



ANALYTICAL STUDY OF MULTIPLE UNDER REAMED PILE BY GEOMETRICAL VARIATIONS AND LOADING CONSIDERATIONS

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ABSTRACT

When the water table is high, good foundation is not available at an adequate depth, under such circumstances casting of simple pile is most uneconomical. To overcome these conditions, under reamed pile is the best option. The under-reamed pile are casted in an expansive soil. The piles are constructed to transfer the load of heavy structures as high rise structures, industrial structures transmission towers. The bulbs are provided at an adequate depth to normal pile shaft and this pile is known as under-reamed pile. As per the requirement of loads, number of bulbs are provided to pile shaft. As the number of increases, load bearing capacity of pile also increases. Paper deals with analysis of one, two and three bulbs of under-reamed R C C circular piles. All three types of piles were analyzed for number of loading conditions and variable geometrical condition was considered. In case I single bulb under reamed circular R C C pile was taken into account. (1) Different parameters for Stem diameter (D) and length (L) of pile were considered Thus ultimate bearing capacity (Q_u) of pile was obtained. In case II for single bulb pile (2) Substituting various dimensions were considered for ultimate bearing capacity (Q_u) and different parameters were provided to diameter to stem (D). With the help of these two variables, required length of pile (L) were obtained. In case III for same pile (3) Different magnitude of ultimate bearing capacity (Q_u) and for different length of pile (L), the required diameter of stem (D) was obtained. All the above mentioned three cases were applied for two bulb and three bulb piles. All the results thus obtained were shown in tabular form. The results obtained will provide adequate guidelines to civil engineers and contractors.

Keywords: Adhesion Coefficient, Bulb Diameter, Skin Friction, Ultimate Bearing Capacity, Under-Reamed Pile.

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1. INTRODUCTION

For deep foundation/under reamed pile plays a vital role to achieve an economy in terms of material cost as well as labor cost. It also saves time of construction. Under reamed pile with one or more than one bulbs, increase the load bearing capacity. In case of high water table, simple pile can not be selected. Under such condition only the under reamed pile can be used successfully. Before application of over the pile, it is mandatory to apply the check for deviation. In case of single pile up to a diameter of 600 mm, deviation should not be more than 50 mm or $\frac{1}{4}$ th of diameter of pile, whichever is less. If the stem diameter of pile is more than 600 mm then the deviation limit is 100 mm or $\frac{1}{4}$ th of diameter of pile, whichever is less

In this paper, three types of under reamed piles were considered for analysis. One bulb, two bulb, and three bulb piles were taken into considerations. The details of all the three under reamed piles is shown in **Fig. 1**

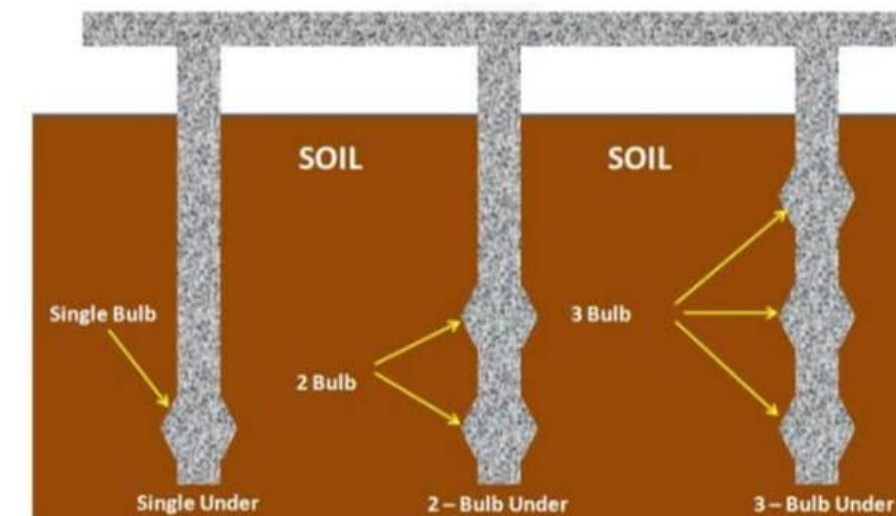


Fig. 1 Under Reamed Pile Details

While analyzing these piles, only axial ultimate axial load was taken into account. Lateral loads, moments, uplift pressure, wind effect, earth quake effects were not taken into considerations. For analysis, total seven parameters were considered. These parameters were L_1 , L_2 , L_3 , L , D , D_u and Q_u . L_1 = Length of pile from ground to first centre of bulb. L_2 = Center to center distance between bulbs. L_3 = Distance from tip of pile to center of last bulb. L = Total length of pile from ground to tip of pile = $L_1 + L_2 + L_3$. D = Diameter of pile/stem. D_u = Diameter of bulb = $2.5 \times$ Diameter of pile. Q_u = Ultimate bearing capacity of soil. Similarly $L_3 = 0.25 \times L_1$. Analysis of piles were taken in three phases.

In phase I Circular Under reamed R C C pile with single bulb was taken in considerations. Only three parameters as L_1 , D and Q_u were selected. With permutation and combinations of different values to these parameters, total nine cases were prepared and the results thus obtained were shown in tabular form The results were displayed in **Table No 1 to Table No 9**.

In phase II Circular Under reamed R C C pile with two bulb were taken in considerations. Only three parameters as L_1 , D and Q_u were selected. With permutation and combinations of different values to these parameters, total twelve cases were prepared and the results thus obtained were shown in tabular form. The results were displayed in **Table No 10 to Table No 21**.

In phase III Circular Under reamed R C C pile with three bulb was taken in considerations. Only three parameters as L1, D and Qu were selected. With permutation and combinations of different values to these parameters, total eleven cases were prepared and the results thus obtained were shown in tabular form. The results were displayed in **Table No 22 to Table No 32**.

2. METHODOLOGY

To analyze the under reamed circular R C C pile number of required parameters were considered, These parameters includes length of pile, diameter of pile, diameter of bulb, number of bulbs, center to center distance and ultimate bearing capacity of pile. For analysis adhesion factor of soil was taken as 0.5 (from IS Code 2911-1980), Similarly the bearing capacity factor was taken as $N_c = 9$. These two parameters were adopted for all the 32 cases mentioned below. Analysis of all under reamed piled was carried out in major three phases.

In **Phase 01**, following **Nine case** details were studied for **single bulb** under reamed circular R C C pile

Case 01: (a) Diameter of shaft (D) was kept constant = 0.3 M (b) Qu varies from 400 KN to 1000 KN (c) To calculate length of pile (L) for all seven values in M

Case 02: (a) Diameter of shaft (D) was kept constant = 0.4 M (b) Qu varies from 600 KN to 1300 KN (c) To calculate length of pile (L) for all eight values in M

Case 03 (a) Diameter of shaft (D) was kept constant = 0.5 M (b) Qu varies from 800 KN to 1200 KN (c) To calculate length of pile (L) for all five values in M

Case 04: (a) Length of shaft (L) was kept constant= 3. M (b) Qu varies from 100 KN to 1000 KN (c) To calculate Diameter of pile (D) for all ten values in MM

Case 05: (a) Length of shaft (L) was kept constant = 4. M (b) Qu varies from 100 KN to 1000 KN (c) To calculate Diameter of pile (D) for all ten values in MM

Case 06: (a) Length of shaft (L) was kept constant = 5. M (b) Qu varies from 100 KN to 1000 KN (c) To calculate Diameter of pile (D) for all ten values in MM

Case 07: (a) Length of shaft (L1) varies from = 3.0 to 10 M (b) Diameter (D is constant = 0.3 M (c) To calculate Qu of pile for all eight values in KN

Case 08: (a) Length of shaft (L1) varies from = 3.0 to 10 M (b) Diameter (D is constant = 0.4 M (c) To calculate Qu of pile for all eight values in KN

Case 09: (a) Length of shaft (L1) varies from = 3.0 to 10 M (b) Diameter (D is constant = 0.5 M (c) To calculate Qu of pile for all eight values in KN

Phase II: Total **thirteen cases for case (Number 10 to 21)** details were studied for **Double bulb** under reamed circular R C C pile

Phase III: Total **Eleven cases for case (Number 22 to 32)** details were studied for **Three bulb** under reamed circular R C C pile

3. OBSERVATIONS

In phase I

Case 01: Analysis of single bulb under reamed pile was carried out. The diameter of pile shaft (D) was kept constant = 0.3 m. The length of pile (L) was calculated for different values of ultimate bearing capacity of pile (Qu) varying from 400 KN to 1000 KN. The results were shown in table 1

Table 1: Showing the relation between Qu and L

Dia in M	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Qu in kn	400	500	600	700	800	900	1000
L in M	4.74	7.1	9.5	11.8	14.2	16.6	18.0

Case 02: Analysis of single bulb under reamed pile was carried out. The diameter of pile shaft (D) was kept constant = 0.4 m. The length of pile (L) was calculated for different values of ultimate bearing capacity of pile (Qu) varying from 600 KN to 1200 KN. The results were shown in table 2

Table 2: Showing the relation between Qu and L

Dia in M	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Qu in kn	600	700	800	900	1000	1100	1200
L in M	4.4	6.3	8.0	10.8	11.5	13.2	15.0

Case 03: Analysis of single bulb under reamed pile was carried out. The diameter of pile shaft (D) was kept constant = 0.5 m. The length of pile (L) was calculated for different values of ultimate bearing capacity of pile (Qu) varying from 800 KN to 1200 KN. The results were shown in table 3

Table 3: Showing the relation between Qu and L

Dia in M	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Qu in kn	X	X	800	900	1000	1100	1200
L in M	X	X	3.6	5.0	6.5	8.06	9.5

Case 04: Analysis of single bulb under reamed pile was carried out. The length of pile shaft (L) was kept constant = 3.0 m. The diameter of pile (D) was calculated for different values of ultimate bearing capacity of pile (Qu) varying from 400 KN to 1000 KN. The results were shown in table 4

Table 4: Showing the relation between Qu and L

L in M	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Qu in kn	400	500	600	700	800	900	1000
D in M	0.325	0.370	0.420	0.460	0.500	0.540	0.570

Case 05: Analysis of single bulb under reamed pile was carried out The length of pile shaft (L) was kept constant = 4.0 m. The diameter of pile (D) was calculated for different values of ultimate bearing capacity of pile (Qu) varying from 400 KN to 1000 KN. The results were shown in table 5

Table 5: Showing the relation between Qu and L

L in M	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Qu in kn	400	500	600	700	800	900	1000
D in M	0.300	0.350	0.400	0.430	0.470	0.500	0.530

Case 06: Analysis of single bulb under reamed pile was carried out The length of pile shaft (L) was kept constant = 5.0 m. The diameter of pile (D) was calculated for different values of ultimate bearing capacity of pile (Qu) varying from 400 KN to 1000 KN. The results were shown in table 6

Table 6: Showing the relation between Qu and D

L in M	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Qu in kn	400	500	600	700	800	900	1000
D in M	0.270	0.320	0.360	0.400	0.450	0.480	0.500

Case 07: Analysis of single bulb under reamed pile was carried out The length of pile shaft (L) varies from 4.0 to 10.0 m. The diameter of pile (D) was kept constant = 0.3 M. To find Ultimate bearing capacity of pile (Qu). The results were shown in table 7

Table 7: Showing the relation between Qu and L1

L1 in M	4	5	6	7	8	9	10
Qu in kn	410	470	520	570	630	680	1000
D in M	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Case 08: Analysis of single bulb under reamed pile was carried out. The length of pile shaft (L) varies from 4.0 to 10.0 m. The diameter of pile (D) was kept constant 0.4M. To find Ultimate bearing capacity of pile (Qu). The results were shown in table 8

Table 8: Showing the relation between Qu and L1

L1 in M	4	5	6	7	8	9	10
Qu in kn	640	700	780	850	920	990	1060
D in M	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Case 09: Analysis of single bulb under reamed pile was carried out The length of pile shaft (L) varies from 4.0 to 10.0 m The diameter of pile (D) was kept constant 0.5M. To find Ultimate bearing capacity of pile (Qu). The results were shown in table 9

Table 9: Showing the relation between Q_u and L_1

L_1 in M	4	5	6	7	8	9	10
Q_u in kn	900	1000	1080	1170	1260	1350	1440
D in M	0.5	0.5	0.5	0.5	0.5	0.5	5

In phase II

Case 10 : Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) varies from 0.4 m to 1.0 m. The length of pile (L_1) was kept constant = 3.0 M to calculate the values of ultimate bearing capacity of pile (Q_u). The results were shown in table 10

Table 10 : Showing the relation between Q_u and D

L_1 in M	3	3	3	3	3	3	3
Q_u in kn	800	1185	1650	2175	2780	3460	4210
D in M	0.4	0.5	0.6	0.57	0.8	0.9	.1.0

Case 11: Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) varies from 0.4 m to 1.0 m. The length of pile (L_1) was kept constant = 4.0 M to calculate the values of ultimate bearing capacity of pile (Q_u). The results were shown in table 11

Table 11: Showing the relation between Q_u and D

L_1 in M	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Q_u in kn	870	1275	1750	2300	2920	3620	4400
D in M	0.4	0.5	0.6	0.7	0.8	0.9	.1.0

Case 12: Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) varies from 0.4 m to 1.0 m. The length of pile (L_1) was kept constant = 5.0 M to calculate the values of ultimate bearing capacity of pile (Q_u). The results were shown in table 12

Table 12: Showing the relation between Q_u and D

L_1 in M	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Q_u in kn	950	1360	1860	2420	3060	3780	4560
D in M	0.4	0.5	0.6	0.7	0.8	0.9	.1.0

Case 13: Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) varies from 0.4 m to 1.0 m. The length of pile (L_1) was kept constant = 6.0 M to calculate the values of ultimate bearing capacity of pile (Q_u). The results were shown in table 13

Table 13: Showing the relation between Qu and D

L1 in M	6.0	6.0	.6.0	6.0	6.0	6.0	6.0
Qu in kn	1010	1450	1560	2545	3200	3940	4740
D in M	0.4	0.5	0.6	0.7	0.8	0.9	.1.0

Case 14: Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) is to be calculated. The length of pile (L1) was kept constant = 3.0 M. The ultimate bearing capacity of pile (Qu) Varies 200 to 1000 Kn. The results were shown in table 14

Table 14: Showing the relation between Qu and D

L1 in M	3.0	3.0	3.0	3.0	3.0	x	X
Qu in kn	200	400	600	800	1000	x	X
D in M	0.25	0.3	0.35	0.40	0.45	x	X

Case 15 : Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) is to be calculated. The length of pile (L1) was kept constant = 4.0 M. The ultimate bearing capacity of pile (Qu) Varies 200 to 1000 Kn. The results were shown in table 15

Table 15: Showing the relation between Qu and D

L1 in M	4.0	4.0	4.0	4.0	4.0	x	X
Qu in kn	200	400	600	800	1000	x	X
D in M	0.160	0.251	0.350	0.400	0.450	x	X

Case 16: Analysis of **Double bulb** under reamed pile was carried out The diameter of pile shaft (D) is to be calculated The length of pile (L1)was kept constant = 5.0 M The ultimate bearing capacity of pile (Qu) Varies 200 to 1000 Kn. The results were shown in table 16

Table 16: Showing the relation between Qu and D

L1 in M	5	5	5	5	5	x	X
Qu in kn	200	400	600	800	1000	x	X
D in M	0.160	0.230	0.30	0.36	0.42	x	X

Case 17: Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) is to be calculated. The length of pile (L1) was kept constant = 6.0 M The ultimate bearing capacity of pile (Qu) Varies 200 to 1000 Kn. The results were shown in table 17

Table 17: Showing the relation between Qu and D

L1 ln M	6	6	6	6	6	x	x
Qu in kn	200	400	600	800	1000	x	x
D in M	0.140	0.220	00.30	0.35	0.40	x	x

Case 18: Analysis of **Double bulb** under reamed pile was carried out . The diameter of pile shaft (D) is kept constant= 0.3 M. The length of pile (L) to be calculated The ultimate bearing capacity of pile (Qu) Varies 250 to 1000 Kn. The results were shown in table 18

Table 18: Showing the relation between Qu and D

L ln M	2.6< 3	5.1	11.0	16.9	X	x	x
Qu in kn	250	500	750	1000	X	x	x
D in M	0.3	0.3	0.3	0.3	X	x	x

Case 19: Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) is kept constant= 0.4 M. The length of pile (L) to be calculated The ultimate bearing capacity of pile (Qu) Varies 250 to 1000 Kn. The results were shown in table 19

Table 19: Showing the relation between Qu and D

L ln M	1.7.5	3.107	4.35	8.77	X	x	x
Qu in kn	250	500	750	1000	X	x	x
D in M	0.4	0.4	0.4	0.4	X	x	x

Case 20: Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) is kept constant= 0.5 M. The length of pile (L) to be calculated the ultimate bearing capacity of pile (Qu) Varies 250 to 1000 Kn. The results were shown in table 20

Table 20: Showing the relation between Qu and D

L ln M	11.35	7.83	4.28	3.0	X	x	x
Qu in kn	250	500	750	1000	X	x	x
D in M	0.5	0.5	0.5	0.5	X	x	x

Case 21: Analysis of **Double bulb** under reamed pile was carried out. The diameter of pile shaft (D) is kept constant= 0.6 M. The length of pile (L) to be calculated The ultimate bearing capacity of pile (Qu) Varies 250 to 1000 Kn. The results were shown in table 21

Table 21: Showing the relation between Qu and D

L ln M	15.0	12.0	9.0	6.08	X	x	X
Qu in kn	250	500	750	1000	X	x	X
D in M	0.6	0.6	0.6	0.6	X	x	X

In phase III

Case 22 : Analysis of **Three bulb** under reamed pile was carried out. The diameter of pile shaft (D) was varying from 0.3 M to 0.9M The length of pile. (L1) is kept constant =3.0 MT to calculate ultimate bearing capacity of pile (Qu) The results were shown in table 22

Table 22 : Showing the relation between Q_u and D

L1 ln M	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Q_u in kn	622.75	1036.46	1553.22	2173	2896	3722	4651
D in M	0.3	0.4	0.5	0.6	0.7	0.8	0.9

Case 23: Analysis of Three bulb under reamed pile was carried out . The diameter of pile shaft (D) was varying from 0.3 M to 0.9M. The length of pile (L_1) is kept constant = 4.0 M to calculate ultimate bearing capacity of pile (Q_u) The results were shown in table 23

Table 23: Showing the relation between Q_u and D

L1 ln M	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Q_u in kn	675.75	1107	1642	2280	3020	3860	4810
D in M	0.3	0.4	0.5	0.6	0.7	0.8	0.9

Case 24: Analysis of Three bulb under reamed pile was carried out. The diameter of pile shaft (D) was varying from 0.3 M to 0.9M The length of pile (L_1) is kept constant =5.0 M to calculate ultimate bearing capacity of pile (Q_u). The results were shown in table 24

Table 24: Showing the relation between Q_u and D

L1 ln M	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Q_u in kn	730	1178	1730	2385	3145	4005	4970
D in M	0.3	0.4	0.5	0.6	0.7	0.8	0.9

Case 25: Analysis of Three bulb under reamed pile was carried out. The diameter of pile shaft (D) was varying from 0.3 M to 0.9M The length of pile (L_1) is kept constant = 6.0 M to calculate ultimate bearing capacity of pile (Q_u). The results were shown in table 25

Table 25: Showing the relation between Q_u and D

L1 ln M	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Q_u in kn	780	1250	1820	2490	3270	4150	5130
D in M	0.3	0.4	0.5	0.6	0.7	0.8	0.9

Case 26: Analysis of Three bulb under reamed pile was carried out. The diameter of pile shaft (D) was kept constant = 0.2 M. The length of pile (L) is to be calculated Ultimate bearing capacity of pile (Q_u) varying from 300 Kn to 900 Kn. The results were shown in table 26

Table 26: Showing the relation between Q_u and L

L ln M	4.82	8.35	11.90	15.43	19.0	x	x
Q_u in kn	300	400	500	600	700	x	x
D in M	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Case 27: Analysis of Three bulb under reamed pile was carried out. The diameter of pile shaft (D) was kept constant= 0.3 M The length of pile (L) is to be calculated Ultimate bearing capacity of pile (Qu) varying from 300 Kn to 900 Kn. The results were shown in table 27

Table 27: Showing the relation between Qu and L

L in M	3.10	3.75	4.10	5.50	7.82	10.20	12.50
Qu in kn	300	400	500	600	700	800	900
D in M	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Case 28: Analysis of Three bulb under reamed pile was carried out. The diameter of pile shaft (D) was kept constant= 0.4 M The length of pile (L) is to be calculated Ultimate bearing capacity of pile (Qu) varying from 300 Kn to 900 Kn The results were shown in table 28

Table 28: Showing the relation between Qu and L

L in M	12.3	10.5	8.75	7.0	5.2	3.0	X
Qu in kn	300	400	500	600	700	800	900
D in M	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Case 29 : Analysis of Three bulb under reamed pile was carried out The diameter of pile shaft (D) was to calculate The length of pile (L1) is kept constant = 3.0 M. Ultimate bearing capacity of pile (Qu) varying from 300 Kn to 900 Kn. The results were shown in table 29

Table 29: Showing the relation between Qu and D

L in M	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Qu in kn	300	400	500	600	700	800	900
D in M	0.20	0.23	0.27	0.3	0.32	0.35	0.37

Case 30: Analysis of Three bulb under reamed pile was carried out The diameter of pile shaft (D) was to calculate The length of pile (L1) is kept constant = 4.0 M. Ultimate bearing capacity of pile (Qu) varying from 300 Kn to 900 Kn. The results were shown in table 30

Table 30: Showing the relation between Qu and D

L in M	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Qu in kn	300	400	500	600	700	800	900
D in M	0.2	0.22	0.25	0.28	0.31	0.33	0.35

Case 31 : Analysis of Three bulb under reamed pile was carried out. The diameter of pile shaft (D) was to calculate. The length of pile (L1) is kept constant = 5.0 M Ultimate bearing capacity of pile (Qu) varying from 300 Kn to 900 Kn. The results were shown in table 31

Table 31: Showing the relation between Qu and D

L in M	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Qu in kn	300	400	500	600	700	800	900
D in M	0.18	0.20	0.24	0.27	0.30	0.32	0.34

Case 32: Analysis of Three bulb under reamed pile was carried out. The diameter of pile shaft (D) was to calculate the length of pile (L1) is kept constant = 6.0 M. Ultimate bearing capacity of pile (Qu) varying from 300 Kn to 900 Kn. The results were shown in table 32

Table 32: Showing the relation between Qu and D

L in M	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Qu in kn	300	400	500	600	700	800	900
D in M	0.16	0.20	0.23	0.25	0.28	0.30	0.33

RESULTS

Single bulb under reamed R C C circular pile, for every 100 KN increase of bearing capacity of pile with constant pile diameter, the length of pile increases by 2.0 M

For every 100 Kn Increase of bearing capacity of pile and increasing the diameter of pile shaft by 0.1 M, length of increases by 1.5 M

Increase of bearing capacity by every 100 KN and the length of pile was kept constant, the diameter of stem increases by 70 MM

Diameter of pile was kept constant = 0.5 m increment of length by 1.0 M, magnitude of bearing capacity increases by 90 unit for every 1 M change in length.

Keeping the pile length constant and increase the ultimate bearing capacity increases by every 100 units, the diameter of pile shaft increases by 50 mm

Keep the shaft diameter = 0.30 m and change the length of pile by every meter, magnitude of bearing capacity increases by 50 units

As the diameter of pile increases from 0.3 m to 0.4 m and length of pile was kept constant, the magnitude of bearing capacity increases by 70.0 Kn

For constant pile length and for every 0.1 m diameter of pile, the bearing capacity of pile increases by an important relation as = $300 + \text{Diameter of pile} * 100$

For every increase of ultimate bearing capacity of pile by 200 Kn and keeping the pile length constant, the diameter of pile shaft increases by 0.06 M.

For increase of bearing capacity of pile by every 250 KN, keeping the pile diameter constant, the length of pile decreases by 3.0 M

For three bulb under reamed circular pile with p constant pile length and variable diameter of pile, the bearing capacity of pile increases by: $600 + D * 1000$. Always consider the value of D Diameter of pile in M.

Keeping the diameter of pile as constant, bearing capacity of pile increases at an equal interval of 100 KN, the length of pile increases by 3.5 M for every increased value of bearing capacity of pile.

For constant pile length and varying magnitude of bearing capacity of pile at an equal interval of 100 KN, the length of pile increases by 0.20 M

It was observed that for pile diameter of 0.3 m and pile length of 3.0 M, the magnitude of ultimate bearing capacity of two bulb pile is 1.37 times single bulb pile.

It was observed that for pile diameter of 0.3 m 0.4 and 0.5 m, and pile length of 3.0 M ,4.0 m and 5.0m, the magnitude of ultimate bearing capacity of three bulb pile is 1.27 times two bulb type of pile.

It was observed that magnitude of ultimate bearing capacity of three bulb pile is 1.27 times the bearing capacity of two bulb pile for all the diameters and lengths of piles

For all diameters and lengths, the ratio for magnitude of bearing capacity of one, two, and three bulb was 1: 1.37: 1.74

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