at spacing 0.5 metre than at spacing 1.5 metre throughout the depth of pile.This is due to more interaction at smaller spacing.

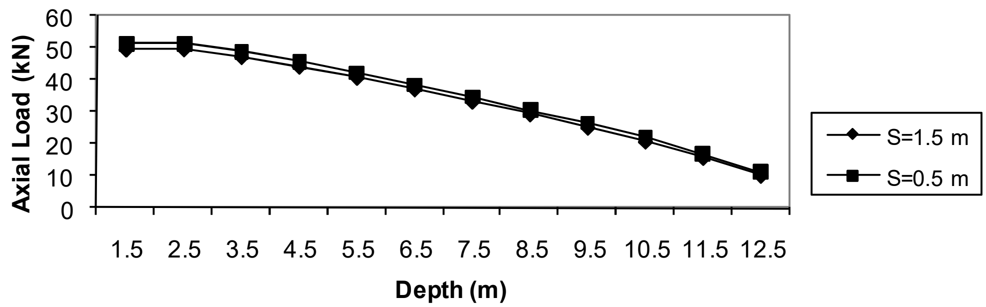

Fig.12 Axial Load Distribution (L/d=30, Udl=20 kN/m^2)

Fig.13 shows the axial load distribution for loading intensity 60 kN/m^2 for L/d ratio equal to 30. Comparison with Fig.12 shows that the axial load distribution is greater for udl equal to 60 kN/m^2 than the udl equal to 20 kN/m^2 for same length to diameter ratio.

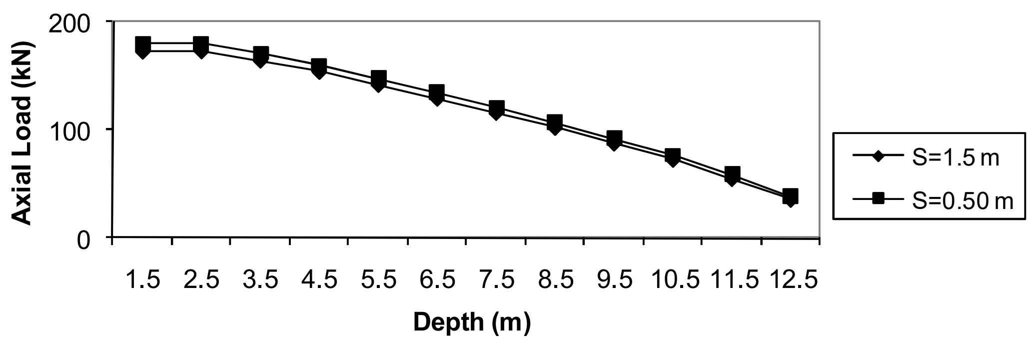

Fig.13 Axial Load Distribution (L/d=30,Udl ,Udl=60 kN/m^2)

Fig.14 shows the axial load distribution for different loading intensities for pile with L/d ratio 20 and spacing 1.5 m. For all loading intensities the axial load is maximum in the top pile element and minimum in the bottom element. The axial load distribution is nonlinear. At loading intensity 100 and 120 kN/m^2 both the curves show approximately same axial load distribution.

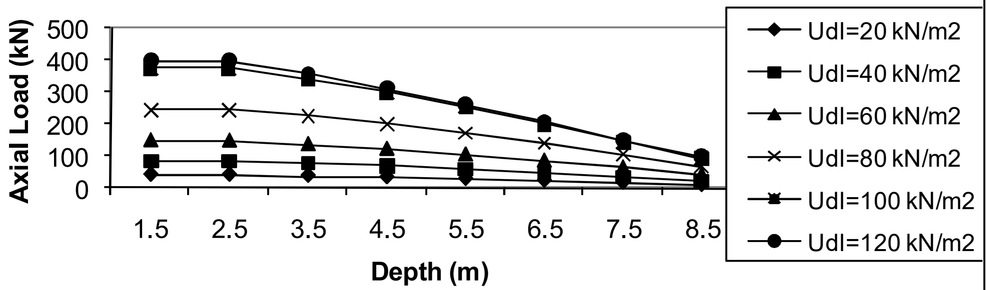

Fig.14 Typical Axial Load Distribution Curve (L/d=20, S=1.5 m)

Fig.15 shows the axial load distribution for various loading intensities at spacing 0.5 m. The axial load distribution vary nonlinearly with depth. For all loading intensities the axial load is maximum at top element and minimum for bottom element.

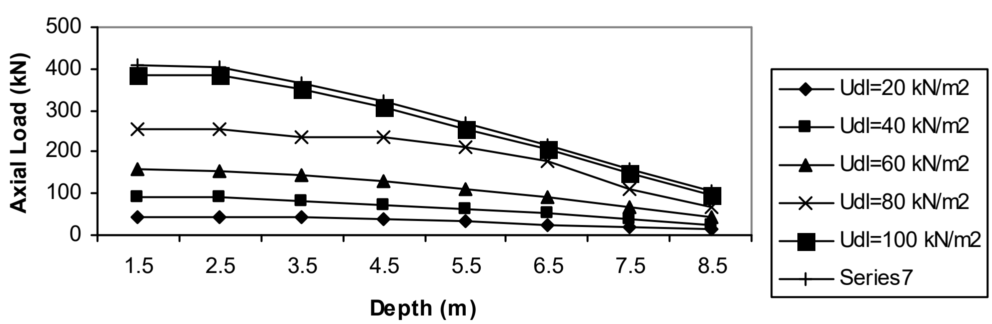

Fig.15 Typical Axial Load Distribution Curve (L/d=20, S=0.50 m)

CONCLUSIONS

The settlement of cap for all spacings remains the same upto 80 kN/m^2. After uniformly distributed loading intensity equal to 80 kN/m^2, the settlement for spacing 0.50 m is maximum and for spacing equal to 1.5 is minimum. This shows that at smaller spacing caps interact more than at larger spacing. For piled cap having length to diameter ratio 10,20 and 30 at smaller spacing interaction is more and hence the pile cap settles more. At larger spacing interaction is less and hence the piled cap settles less. The settlement is maximum for cap and it reduces with increase in length to diameter ratio of pile. The axial load is maximum at top of pile and then it decreases with depth and is minimum at bottom element of pile. This is true for all length to diameter ratio of piles. The axial load distribution is more at spacing 0.50 metre and minimum at spacing equal to 1.5 metre. This is because pile interacts more at smaller spacing. For pile with length to diameter ratio 20 for all loading intensities the axial load is maximum in the top pile element and minimum in the bottom element. The axial load distribution is nonlinear. At loading intensity 100 and 120 kN/m^2 both the curves show approximately same axial load distribution. For no interaction the piled caps should be placed at a distance greater than 1.5 metre.

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