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CLIENT	**GP HOMES PVT. LTD., CHENNAI**
PROJECT	**PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (STILT+05) AT NO: 218/2A, 2B, MADHANANDHAPURAM VILLAGE, ALANDUR TALUK, CHENNAI**
TITLE	**GEOTECHNICAL INVESTIGATION REPORT**

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For Geo Mines Engineers Pvt Ltd

Director

GEO MINES ENGINEERS (P) LTD., GMEPL Chennai

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CHAPTER-1

INTRODUCTION

1.0 Preamble

GP Homes Pvt. Ltd., Chennai proposed to construct a **Residential Building (Stilt+05) at No: 218/2A, 2B, Madhanandhapuram Village, Alandur Taluk, Chennai.** For the purpose of designing the foundations, the responsibility of carrying out suitable soil investigations was entrusted to **M/s. Geo Mines ENGINEERS Pvt. Ltd., Chennai.**

This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

1.1 Scope of Work

- Sinking Four Standard Soil investigation bore holes of 150mm diameter up to a depth of 19.00m below existing ground level as directed by the engineer-in-charge.
- Conducting Standard Penetration Test (SPT) at regular depth intervals.
- Collection of Split Spoon Samples or Disturbed Soil Samples
- Collection of water samples from each bore hole.
- Conducting relevant laboratory test results.

1.2 Structure of the Report

- Contents
- Introduction
- Investigation Methodology & Test Results
- Figures & Tables
- Sub-Surface Stratification
- Foundation Systems
- Recommendations
- Annexure (Design Computations)

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CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 Field Testing:

2.1 Preamble:

Four standard soil investigation boreholes were put. The equipment used and the methodology adopted to carry out the fieldwork is described below.

2.2 Equipment Used and Method of Drilling:

2.2.1 Equipment Used

The equipment used for performing the drilling operations is a Calyx Rotary Drill Rig with direct mud circulation technique. The drill mud used was made out of Sodium Bentonite.

2.2.2 Methodology of drilling

In the soil strata, the drilling operations have been carried out using special drill bits and cutters coupled with direct mud circulation.

2.3 In-Situ Strength Tests:

2.3.1 Standard Penetration Test:

Standard penetration tests were conducted at the borehole locations, in accordance with IS: 2131. The tests were conducted at every change of strata up to the depth of termination of the borehole as directed by the engineer-in-charge.

2.4. Collection of Samples:

2.4.1 Disturbed Soil Samples

The SPT-samples collected were used as disturbed soil samples. These samples were used for visual and physical identification and for conducting laboratory classification tests as per I.S.1498-1970.

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2.4.2 Ground Water

For conducting suitable chemical tests, the ground water samples were collected from the respective boreholes.

2.5 Summary of Field Work

The locations of the boreholes are shown in site plan given in Fig.2.0. The soil profiles obtained at each location is shown in Figs.2.1 to 2.4.

2.6 Laboratory Testing:

2.6.1 Coarse Grained Samples:

2.6.1.1 Grain size Analysis Tests:

On the coarse-grained soil samples, grain size distribution tests were conducted as per I.S.2720 (Part 4)-1985, to know the gradation characteristics and to classify them. These results are presented in Tables 2.1 to 2.4.

2.6.2 Fine Grained Samples:

2.6.2.1 Index Property – Free Swell Tests:

Atterberg Limits were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally Liquid limits, Plastic limits and Shrinkage Limits tests were conducted as per I.S.2720 (Part-5)-1985 and I.S.2720 (Part 6)-1972. On such type of soil strata were encountered at the investigation locations, such tests were conducted and the test results are presented in Tables 2.1 to 2.4.

2.6.3 Chemical Analysis Tests:

2.6.3.1 Water Samples:

On representative water samples, chemical analysis tests were conducted to estimate pH, Chlorides and Sulphates. These results are presented in Table-2.5.

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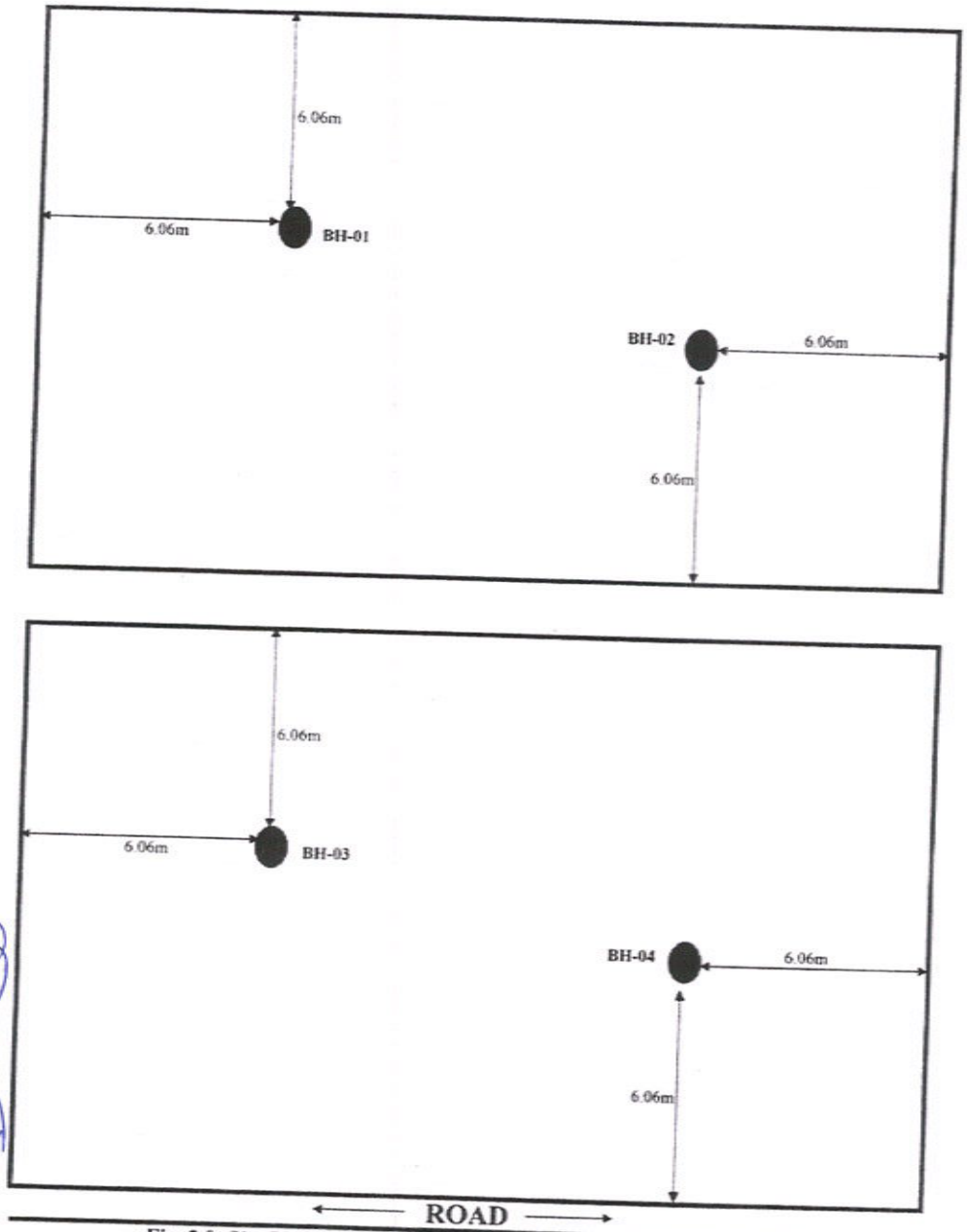


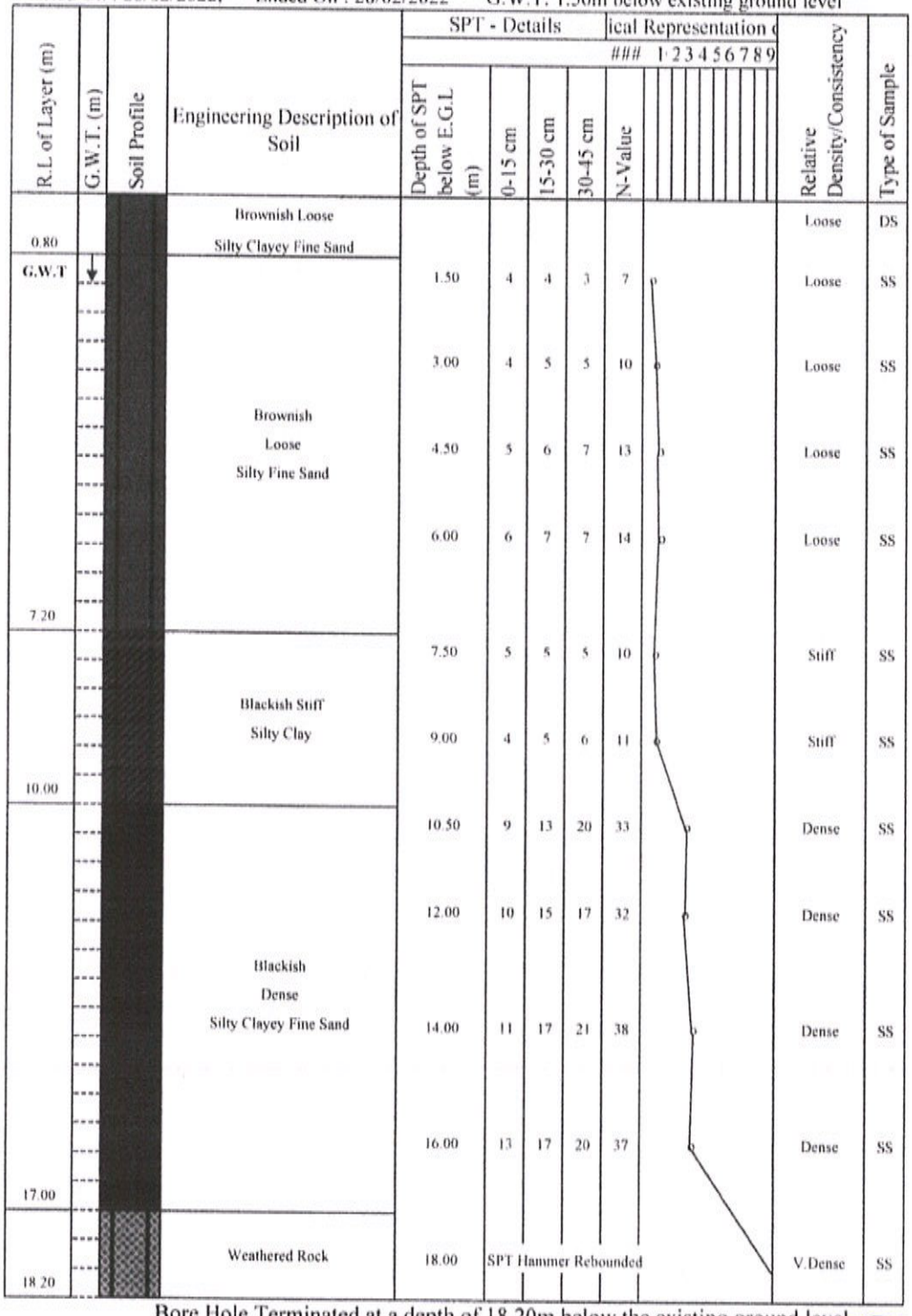
Fig. 2.0: Site Plan Representing the locations of Field Investigation Points

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Project : Proposed Construction of Residential Building (Stilt+05) at No: 218/2A, 2B, Madhanandhapuram Village, Alandur Taluk, Chennai.

Location: BH-01

Started On : 28/02/2022; Ended On : 28/02/2022 G.W.T: 1.50m below existing ground level



Bore Hole Terminated at a depth of 18.20m below the existing ground level

Fig. 2.1 Soil Profile at BH-01 Location

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Project : Proposed Construction of Residential Building (Stilt+05) at No: 218/2A, 2B, Madhanandhapuram Village, Alandur Taluk, Chennai.

Location: BH-02

Started On : 01/03/2022; Ended On : 01/03/2022 G.W.T: 1.50m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details: Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
0.80			Brownish Loose Silty Clayey Fine Sand								
G.W.T				1.50	4	3	4	7		Loose	DS
										Loose	SS
			Brownish Loose Silty Fine Sand	3.00	5	6	6	12		Loose	SS
5.00				4.50	4	5	6	11		Loose	SS
			Brownish Medium Dense Silty Fine Sand	6.00	7	8	10	18		M.Dense	SS
7.20											
			Blackish Medium Stiff Silty Clay	7.50	3	4	4	8		M.Stiff	SS
9.50				9.00	3	4	3	7		M.Stiff	SS
10.20			Blackish Medium Dense Silty Clayey Fine Sand	10.00	9	14	15	29		M.Dense	SS

Bore Hole Terminated at a depth of 10.20m below the existing ground level

Fig. 2.2 Soil Profile at BH-02 Location

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Project : Proposed Construction of Residential Building (Stilt+05) at No: 218/2A, 2B, Madhanandhapuram Village, Alandur Taluk, Chennai.

Location: BH-03

Started On : 01/03/2022; Ended On : 01/03/2022 G.W.T: 1.50m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details: Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
1.00			Brownish Loose Silty Clayey Fine Sand								
G.W.T				1.50	4	4	5	9		Loose	DS
			Brownish Loose Silty Fine Sand	3.00	5	6	6	12		Loose	SS
4.00										Loose	SS
			Brownish Medium Dense Silty Fine Sand	4.50	7	8	9	17		M.Dense	SS
5.50				6.00	4	6	7	13		Loose	SS
			Brownish Loose Silty Fine Sand								
7.20				7.50	3	4	3	7		M.Stiff	SS
			Blackish Medium Stiff Silty Clay	9.00	3	3	4	7		M.Stiff	SS
9.50											
			Blackish Dense Silty Clayey Fine Sand	10.00	11	14	17	31		Dense	SS
10.20											

Bore Hole Terminated at a depth of 10.20m below the existing ground level

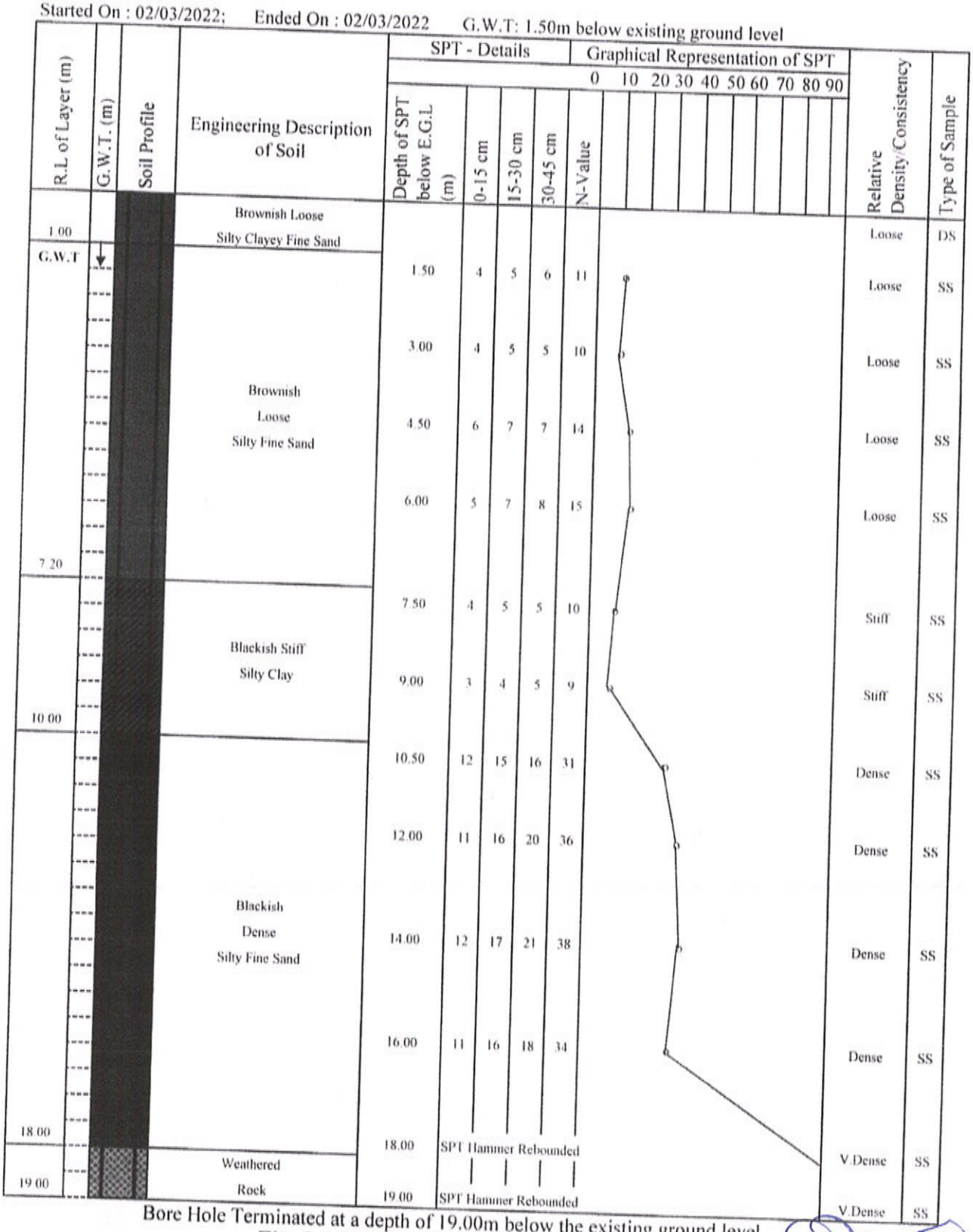
Fig. 2.3 Soil Profile at BH-03 Location

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Project : Proposed Construction of Residential Building (Stilt+05) at No: 218/2A, 2B, Madhanandhapuram Village, Alandur Taluk, Chennai.

Location: BH-04

Started On : 02/03/2022; Ended On : 02/03/2022 G.W.T: 1.50m below existing ground level



Bore Hole Terminated at a depth of 19.00m below the existing ground level

Fig. 2.4 Soil Profile at BH-04 Location

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Table 2.1: Laboratory Test Result on the Soil Sample Collected from BH-01

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Natural Density (g/cc)	Clay					Relative Density/ Consistency	Sieve Analysis						IS-Classification
						LL (%)	PL (%)	PI	I_c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 0.80	-	DS	Silty Clayey Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	0	61	13	26	SM
0.80 to 7.20	11	SS	Silty Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	0	73	27	0	SM
7.20 to 10.00	10	SS	Silty Clay	32	1.7	65	25	40	0.83	-	Stiff	0	0	0	0	18	82	CH
10.00 to 17.00	35	SS	Silty Clayey Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	77	9	14	SM
17.00 to 18.20	>100	SS	Weathered Rock	-	2.0	-	-	-	-	-	V.Dense	34	17	21	18	10	0	SDR

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Table 2.2: Laboratory Test Result on the Soil Sample Collected from BH-02

Depth of Sample below E.G.L., (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Natural Density (g/cc)	Clay					Relative Density/ Consistency	Sieve Analysis						IS-Classification
						LL (%)	PL (%)	PI	I_c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 0.80	-	DS	Silty Clayey Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	0	61	16	23	SM
0.80 to 5.00	10	SS	Silty Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	6	73	21	0	SM
5.00 to 7.20	18	SS	Silty Fine Sand	-	1.6	-	-	-	-	-	M.Dense	0	0	0	79	21	0	SM
7.20 to 9.50	7	SS	Silty Clay	38	1.6	67	25	42	0.69	-	M.Stiff	0	0	0	0	17	83	CH
9.50 to 10.20	29	SS	Silty Clayey Fine Sand	-	1.8	-	-	-	-	-	M.Dense	0	0	0	70	14	16	SM

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Table 2.3: Laboratory Test Result on the Soil Sample Collected from BH-03

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Natural Density (g/cc)	Clay					Relative Density/ Consistency	Sieve Analysis						IS-Classification
						LL (%)	PL (%)	PI	I_c	FS		Gravel (%)	Course (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 1.00	-	DS	Silty Clayey Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	0	66	14	20	SM
1.00 to 4.00	10	SS	Silty Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	4	72	24	0	SM
4.00 to 5.50	17	SS	Silty Fine Sand	-	1.6	-	-	-	-	-	M.Dense	0	0	0	77	23	0	SM
5.50 to 7.20	13	SS	Silty Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	0	74	26	0	SM
7.20 to 9.50	7	SS	Silty Clay	36	1.6	68	25	43	0.74	-	M.Stiff	0	0	0	0	17	83	CH
9.50 to 10.20	31	SS	Silty Clayey Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	73	12	15	SM

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Table 2.4: Laboratory Test Result on the Soil Sample Collected from BH-04

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Natural Density (g/cc)	Clay					Relative Density/ Consistency	Sieve Analysis						IS-Classification
						LL (%)	PL (%)	PI	I_c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 1.00	-	DS	Silty Clayey Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	0	70	14	16	SM
1.00 to 7.20	11	SS	Silty Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	0	75	25	0	SM
7.20 to 10.00	10	SS	Silty Clay	29	1.7	58	25	33	0.88	-	Stiff	0	0	0	0	18	82	CH
10.00 to 18.00	35	SS	Silty Clayey Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	75	13	12	SM
18.00 to 19.00	>100	SS	Weathered Rock	-	2.0	-	-	-	-	-	V.Dense	32	21	16	23	8	0	SDR

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Table 2.5: Chemical Analysis Results conducted on Water Samples collected from BH-01 to BH-04

Location	Depth of Sample below E.G.L. (m)	pH	Chlorides (ppm)	Sulphates (ppm)
BH-01	3.00	7.01	319.41	359.33
BH-02	3.00	7.04	310.84	349.69
BH-03	3.00	7.03	314.81	354.16
BH-04	3.00	7.02	318.99	358.86

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CHAPTER-3

SUB-SURFACE STRATIFICATION

3.0 Preamble

The sub surface stratification at borehole locations, with respect to foundation/geotechnical engineering application are derived based on the visual identification, laboratory classification tests and field in-situ strength tests. Further, the strength parameters are estimated based on the in-situ strength test results as per the following correlation.

* **For Coarse Grained Samples, Ref. Fig.1, IS: 6403 to estimate Angle of Shearing Resistance.**
* **For Fine Grained Samples, Ref. Terzaghi & Peck, 1948, to estimate Unconfined Compressive Strength.**

3.1 Sub Surface Stratification:

3.1.1 Soil Profile at BH-01 Location

(At BH-01 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.80m depth)**

Type of Strata	Silty Clayey Fine Sand
Colour	Brownish
Thickness of Layer	0.80m
SPT of the layer	-
Relative Density	Loose
Angle of Shearing Resistance, ϕ	-

* **Layer-2 (from 0.80m to 7.20m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	6.40m
SPT of the layer	11
Relative Density	Loose
Angle of Shearing Resistance, ϕ	30.30^0

* **Layer-3 (from 7.20m to 10.00m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.80m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa

* **Layer-4 (from 10.00m to 17.00m depth)**

Type of Strata — Silty Clayey Fine Sand

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Colour	Blackish
Thickness of Layer	7.00m
SPT of the layer	35
Relative Density	Dense
Angle of Shearing Resistance, ϕ	37.375⁰

* **Layer-5 (from 17.00m to 18.20m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	1.20m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	42.50⁰

Ground Water

Ground water table was encountered at a depth of 1.50m below the existing ground level during the last week of February 2022.

3.1.2 Soil Profile at BH-02 Location

(At BH-02 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 0.80m depth)**

Type of Strata	Silty Clayey Fine Sand
Colour	Brownish
Thickness of Layer	0.80m
SPT of the layer	-
Relative Density	Loose
Angle of Shearing Resistance, ϕ	-

* **Layer-2 (from 0.80m to 5.00m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	4.20m
SPT of the layer	10
Relative Density	Loose
Angle of Shearing Resistance, ϕ	30.00⁰

* **Layer-3 (from 5.00m to 7.20m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	2.20m
SPT of the layer	18
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	32.40⁰

* **Layer-4 (from 7.20m to 9.50m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.30m
SPT of the layer	07
Consistency	Medium Stiff
Un-drained Cohesion, Cu	46.66kPa

* **Layer-5 (from 9.50m to 10.20m depth)**

Type of Strata — Silty Clayey Fine Sand

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Colour	Blackish
Thickness of Layer	0.70m
SPT of the layer	29
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	35.70⁰

Ground Water

Ground water table was encountered at a depth of 1.50m below the existing ground level during the first week of March 2022.

3.1.3 Soil Profile at BH-03 Location
(At BH-03 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 1.00m depth)**

Type of Strata	Silty Clayey Fine Sand
Colour	Brownish
Thickness of Layer	1.00m
SPT of the layer	-
Relative Density	Loose
Angle of Shearing Resistance, ϕ	-

* **Layer-2 (from 1.00m to 4.00m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	3.00m
SPT of the layer	10
Relative Density	Loose
Angle of Shearing Resistance, ϕ	30.00⁰

* **Layer-3 (from 4.00m to 5.50m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	17
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	32.10⁰

* **Layer-4 (from 5.50m to 7.20m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.70m
SPT of the layer	13
Relative Density	Loose
Angle of Shearing Resistance, ϕ	30.90⁰

* **Layer-5 (from 7.20m to 9.50m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.30m
SPT of the layer	07
Consistency	Medium Stiff
Un-drained Cohesion, Cu	46.66kPa

* **Layer-6 (from 9.50m to 10.20m depth)**

Type of Strata	Silty Clayey Fine Sand

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Colour	Blackish
Thickness of Layer	0.70m
SPT of the layer	31
Relative Density	Dense
Angle of Shearing Resistance, ϕ	36.275^0

Ground Water

Ground water table was encountered at a depth of 1.50m below the existing ground level during the first week of March 2022.

3.1.4 Soil Profile at BH-04 Location
(At BH-04 Location, as presented in Site plan)

* **Layer-1 (from E.G.L to 1.00m depth)**

Type of Strata	Silty Clayey Fine Sand
Colour	Brownish
Thickness of Layer	1.00m
SPT of the layer	-
Relative Density	Loose
Angle of Shearing Resistance, ϕ	-

* **Layer-2 (from 1.00m to 7.20m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	6.20m
SPT of the layer	12
Relative Density	Loose
Angle of Shearing Resistance, ϕ	30.60^0

* **Layer-3 (from 7.20m to 10.00m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.80m
SPT of the layer	09
Consistency	Stiff
Un-drained Cohesion, Cu	60.00kPa

* **Layer-4 (from 10.00m to 18.00m depth)**

Type of Strata	Silty Fine Sand
Colour	Blackish
Thickness of Layer	8.00m
SPT of the layer	34
Relative Density	Dense
Angle of Shearing Resistance, ϕ	37.10^0

* **Layer-5 (from 18.00m to 19.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	1.00m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	42.50^0

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Ground Water

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CHAPTER-4

FOUNDATION SYSTEM

4.0 Preamble

The foundation system design is an interface between super structure and the sub soil bearing strata characteristics. A sound foundation system should be safe against bearing strata shear response under the super structure load intensity. Similarly, the stability of the foundation system is governed by the bearing strata deformation response under the super structure load intensity. In addition, as a combined system of super structure and foundation, the overall stability is also governed by the super structure arrangement.

Considering the above aspects of foundation design, the suitable type of foundation system with respect to the sub soil conditions encountered at the borehole locations is presented in the subsequent sections.

4.1 Bearing Strata Characteristics

From field investigations, it can be observed that the sub-soil strata encountered at shallow depths are coarse-grained type and good from both shear strength characteristics and deformation considerations to act as bearing strata for proposed impending loads form structure.

If coarse-grained soil strata encountered at shallow depths are considered as bearing strata, the safe bearing capacity of open foundation system will be a function of least dimension of footing and effective surcharge over the bearing strata.

Further, the refusal soil strata (SPT>50) encountered below a maximum depth of 18.00m from present existing ground level can also be considered as good end bearing strata for proposed impending loads from structure.

Considering the above, suitable foundation systems are presented below.

4.2 Foundation System

4.2.1 Open Foundation System (BH-01)

Considering the shear strength characteristics of coarse-grained soil strata encountered at shallow, open foundation system of ***Strip Raft*** *type located at a design depth of 2.50m below present existing ground level can be adopted.*

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The safe bearing capacity of such type of open foundation system is presented below which can be adopted for foundation design purposes.

Type of Open Foundation System	Depth of Strip Raft below Existing Ground Level (m)	Observed Thickness of Fill (m)	Depth of Strip Raft below Natural Ground Level (m)	Type of Bearing Strata	Safe Bearing Capacity (MT/m^2)	Elastic Settlements <=70mm (mm)
Strip Raft	2.50	0.00	2.50	Silty Fine Sand	10	48

The computations for above are annexed to this report.

4.2.2 Deep Foundation System-19.00m Long Bored Cast-in-Situ Friction cum End Bearing Piles

In case, the safe bearing capacity of open foundation system presented above in Clause 4.2.1 is lower than the impending foundation stresses, deep foundation system consisting of 19.00m long bored cast-in-situ Friction cum End Bearing Piles can also be adopted.

Piles shall be drilled through DMC (direct mud circulation) technique.

For four different diameters, the safe load carrying capacities of 19.00m long bored cast-in-situ Friction cum End Bearing Piles are computed and presented below which can be adopted for foundation design purposes.

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S. No	Type of Installation of Pile	Type of Pile	Length of Pile below Existing Ground Level (m)	Diameter of Pile (mm)	Safe Load Carrying Capacity (MT)	Safe Pull Out Capacity (MT)
1	Bored Cast-in-Situ	Fixed Head Pile	19.00	400	85	65
2				450	100	73
3				500	115	81
4				550	130	89

The computations of safe load carrying capacity for 400mm diameter and 19.00m long bored cast-in-situ Friction cum End Bearing pile are annexed to this report.

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CHAPTER5

CONCLUSIONS & RECOMMENDATIONS

1. Foundation systems presented in Clause 4.2.1 & 4.2.2, Chapter-IV can be adopted for foundation design purposes.
2. Open foundation System of isolated column footing type located at shallow depths over coarse-grained strata can be adopted for foundation design purposes.
3. Care shall be taken so that the ultimate bearing strata are none other than coarse-grained **Loose Silty Fine Sand** type.

Open Foundation Depths

4. Depth of open excavations below present existing ground level shall be 2.50m.
5. Recommended Thickness of CNS Back-Fill @ Site is 0.00m.
6. Depth of Strip Raft below natural ground level will be 2.50m.
7. **It is recommended to connect the grade beams so that the structure can act as a single unit against any differential settlements in between the individual footings.**
8. Special provisions to contain any lateral collapse of soil from the walls excavated foundation pits are required.
9. In case, the ground water table is encountered within the recommended depths of foundation system, the same shall be bailed out continuously to keep the sub-grade well consolidated.

Deep Foundation System

10. *Care shall be taken so that the ultimate end bearing soil strata are none other than recommended "Weathered Rock" type. The same shall be reaffirmed by our Geotechnical Engineer during foundation laying works are under progress.*
11. Suitable pile load tests (as per I.S: 2911, part-IV) shall be performed to confirm the presented safe load carrying capacities **(provisional)**.

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12. Pile cap can be located over 0.30m thick re-compacted existing ground surface.
13. Piles shall be grouped according to the column design load requirements.
14. Safe load carrying capacities of piles shall be limited to their structural capacities.

General

15. As the chlorides and sulphates present in the collected water samples are within the permissible limits, no special steel or cement is recommended to be used for foundation construction purposes.

For Geo Mines Engineers Pvt Ltd

Director

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DESIGN OF OPEN FOUNDATION SYSTEM (Ref. BH-01)

1 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Type of Foundation System:	Strip Raft	
R.L of the top of Borehole (m):	0.00	m
Depth of Foundation below existing ground level (D_f):	2.50	m
Observed Thickness of fill at site:	0.00	m
Effective Depth of Foundation below natural ground level (D_f):	2.50	m
Design Width of Foundation (B):	1.00	m
Thickness of Foundation (T) :	0.25	m

1.2 Soil Data :

Type of Bearing Strata :	Silty Fine Sand	
Design SPT-value of the Bearing Strata :	10	
(considered based upon the density of the strata)		
Type of Shear Failure:	General	
Angle of Shearing Resistance - Limited to a Maximum of:	30.00	Deg.

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	15.00	kN/m^3
Effective Overburden pressure at foundation level (q)	12.50	kPa
Water Table Correction Factor (w')	0.50	

Bearing Capacity Factors:

N_c = N/A

N_q = 18.40

N_γ = 22.40

Shape Factors:

S_c = N/A

S_q = 1.58

S_γ = 0.60

Depth Factors :

D_c = N/A

D_q = 1.00

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$D_\gamma = 1.00$

Inclination Factor:

I_c = N/A

$I_q = 1.00$

$I_\gamma = 1.00$

1.4 Ultimate Bearing Capacity (Qu) :

$Qu = Cu*Nc*Sc*D_C*I_C+q*(Nq-1)*Sq*Dq*Iq + 0.5*B*\gamma*N\gamma*S\gamma*D\gamma*Ig*w'$

$Q_u =$ 413.19 kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50
Qsafe :	165.28 kPa
Recommended Safe Bearing Capacity:	100.00 kPa

1.6 Settlements

Since, the bearing strata are coarse-grained type, the settlements under the allowable safe bearing pressure 100kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 100kPa and average SPT of 10 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 48mm which is within the permissible limits of 70mm for strip rafts as per I.S:1904.

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DESIGN OF PILE FOUNDATION (BH-01)

Refer, IS:2911(Part I/Sec 2)-1979, Reaffirmed 1997

1.0 Type of Installation of Pile — **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile(D):	**400.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**18.000**	m
R.L. of Bot. of Pile	-18.00	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.2.1.1

Layer-II

Type of Strata:	Silty Fine Sand	
Average SPT of the strata,N:	11	
Bulk Density of the strata,γ:	15	kN/m^3
Angle of Shearing Resistance,ϕ:	30.3	Deg.
R.L of top of Strata:	-0.80	m
R.L of bottom of Strata:	-7.20	m
Average Thickness of Strata,I_c:	6.40	m
Effective overburden pressure over the top of strata,σ_{top}:	0.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	32.00	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	16.00	kN/m^2
Coeff. Of Earth Pressure, k:	1.00	
Skin Resistance of the pile,q_s:	75.19	kN

(q_s:σ*k*tanϕ*pi()*d*Ic)

1.2.1.2

Layer-III

Type of Strata:	Silty Clay	
Average SPT of the strata,N:	10	
Bulk Density of the strata,γ:	17	kN/m^3
Undrained Shear Strength,C_u:	66.67	kPa
R.L of top of Strata:	-7.20	m
R.L of bottom of Strata:	-10.00	m
Average Thickness of Strata,I_c:	2.80	m
Effective overburden pressure over the top of strata,σ_{top}:	32.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	51.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	41.80	kN/m^2
Adhesion,α:	0.40	
Skin Resistance of the pile,q_s:	93.83	kN

(q_s:α*Cu*pi()*d*Ic)

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1.2.1.3 **Layer-IV**

Type of Strata:	Silty Clayey Fine Sand	
Average SPT of the strata,N:	35	
Bulk Density of the strata,γ:	19	kN/m^3
Angle of Shearing Resistance,ϕ:	37.375	Deg.
R.L of top of Strata:	-10.00	m
R.L of bottom of Strata:	-17.00	m
Average Thickness of Strata,l_c:	7.00	m
Effective overburden pressure over the top of strata,σ_{top}:	51.60	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	114.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	83.10	kN/m^2
Coeff. Of Earth Pressure, k:	2.00	
Skin Resistance of the pile,q_s:	1116.75	kN
(q_s:σ*k*tanϕ*pi()*d*lc)		

1.2.1.4 **Layer-V**

Type of Strata:	Weathered Rock	
Average SPT of the strata,N:	60	
Bulk Density of the strata,γ:	20	kN/m^3
Angle of Shearing Resistance,ϕ:	42.5	Deg.
R.L of top of Strata:	-17.00	m
R.L of bottom of Strata:	-18.00	m
Average Thickness of Strata,l_c:	1.00	m
Effective overburden pressure over the top of strata,σ_{top}:	114.60	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	124.60	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	119.60	kN/m^2
Coeff. Of Earth Pressure, k:	2.50	
Skin Resistance of the pile,q_s:	344.30	kN
(q_s:σ*k*tanϕ*pi()*d*lc)		

Ultimate Skin Resistance,q_s: 1630.07 kN

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Weathered Rock	
Cross-Sectional Area of pile,Ap:	0.126	m^2
R.L of bottom of pile:	-18.00	
Minimum SPT-value of the Bearing Strata	60	
Angle of Shearing Resistance(ASR)	42.50	Degrees
Bearing Capacity Factor(Nq)	220.00	
Effecitve Over Burden Pressure at the bottom of pile (q)	28.00	kPa
Ultimate End Bearing Resistance (Qp)	**774.1**	**kN**
(Qp=Ap*q*Nq)		

1.3.0 Ultimate Load Carrying Capacity ($Qu=Qs+Q_p$) 2404.2 kN

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Safe Load Carrying Capacity (Qsafe =Qu/2.50) 961.7 kN

However, limit Q_{safe} to the structural capacity of pile: 850.0 kN

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