REPORT ON

SUB SOIL INVESTIGATION AND RECOMMENDATION FOR THE FOUNDATION OF PROPOSED HIGH LEVEL BRIDGE [HLB] ACROSS RIVER VRUDHA GOWTHAMI @ G MOOLAPALEM IN KM 10/140 OF YEDURULANKA – G MOOLAPALEM ROAD IN EAST GODAVARI DISTRICT – ANDHRA PRADESH [PIER, P-9 BORE HOLE]

1 INTRODUCTION

The Executive Engineer, R & B Division, Amalapuram and Superintending Engineer, R&B Circle, Kakinada requested the Civil Engineering Department of V.R.Siddhartha Engineering College, Vijayawada to conduct necessary soil investigation and provide the soil parameters & recommend suitable foundation and bearing capacity of soil for the proposed High Level Bridge [**HLB**] across **Vrudha Gowthami river @ G Moolapalem in KM 10/140 of Yedurulanka – G Moolapalem road in East Godavari District** of Andhra Pradesh [vide letter No.2414/HLB/JTO/TO/2007-16(2) dated 26.02.2016].

The following are the responsibilities of M/S V. R. Siddhartha Engineering College, Vijayawada.

- Soil boring of 150 mm diameter upto 60 metres depth in **Pier, P 9** location as specified by the client.
- Collection of undisturbed and disturbed soil samples from the bore
- Conducting Standard Penetration Test (SPT) at regular intervals within the bore.
- Testing of undisturbed and disturbed soil samples collected from the bore in the laboratory.
- Recommendation of suitable bearing capacity and type of foundation for the proposed structure.

M/S Sri Manikantha Tube Well Works, Peravali did the soil boring, sample collection and field testing on behalf of V R Siddhartha Engineering College, Vijayawada.

This report contains the results of field and laboratory tests. Recommendations on bearing capacity of soil and type & depth for foundation for the proposed High Level Bridge [**HLB – Pier, P 9**] are also included.

2 **THE STRUCTURE AND LOCATION**

The proposed structure is a High Level Bridge [HLB] across **Vrudha Gowthami river @ G Moolapalem in KM 10/140 of Yedurulanka – G Moolapalem road in East Godavari District** of Andhra Pradesh [**Pier P-9 location**]

3 FIELD SOIL INVESTIGATION PROCEDURES

The following methods were adopted for sub-soil investigations as per IS: 1892-1979. One soil investigation bores of 150 mm diameter upto a depth of 60 metres was proposed and drilled within the proposed structure location. Boring was done using combination of shell and auger methods with casing pipe to depending upon the type of strata met with in the bore hole location using hand boring machine. Bore holes of 150 mm diameter with casing pipe were drilled to facilitate collection of Undisturbed and Disturbed soil samples and to conduct Standard Penetration Tests.

Standard Penetration Tests (SPT) were conducted at 2.0 meter intervals within each bore. These tests were conducted as per IS:2131-1981. Number of disturbed but representative soil samples were collected from the auger cuttings sand bailers for identification and for conducting laboratory tests. Undisturbed soil samples (in Clayey soil) were also collected at 2.0 metre intervals from the boreholes. The bore hole **Pier P-9** was advanced upto a depth of 60 metres below the existing ground level. A Strata is considered to be hard, when the standard penetration test value, N i.e. the number of blows required for 300 mm penetration of the SPT spoon beyond a seating penetration of 150 mm in the strata is more than 100 (Clause 3.3.3 of IS:3132-1981). If the penetration of the spoon is less than 300 mm more than 50 blows, the N value is written as N>100. The depth of water table at the end of boring is observed. All the results obtained from the field operations are shown in the log of bore (Figure: 1)

4 **LABORATORY TESTS**

Indices tests such as natural moisture content, liquid limit, plastic limit and unit weight were conducted on DS/UDS soil samples as per Indian Standard to identify and

establish the consistency of these soils. Sieve analysis tests were also conducted on sandy/gravelly soil for knowing the particle size distribution and classification of soil. Unconfined compressive strength tests and direct shear tests were conducted on UDS soil sample to know the shear strength of soil. The results are given in Table 1 to 2.

5 SUB SOIL PROFILES

The Sub soil profile at the bore hole locations, based on the identification of soil samples and the results of tests (both field and laboratory) are indicated in Figure 1. The idealized design soil parameters are given in Table 1.

5.1 Bore Hole Number: 1 – Pier P-9

Depth Below Ground Level	Soil Type and Classification	Recorded SPT "N" Value
0.00 – 2.50	Blackish plastic silty clay [MH-CH] - soft	UDS
2.50 – 5.60	Blackish brown plastic marine silty clay – soft [CH]	2
5.60 – 8.00	Blackish brown sandy silty with binder [SM-SC]	16
8.00– 10.00	Brownish silty fine to medium sand [SM-SP]	6
10.00 – 11.00	Brownish silty fine to medium sand [SM-SP]	15
11.00 – 14.00	Blackish brown plastic silty clay [CH]	2
14.00 – 16.00	Blackish brown plastic silty clay [CH]	3
16.00 – 20.00	Blackish brown plastic silty clay [CH]	4, 5
20.00 – 30.00	Blackish brown plastic silty clay [CH]	6, 4
30.00 – 44.00	Blackish brown plastic silty clay [CH] – medium stiff	10,11,12
44.00 – 46.50	Blackish brown plastic silty clay [CH] – medium stiff	14, 17
46.50 – 50.00	Brownish silty sand with binder – [SM-SC]	24
50.00 - 56.50	Brownish silty fine to medium sand [SM-SP]	29
56.50 – 58.50	Brownish silty fine to medium sand [SM-SP], Dense	50
58.50 – 60.00	Brownish silty fine to medium sand [SM-SP], Dense	>100

SILT FACTOR:

The silt factor, f as per Lacy's equation can be calculated from the sieve analysis of soil samples using weighted mean grain size.

Lacy's Silt factor, f will be **1.76 √ Dm**

where Dm = weighted mean grain size

The design calculations are as follows:

Bed material – Silty clay upto 5.60m depth – silty clay will have a very low silt factor. The clay is not erodible as per sediment transport equation. More over, IS : 3955-1967 there is no provision in the list of bed material [Table 1 – Silt factor for coarse silt to gravel] .

However, for design purpose a silt factor, **f = 1.00 is proposed for the silty clay**

6 SELECTION OF FOUNDATION AND BEARING CAPACITY OF SOIL

Since the proposed structure is a High Level Bridge, Deep foundation in the form of Pile foundation is suitable.

Bore Hole No. : Pier, P-9

---------- 0.0 metres
Cohesion, C = 1.6 t/m^2 Clay UDS
Angle of friction, ϕ = 0 deg α = 0.7
---------- 2.50 metres
Cohesion, C = 1.0 t/m^2 Clay N = 2
Angle of friction, ϕ = 0 deg α = 0.7
---------- 5.60 metres
Cohesion, C = 1.0 t/m^2 Sand N = 16
Angle of friction, ϕ = 33deg
---------- **8.00 metres**
Cohesion, C = 0.0 t/m^2 Silty sand, N = 6
Angle of friction, ϕ = 28deg
---------- 10.00 metres
Cohesion, C = 0.0 t/m^2 Silty sand, N = 15
Angle of friction, ϕ = 32deg
---------- 11.00 metres
Cohesion, C = 1.0 t/m^2 Clay N = 2
Angle of friction, ϕ = 0 deg α = 0.7
---------- 14.00 metres
Cohesion, C = 1.5 t/m^2 Clay N = 3
Angle of friction, ϕ = 0 deg α = 0.7
---------- 16.00 metres

Cohesion, C = 2.0 to 2.5 t/m^2 Clay N = 4,5
Angle of friction, ϕ = 0 deg α = 0.7
---------- 20.00 metres
Cohesion, C = 3.0 t/m^2 Clay N = 6,4
Angle of friction, ϕ = 0 deg α = 0.7
---------- 30.00 metres
Cohesion, C = 5.0, 5.5, 6.0 t/m^2 Clay N = 10, 11,12
Angle of friction, ϕ = 0 deg α = 0.4
---------- 44.00 metres
Cohesion, C = 6.9, 8.5 t/m^2 Clay N = 14, 17
Angle of friction, ϕ = 0 deg α = 0.40 & 0.30
---------- 46.5 metres
Cohesion, C = 4.4 t/m^2 Sand N = 24
Angle of friction, ϕ = 33deg Nq = 30-35
---------- **50.0**metres
Cohesion, C = 0.0 t/m^2 Sand N = 2294
Angle of friction, ϕ = 33deg Nq = 30-35
---------- **56.5**metres
Cohesion, C = 0.0 t/m^2 Sand N = 50
Angle of friction, ϕ = 36deg Nq = 50-55
---------- **58.50**metres
Cohesion, C = 0.0 t/m^2 Sand N = >100
Angle of friction, ϕ = 40deg Nq = 75
---------- **60.0**metres

Deep Foundation in the form of Bored cast in situ pile foundation is ideal for this location. The length and size & its load carrying capacity can be obtained from the soil properties given in Table 1

In case of pile foundation, the load carrying capacity of the pile can be calculated using the static formula given by IS: 2911 (Part 1 /Sec 2) - 2010 considering both friction and bearing resistance. The allowable load is normally obtained by using an overall factor of safety of 2.5. The load carrying of pile can also be obtained from the SPT, N values.

For the correlation of cohesion and unconfined compressive strength, static cone resistance from N values, IS: 2911 (Part 1 /Sec 2) - 2010 is followed.

Unconfined compressive strength = qc = N

Cohesion, c = qc/2

Static cone resistance = 2N

Pile foundation in the form of Bored cast in-situ piles with casing is preferable in this location. Already 1300 mm diameter piles of 33 metres long is proposed and constructed in this location [**6 piles of 1300 mm diameter, 33 metres long with 3.90 m centre to centre spacing for Pier, P9]**

The ultimate load carrying capacity of single pile can be obtained from Static Formula as given in IS: 2911 (Part 1 /Sec 2) - 2010 for bored piles considering Skin Friction and bearing resistance.

For Piles in Cohesive Soil [Clay]

$Qu = Ap \cdot Nc \cdot Cp + \alpha \cdot C \cdot As$ ----- (1)

Ap = Cross sectional area of the pile toe

Nc = Bearing capacity factor usually taken as 9 for deep foundation

Cp = Average cohesion at pile tip

α = reduction factor [usually 0.3 to 1 depends on the strength of clay]

C = Average cohesion through out the length of pile

For Piles in Cohesionless Granular Soil [Sand]

$Qu = Ap \cdot Pd \cdot Nq + \sum K. Pdi \cdot \tan \delta \, Asi$

Ap = Cross sectional area of the pile toe

Pd = effective overburden pressure at pile toe – limited to 15D to 20 D

Nq = bearing capacity factor depends upon the angle of internal friction, ϕ

K = coefficient of earth pressure, between 1 and 1.5

Pdi = effective overburden pressure for the layer concerned

δ = angle of wall friction between the soil and pile – usually taken as $2/3\phi$ to ϕ

Asi = surface area of pile stem for the layer concerned

Total length = 33 metres for load carrying capacity calculation

Scour Depth = 16.00 metres [assumed]

Submerged unit weight of soil, γ_{sub} = 1.0 t/m^3

Critical depth, Dc = 15 times the diameter of pile = 19.5 m;

Pd at the tip = 15.0 t/m^2

1. <u>For a pile of **1300** mm diameter and 33 metres long</u>, the ultimate load will be

Depth {m}	Length [m]	Skin Friction / Bearing	Skin Friction / Bearing [tonnes]	Total
0 to 2.50 m	2.50 m	3.14 x 1.3 x 2.5 x 1.6 x 0.7	11.435	Upto scour depth of 16 metres
2.50 to 5.60	3.10 m	3.14 x 1.3 x 3.1 x 1.0 x 0.7	8.862	
5.60 to 8.00	2.40 m	3.14 x 1.3 x 2.4 x 1 x 6 x tan 33	38.19	
8.0 to 10.00	2.00 m	3.14 x 1.3 x 2.0 x 1 x 8 x tan 28	34.74	
10.0 to 11.00	1.00 m	3.14 x 1.3 x 1.0 x 1 x 9 x tan 32	22.97	
11.00 to 14.0	3.00 m	3.14 x 1.3 x 3 x 1.00 x 0.7	8.576	
14.00 to 16.0	2.00 m	3.14 x 1.3 x 2 x 1.50 x 0.7	8.576	133.349
16.0 to 18.00	2.00 m	3.14 x 1.3 x 2 x 2.0 x 0.7	11.435	
18.0 to 20.00	2.00 m	3.14 x 1.3 x 2 x 2.5 x 0.7	14.294	
20.0 to 25.00	5.00 m	3.14 x 1.3 x 5 x 3.0 x 0.7	42.883	
25.0 to 30.00	5.00 m	3.14 x 1.3 x 5 x 3 x 0.7	42.883	
30.0 to 33.00	3.00 m	3.14 x 1.3 x 3 x 5.0 x 0.40	24.50	269.344
	Bearing	[{3.14 x 1.3 x1.3}/4 x 9 x 5.5]	65.70	335.044

$Qu = Q_{Skin} + Q_{Bearing}$

= 269.344+ 65.70 = 335.044

Qs = Qu / FS = 335.044/ 2.5 =134.017 tonnes say 134 tonnes

Assuming there will not be resistance upto 16.00 metres [Scour depth]

Qu = 135.995+ 65.70 = 201.695

Qs = 201.695/ 2.5 = 80.68 t say 81 tonnes

Total skin friction upto 16.00 metres (allowable) =133.349/ 2.5 = 53 tonnes

For lateral load on piles, IS: 2911 (Part 1 /Sec 2) - 2010 proposed a method for the determination of depth of fixity of pile required for design.

Since the piles are connected by means of pile cap at the top, the piles are assumed as fixed cantilever.

The value of constant modulus of horizontal subgrade reaction, n_h , or the modulus of subgrade reaction K of the soil may be estimated from Table 3 or Table 4 of IS: 2911 (Part 1 /Sec 2) - 2010 [Annex C] for sands and clay respectively.

The value of L, the equivalent length of cantilever giving the same deflection at the ground level as the actual pile may be obtained from graphs given in Figure 2 and 3.

Since the soil at the top is silty clay, constant modulus of horizontal subgrade reaction,

K1 = 3.00 is proposed for this soil condition in silty clay, having a N value of 2 at the top.

The constants, K1 and K2 for sand and clay respectively can be obtained from Table 3 and Table 4 of IS:2911-2010 [Appendix – C : Clause 5.5.2 – Determination of Depth of Fixity, Lateral Deflection and maximum moment of laterally loaded piles]

The depth of fixity is depends on the size of pile and length of pile [L/T or L/R]

K1 = 3.0

K = [K1/1.5] x [0.3/B] = 0.46

Calculation of Lateral Load Carrying Capacity 1300 mm diameter Pile:

Grade of Concrete = M 35

Concrete Elastic Modulus [E] = 5000 $\{fck\}^{1/2}$ = 29580 N/mm^2

Moment of Inertial {I} = 0.1402 m^4

For K = 0.46

Stiffness factor, R in [m] = $[E I / KB]^{1/4}$

= $[(29580x 0.1402)/ (0.46 x 1.3)]^{1/4}$

R = 9.126 m

Length of pile = L = 33 m

L/R = 33/ 9.126 = 3.616 hence it is long column

Assuming L1 = 16.00 m [actual scour depth, 16.00 m]

Lf = 17.00 m

Depth of fixity for long piles and fixed at top with pile cap

For Fixed end pile and Pre loaded clay, Zf/R = 1.62 for L1/R = 1.75

Z_f = 1.62 x 9.126 = 14.80 m which is less than 17.0 m [available] and hence O.K.

Allowable deflection (y) in mm = 1.0 % pile diameter at the scour level as per IRC 78 - 2000

Allowable deflection (y) = 13 mm

Lateral load carrying capacity of fixed pile = $\{12 \text{ y E I}\} / [L_f]^3$

$= [(12 \text{ x } 13 \text{ x } 29580 \text{ x } 0.1402)/14.8^3]$

Q = 199.57 KN = 19.96 tonnes say 20.0 tonnes

- **silt factor, f = 1.00 is proposed for the silty clay**
- **Casing is proposed for the pile foundation. The Casing will be provided upto a length of 33 meters ie upto the sand layer.**

Modulus of horizontal subgrade reaction, K1= 3.00 and K = 0.46 is proposed for this soil condition.

Depth of fixity for long piles and fixed at top with pile cap = 14.80 metres

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It is proposed now an additional pier in between the existing piers

It is suggested 1000 /1300 mm diameter piles upto 48 to 50 metres

<u>IS: 2911 (Part 1 /Sec 2) – 2010 Annex B suggested for piles passing through cohesive strata (clay) and terminating in a granular stratum (sand), a penetration of at least twice the diameter of the pile shaft should be given in to the granular stratum</u>

Pile lengths considered for analysis – 48 metres, 50 metres and 50 metres
Scour Depth = 16.00 metres
Skin Friction upto 16.00 metres = 53 tonnes

2. For a pile of **1300** mm diameter and 48/49/ 50 metres long, the ultimate load will be

Depth {m}	Length [m]	Skin Friction / Bearing	Skin Friction / Bearing [tonnes]	Total
0 to 2.50 m	2.50 m	3.14 x 1.3 x 2.5 x 1.6 x 0.7	11.435	Upto scour depth of 16 metres
2.50 to 5.60	3.10 m	3.14 x 1.3 x 3.1 x 1.0 x 0.7	8.862	
5.60 to 8.00	2.40 m	3.14 x 1.3 x 2.4 x 1 x 6 x tan 33	38.19	
8.0 to 10.00	2.00 m	3.14 x 1.3 x 2.0 x 1 x 8 x tan 28	34.74	
10.0 to 11.00	1.00 m	3.14 x 1.3 x 1.0 x 1 x 9 x tan 32	22.97	
11.00 to 14.0	3.00 m	3.14 x 1.3 x 3 x 1.00 x 0.7	8.576	
14.00 to 16.0	2.00 m	3.14 x 1.3 x 2 x 1.50 x 0.7	8.576	133.349
16.0 to 18.00	2.00 m	3.14 x 1.3 x 2 x 2.0 x 0.7	11.435	
18.0 to 20.00	2.00 m	3.14 x 1.3 x 2 x 2.5 x 0.7	14.294	
20.0 to 25.00	5.00 m	3.14 x 1.3 x 5 x 3.0 x 0.7	42.883	
25.0 to 30.00	5.00 m	3.14 x 1.3 x 5 x 3 x 0.7	42.883	
30.0 to 33.00	3.00 m	3.14 x 1.3 x 3 x 5.0 x 0.40	24.50	269.344
33.0 to 36.0	3.00 m	3.14 x 1.3 x 3 x 5.5 x 0.40	26.955	
36.0- 39.00	3.00 m	3.14 x 1.3 x 3 x 5.5 x 0.4	26.955	
39.0 – 42.00	3.00 m	3.14 x 1.3 x 3 x 6.0 x 0.4	29.405	
42.0 – 44.00	2.00 m	3.14 x 1.3 x 2 x 6.0 x 0.4	19.603	
44.0 – 45.00	1.00 m	3.14 x 1.3 x 1 x 6.9 x 0.4	11.272	
46.0 – 46.50	1.50 m	3.14 x 1.3 x 1.5 x 8.5 x 0.3	15.622	
46.50 – 48.00	1.50 m	3.14 x 1.3 x 1.5 x 1 x 15 x tan 30	53.05	452.206
48.00 – 49.00	2.00 m	3.14 x 1.3 x 1 x 1 x 15 x tan 33	35.365	487.571
49.00- 50.00	2.00 m	3.14 x 1.3 x 1 x 1 x 15 x tan 33	35.365	522.936
Bearing upto 48 metes		[{3.14 x 1.3 x1.3}/4 x15 x 30]	597.3	
Bearing upto 50 metes		[{3.14 x 1.3 x1.3}/4 x15 x 30]	597.3	
Bearing upto 52 metes		[{3.14 x 1.3 x1.3}/4 x15 x 30]	597.3	

For a pile of 1300 mm diameter upto 48 metres depth

$Qu = Q_{Skin} + Q_{Bearing}$
= 452.206 + 597.3 = 1049.506

Qs = Qu / FS = 1049.506/2.5 = 419.8 tonnes say 420 tonnes

Assuming there will not be resistance upto 16.0 metres [Scour depth]

Total skin friction upto 16.00 metres (allowable) = 53 tonnes
Q safe = 420 – 53 = 367 tonnes for a pile of 1300 mm diameter and 48 metres

3. For a pile of **1300** mm diameter and 49 metres long, the ultimate load will be

Q Safe = [487.571 + 597.3] / 2.5 = 1084.871/ 2.5

= 433.95 tonnes say 434 tonnes

Q safe = 434 tonnes – 53 tonnes = 381 tonnes

4. For a pile of **1300** mm diameter and 50 metres long, the ultimate load will be

Q Safe = [522.936 + 597.3] / 2.5 = 1120.236/ 2.5

= 448.09 tonnes say 448 tonnes

Q safe = 448 tonnes – 53 tonnes = 395 tonnes

5. For a pile of 1000 mm diameter upto 33 metres depth

$Qu = Q_{Skin} + Q_{Bearing}$

= 207.187 + 38.875 = 246.06

Qs = Qu / FS = 246.06/2.5 = 98.425 tonnes say 98 tonnes

Assuming there will not be resistance upto 16.0 metres [Scour depth]

Total skin friction upto 16.00 metres (allowable) = 102.576/2.5 = 41 tonnes

Q safe = 98 – 41 = 57 tonnes for a pile of 1000 mm diameter and 33 metres

6. For a pile of 1000 mm diameter upto 48 metres depth

$Qu = Q_{Skin} + Q_{Bearing}$

= 347.850 + 353.43 = 701/28

Qs = Qu / FS = 701.28/2.5 = 280.5 tonnes say 280 tonnes

Assuming there will not be resistance upto 16.0 metres [Scour depth]

Total skin friction upto 16.00 metres (allowable) = 41 tonnes

Q safe = 280 – 41 = 250 tonnes for a pile of 1000 mm diameter and 48 metres

7. For a pile of 1000 mm diameter upto 49 metres depth

Qu = Q_{Skin} + $Q_{Bearing}$

= 375.007 + 353.43 = 728.44

Qs = Qu / FS = 728.44/2.5 = 291.38 tonnes say 291 tonnes

Assuming there will not be resistance upto 16.0 metres [Scour depth]

Total skin friction upto 16.00 metres (allowable) = 41 tonnes

Q safe = 291 – 41 = 250 tonnes for a pile of 1000 mm diameter and 49 metres

8. For a pile of 1000 mm diameter upto 50 metres depth

Qu = Q_{Skin} + $Q_{Bearing}$

= 402.258 + 353.43 = 755.688

Qs = Qu / FS = 755.688/2.5 = 302.275 tonnes say 302 tonnes

Assuming there will not be resistance upto 16.0 metres [Scour depth]

Total skin friction upto 16.00 metres (allowable) = 41 tonnes

Q safe = 302 – 41 = 261 tonnes for a pile of 1000 mm diameter and 50 metres

- **The following load carrying capacity is proposed for different size and length.**

Scour depth = 16.0 metres

Size of the pile	Length of the pile	Safe load carrying capacity in Compression	Safe Lateral Load carrying Capacity
1300mm diameter	33 metres in clay	134 tonnes	20.0 tonnes
	48 m in sand	420 tonnes	
	49 m in sand	434 tonnes	Depth of fixity 14.80 metres
	50 m in sand	448 tonnes	

Allowable skin friction Resistance upto scour depth namely 16.00 metres depth will be 60 tonnes for a pile of 1300 mm diameter

Size of the pile	Length of the pile	Safe load carrying capacity in Compression	Safe Lateral Load carrying Capacity
1000mm diameter	33 metres in clay	98 tonnes	
	48 m in sand	280 tonnes	
	49 m in sand	291 tonnes	
	50 m in sand	302 tonnes	

Allowable skin friction Resistance upto scour depth namely 16.00 metres depth will be 41 tonnes for a pile of 1000 mm diameter

RECOMMENDATIONS: Pier, P09

- **An average silt factor, f = 1.00 is proposed for the bed namely silty clay**
- **Bored cast – in – situ pile foundation with casing is ideal.**
- **1300 mm diameter piles are suggested**
- **Modulus of horizontal subgrade reaction, K1= 3.00 and K = 0.46 is proposed for this soil condition.**
- **Depth of fixity for long piles and fixed at top with pile cap = 14.80 metres**
- **The following load carrying capacity is proposed for different size and length.**

Scour depth = 15.8 metres

Size of the pile	Length of the pile	Safe load carrying capacity in Compression	Safe Lateral Load carrying Capacity
1300mm diameter	33 metres in clay	134tonnes	20.0 tonnes Depth of fixity 14.80 metres
	17.0 m in clay (excluding scour depth length)	81 tonnes	

Allowable skin friction Resistance upto scour depth namely 15.80 metres depth will be 53 tonnes for a pile of 1300 mm diameter

- **The following load carrying capacity is proposed for different size and length.**

Size of the pile	Length of the pile	Safe load carrying capacity in Compression	Safe Lateral Load carrying Capacity
1300mm diameter	33 m in clay [17.0m]	81 tonnes	20.0 tonnes Depth of fixity 14.80 metres
	48 m in sand [32.0m]	367 tonnes	
	49 m in sand [33.0m]	381 tonnes	
	50 m in sand [34.0m]	495 tonnes	
1000mm diameter	33 m in clay [17.0m]	57 tonnes	
	48 m in sand [32.0m]	239 tonnes	
	49 m in sand [33.0m]	250 tonnes	
	50 m in sand [34.0m]	261 tonnes	

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