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CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
'ThalamuthuNatarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

# PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Dr. G. MANOJKUMAR** has enrolled as **Registered Geo-Technical Engineer (RGTE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E., (Soil Mechanics & Foundation Engg.)** and experience in the relevant field for **11years**.

He has been given the Registration No.**GTE/2019/03/012** Renewed on **21.03.2024.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **20.03.2029**.




**(A. MEGANATHAN)**
**Superintendent**

GS_DEC23_CTN_A102_ANNA NAGAR
REPORT DATE: 13.12.2023

GLOBE GEOTECHNIQUES

Er.G.Manoj Kumar B.E(Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

# GLOBE GEOTECHNIQUES

## GEOTECHNICAL INVESTIGATION REPORT

**PROJECT:** Geotechnical investigation for the proposed construction of Stilt+05 Floors RCC Framed Residential Building at AD-74, Plot No.2329, AD Block, Shanthi Colony, 4th Avenue, Anna Nagar, Chennai - 600 040.

**CLIENT:** M/s. Manghalam Properties rep. by its Sole Proprietor, Mr.T.V.Aanand

Soil Investigation carried out and Report prepared by:

GLOBE GEOTECHNIQUES

CMDA REG.NO.GTE/19/03/012

DTCP REG.NO.GTE/TVLR/01/2019

**REPORT NO: GS_DEC23_CTN_A102_ANNA NAGAR**


Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com


13/12/2023


New No.42, Old No.70, Bajanai Koil Street, Choolaimedu, Chennai - 600 094.
Mobile: 9445315710 / 6381663653. E-mail: globegeotechniques@gmail.com

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GLOBE GEOTECHNIQUES

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This Registration is valid upto **20.03.2029**.




21/3/24

**(A. MEGANATHAN)**
**Superintendent**

GJ-DEC23_CTN_A102_ANNA NAGAR
REPORT_DATE: 13.12.2023

13/12/23

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

## INTRODUCTION

This report presents the results of the geotechnical investigations carried out by **GLOBE GEOTECHNIQUES,** for the proposed construction of Stilt+05 Floors RCC Framed Residential Building at AD-74, Plot No.2329, AD Block, Shanthi Colony, 4th Avenue, Anna Nagar, Chennai – 600 040.

This work was authorized by **M/s. Manghalam Properties rep. by its Sole Proprietor, Mr.T.V.Aanand.** This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

One (01) Standard Penetration Testing bore was drilled at the proposed site up to maximum depth of 30.00 m at Borehole location BH-01 below existing ground level as per the request of the client.

The investigation consists of drilling One (01) borehole, soil sampling, field and laboratory testing and preparation of a Geotechnical Report for the proposed construction of Stilt+05 Floors RCC Framed Residential Building at AD-74, Plot No.2329, AD Block, Shanthi Colony, 4th Avenue, Anna Nagar, Chennai – 600 040.

## OBJECTIVE

The objective of soil investigation is to ascertain the nature and characteristics of sub-soil below the ground level at the site and to establish relevant properties for determination of safe bearing capacity of soil.

## SCOPE OF WORK

The scope of this investigation is to: Mobilization of equipment to the site and demobilization of the same on completion of field work. Determine the soil

Er.G.Manoj Kumar B.E (civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

profile at the site by conducting Standard Penetration tests at various depths, with ground water observation.

i) Collection of disturbed samples and undisturbed samples wherever possible.

ii) Laboratory tests for determination of Index and Engineering Properties of soil.

Recommend a suitable foundation system and safe bearing pressure at the founding levels for the proposed construction of Stilt+05 Floors RCC Framed Residential Building at AD-74, Plot No.2329, AD Block, Shanthi Colony, 4th Avenue, Anna Nagar, Chennai – 600 040.

To achieve the above, one (01) bore was drilled at the proposed site up to maximum depth of 30.00 m at Borehole location BH-01. The borehole location was selected by our geotechnical engineer in-charge. Soil samples were collected for visual identification, classification and laboratory testing.

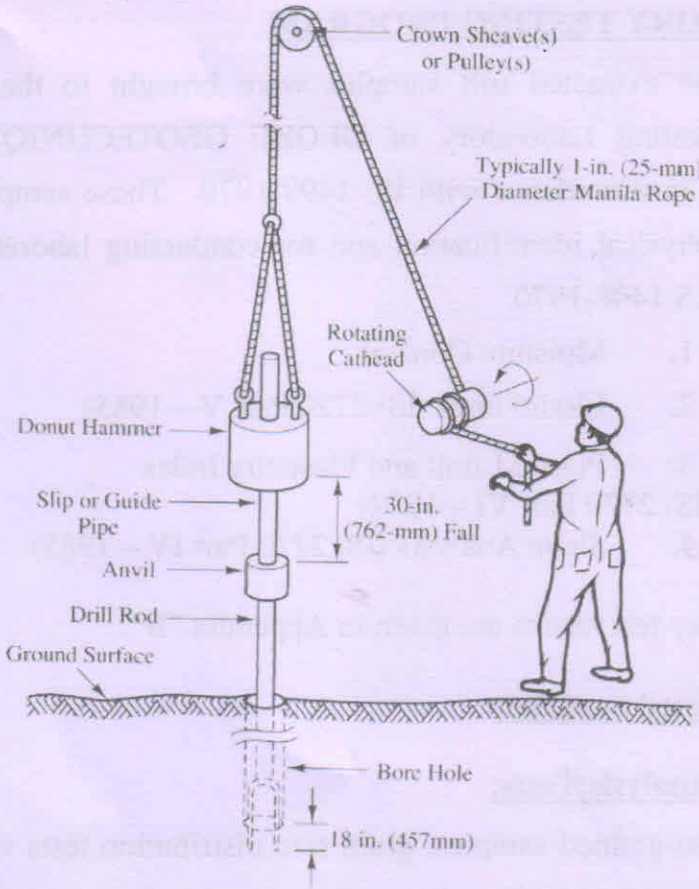
The Borehole log is given in Appendix ~A~ and the laboratory test results is presented in Appendix ~B~.

**INVESTIGATION PROGRAM & TECHNIQUES**

After the visual inspection of the site, the subsurface investigation was started on 01st December 2023 and completed on the same day of 01st December 2023.

One (01) bore was drilled at the proposed site up to maximum depth of 30.00 m at Borehole location BH-01 selected by the geotechnical engineer in-charge. Rotary drilling was performed using water as drilling fluid in the sub soil with casing pipe to stabilize the boreholes up to the required depth. Field testing and sampling were conducted in accordance with IS: 2131-1981.

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech,
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com




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. In this test, a standard split spoon of length about 460 mm and external/internal diameter of 51/35 mm initially penetrates the soil for 15cm to bypass the expected accumulated sludge at the bottom of the hole by means of a **63.5 kg (140 lb) hammer** falling freely along a guide from a height of 760 mm.

The total number of blows (N) required, to advance the spoon into the bore, for another two successive 15cm (a total of 30 cm) is recorded as a measure of the soil relative density or consistency as given in Table # 1.0. The fieldwork was carried out under the close supervision of our engineer in accordance with Indian Standard mentioned earlier.

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

## LABORATORY TESTING PROGRAM

All the extracted soil samples were brought to the Geotechnical & Materials Testing Laboratory of GLOBE GEOTECHNIQUES, for further examination in accordance with IS: 1498-1970. These samples were used for visual and physical identification and for conducting laboratory classification tests as per I.S.1498-1970.

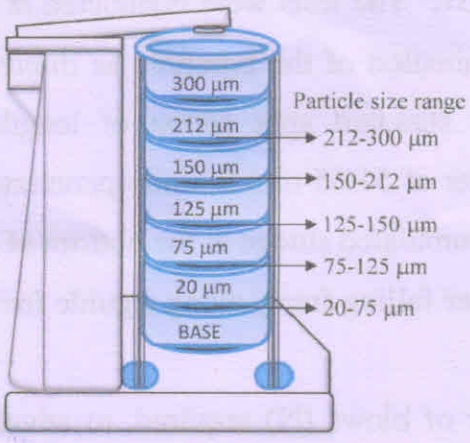
1. Moisture Content
2. Liquid limit (IS: 2720 Part V – 1985)
3. Plastic Limit and Plasticity Index (IS: 2720 Part VI – 1972)
4. Sieve Analysis (IS: 2720 Part IV – 1985)

The laboratory test results are given in Appendix "B".

### Coarse Grained Samples:

### Grain size Analysis Tests:

On the coarse-grained 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.




### Fine Grained Samples:

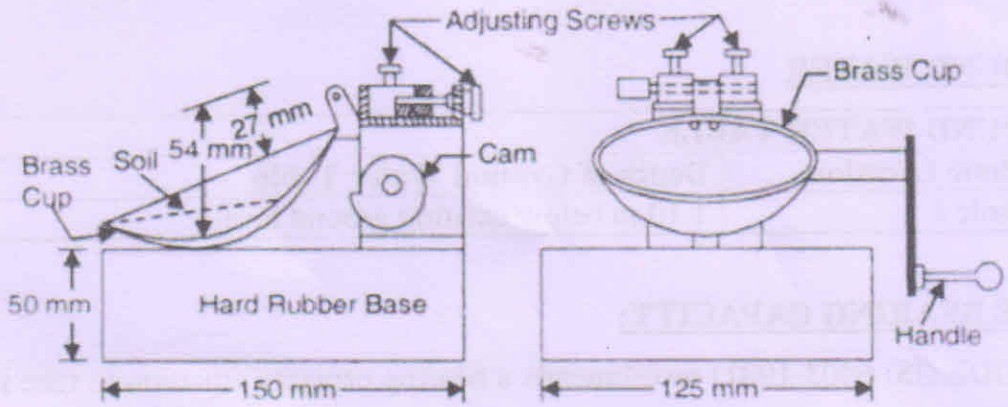
### Index Property – Free Swell Tests:

Atterberg's Limits were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally Liquid limits, Plastic limits and

Er.G.Manoj Kumar B.E (Civil) M.E (Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

Shrinkage Limits tests were conducted as per I.S.2720 (Part-5)-1985 and I.S.2720 (Part 6)-1972. On such type of strata encountered at the investigation locations, such tests were conducted and the test results are presented in tables.






Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech,
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

## SUBSURFACE SOIL DESCRIPTION

Based on the bore-hole information, the existing sub surface soil profile at the captioned site is illustrated below.

| Borehole I | |
|---|---|
| **Layers** | **Description of Soil** |
| 00.00 m - 01.10 m | Filled Up / Made Up Soil |
| 01.10 m – 06.60 m | Greyish Brown Silty Clay |
| 06.60 m – 13.80 m | Blackish Clay |
| 13.80 m – 21.60 m | Greenish Grey Silty Sandy Clay |
| 21.60 m – 29.10 m | Yellowish Brown Silty Sandy Clay with Gravels |
| 29.10 m – 30.00 m | Slate Rock |
| Drilling stopped at 10.50 m below EGL | |

## GROUND WATER

| GROUND WATER TABLE | |
|---|---|
| **Borehole Location** | **Depth of Ground Water Table** |
| Borehole I | 1.10 m below existing ground level |

## SAFE BEARING CAPACITY:

IS CODE (IS: 6403-1981) recommends a bearing capacity equation to take into account, the shape of the footing, inclination of loading, depth of embedment and effect of water table.

**For General shear failure:**

$q_{nf} = cN_c.s_c.d_c.i_c + \sigma (N_q-1)\, s_q.d_q.i_q + 0.5\, B.Y.N_Y.s_Y.d_Y.i_Y W'$

**For Local shear failure:**

$q_{nf} = 2/3\, cN_c'.s_c.d_c.i_c + \sigma (N_q'-1)s_q.d_q.i_q + 0.5\, B.Y.N_Y'.s_Y.d_Y.i_Y W'$

**SHAPE FACTORS (IS: 6403-1981)**

| Shape of base | Shape factors | | |
|---|---|---|---|
| | $s_c$ | $s_q$ | $s_Y$ |
| 1.Continuous strip | 1.0 | 1.0 | 1.0 |
| 2.Rectangle | (1+0.2B/L) | (1+0.2B/L) | (1-0.4B/L) |
| 3.Square | 1.3 | 1.2 | 0.8 |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech,
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

| | | | |
|---|---|---|---|
| 4. Circle | 1.3 | 1.2 | 0.6 |

**PILE LOAD CAPACITY:**

**STATIC FORMULA:**

PILE LOAD CAPACITY = POINT BEARING RESISTANCE + END BEARING RESISTANCE.

**Rock Quality Designation:** RQD is defined as the percentage of intact drill core pieces longer than 10cm recovered during a single core run. The general equation is expressed as shown in below.

RQD: (Σ Rock Pieces ≥10 cm / Core run total Length) x100 %

| RQD (%) | Geotechnical Quality |
|---|---|
| <25 | Very Poor |
| 25-50 | Poor |
| 50-75 | Fair |
| 75-90 | Good |
| 90-100 | Excellent |

**FOUNDATION RECOMMENDATION:**

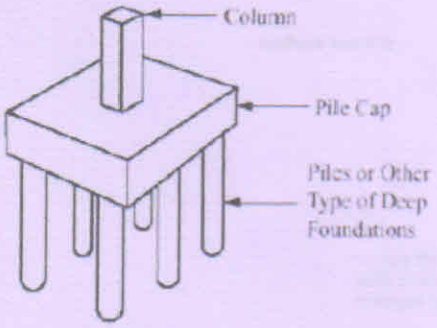
The foundation system design is an interface between super structure and the sub soil bearing strata characteristics. A sound foundation system should be safe against bearing strata shear response under the super structure load intensity. Similarly, the stability of the foundation system is governed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

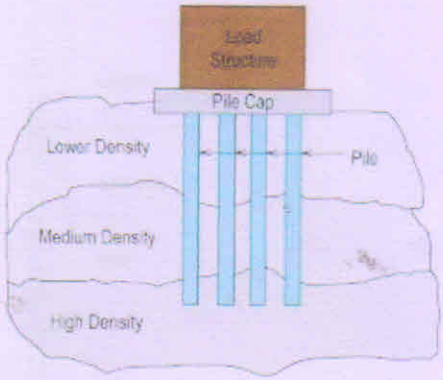
In addition, as a combined system of super structure and foundation, the overall stability is also governed by the super structure arrangement.



Er.G.Manoj Kumar B.E (civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

- Since, the behavior of the pile not only depends upon the soil parameters (theoretical load carrying capacity estimates) but also on the execution skill and care, it is mandatory to construct prototype pile load tests as per the guide lines laid down in IS: 2911-Part IV to confirm the theoretical estimates, before proceeding with the execution work.




Design and construction of bored cast in situ piles are done in accordance with IS 2911 (part-1/Sec-2) – 2010. The work is basically making a borehole of designed diameter at the designated locations to the required depth, after providing temporary or permanent casing and stabilizing with bentonite slurry; and filling the borehole with concrete after placing reinforcement cage.

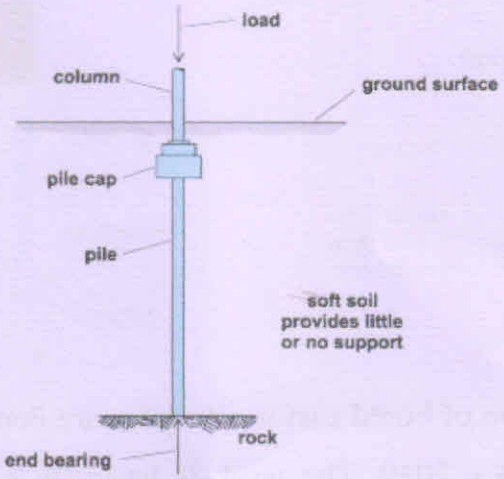
The boreholes are drilled using rotary or percussion type drilling rigs, using direct mud circulation (DMC) or reverse mud circulation (RMC) methods. Drilling can also be done using rope operated or hydraulically operated grabbing tools. Concreting is usually done using tremie pipes.

Direct mud circulation method is the less expensive method for doing the boring activity. In this method bentonite slurry is constantly circulated into the bore hole during the boring activity through the bailer pipes, and overflow is collected and redirected to the bentonite slurry tank. The density of bentonite slurry should be around 1.12. Bentonite has a property of becoming a jelly like substance once left undisturbed for a long time. This jelly acts as plastering on



Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

the walls of the bore holes, and thereby preventing the boreholes from caving. Direct mud circulation method is commonly used while boring with bailer and chisel, and reverse mud circulation is adopted for boring using auger. In reverse mud circulation method, the bentonite is directed into the borehole directly, and the return is collected through the drill pipe.




Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

# APPENDIX A

# BOREHOLE LOG

Client: M/s. Manghalam Properties rep. by its Sole Proprietor, Mr.T.V.Aanand

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project : Geotechnical investigation for the proposed construction of Stilt+05 Floors RCC Framed Residential Building at AD-74, Plot No.2329, AD Block, Shanthi Colony, 4th Avenue, Anna Nagar, Chennai – 600 040.

Location: BH-01

Started On : 01/12/2023; Ended On : 01/12/2023 G.W.T: 1.10 m below existing ground level Final Depth: 30.00 m

| 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 (10 20 30 40 50 60 70 85 100) | Relative Density/Consistency | Type of Sample |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GL. | | | Filled Up / Made Up Soil | | | | | | | | |
| | | | Filled Up / Made Up Soil | | | | | | | | |
| 1.00 | GWT | | Filled Up / Made Up Soil | | | | | | | | |
| 1.10 | | | Filled Up / Made Up Soil | | | | | | | | |
| 2.00 | | | Greyish Brown Silty Clay | 2.00 | 2 | 2 | 3 | 5 | | Firm | DS |
| | | | Greyish Brown Silty Clay | | | | | | | | |
| 3.00 | | | Greyish Brown Silty Clay | 3.00 | 2 | 3 | 3 | 6 | | Firm | DS |
| | | | Greyish Brown Silty Clay | | | | | | | | |
| 4.50 | | | Greyish Brown Silty Clay | 4.50 | 2 | 3 | 3 | 6 | | Firm | DS |
| | | | Greyish Brown Silty Clay | | | | | | | | |
| 6.00 | | | Greyish Brown Silty Clay | 6.00 | 2 | 2 | 3 | 5 | | Firm | DS |
| 6.60 | | | Greyish Brown Silty Clay | | | | | | | | |
| 7.50 | | | Blackish Clay | 7.50 | 2 | 2 | 3 | 5 | | Firm | DS |
| | | | Blackish Clay | | | | | | | | |
| 9.00 | | | Blackish Clay | 9.00 | 3 | 3 | 3 | 6 | | Firm | DS |
| | | | Blackish Clay | | | | | | | | |
| 10.50 | | | Blackish Clay | 10.50 | 2 | 3 | 3 | 6 | | Firm | DS |
| 12.00 | | | Blackish Clay | 12.00 | 2 | 2 | 3 | 5 | | Firm | DS |
| 13.80 | | | Blackish Clay | | | | | | | | |
| 14.00 | | | Greenish Grey Silty Sandy Clay | 14.00 | 2 | 3 | 4 | 7 | | Firm | DS |
| 16.00 | | | Greenish Grey Silty Sandy Clay | 16.00 | 3 | 4 | 5 | 9 | | Stiff | DS |
| 18.00 | | | Greenish Grey Silty Sandy Clay | 18.00 | 4 | 6 | 8 | 14 | | Stiff | DS |
| 20.00 | | | Greenish Grey Silty Sandy Clay | 20.00 | 8 | 11 | 16 | 27 | | Very Stiff | DS |
| 21.60 | | | Greenish Grey Silty Sandy Clay | | | | | | | | |
| 22.00 | | | Yellowish Brown Silty Sandy Clay with Gravels | 22.00 | 15 | 21 | 29 | 50 | | Hard | DS |
| 24.00 | | | Yellowish Brown Silty Sandy Clay with Gravels | 24.00 | 19 | 31 | 43 | 74 | | Hard | DS |
| 26.00 | | | Yellowish Brown Silty Sandy Clay with Gravels | 26.00 | 20 | 27 | 50 / 14 cm | | | Hard | DS |
| 28.00 | | | Yellowish Brown Silty Sandy Clay with Gravels | 28.00 | 39 | 50 / 12 cm Bal | | | | Hard | DS |
| 29.10 | | | Yellowish Brown Silty Sandy Clay with Gravels | | | | | | | | |
| 30.00 | | | Slate Rock | 30.00 | 50 / 41 cm Balance | | | | | Hard | DS |

**Fig. 2.1 Soil Profile at BH-01 Location**

BORE HOLE IS TERMINATED AT THE DEPTH OF 30.00 m FROM EXISTING GROUND LEVEL

Er.G.Manoj Kumar B.E.(Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

# APPENDIX B

# LABORATORY TEST RESULTS

**TABLE – 1**

**Correlations of SPT N values with Common properties of soils**

**A) Granular Soil**

| S.NO. | Standard Penetration No., SPT N | Description | Relative Density, Dr % | Approx. Angle of Internal Friction, Φ° | Approx. Rang of Most. Unit Wt.,ɣ kN/m3 |
|---|---|---|---|---|---|
| 1 | < 4 | Very Loose | < 20 | < 29 | 11 to 16 |
| 2 | 04 to 10 | Loose | 20 to 40 | 29 to 30 | 14 to 18 |
| 3 | 10 to 30 | Medium | 40 to 60 | 30 to 36 | 17 to 20 |
| 4 | 30 to 50 | Dense | 60 to 80 | 36 to 41 | 17 to 22 |
| 5 | > 50 | Very Dense | > 80 | > 41 | 20 to 29 |

**B) Cohesive Soil**

| S.NO. | Standard Penetration No., SPT N | Description | Unconfined Compressive Strength($q_u$), kPa | Cohesive Stength (c), kPa | Approx. Rang of Most. Unit Wt.,ɣ kN/m3 |
|---|---|---|---|---|---|
| 1 | < 02 | Very Soft | 0 to 25 | 0 to 12.50 | 14.40 to 16.00 |
| 2 | 02 to 04 | Soft | 25 to 50 | 12.50 to 25 | 16.00 to 17.74 |
| 3 | 04 to 08 | Firm | 50 to 100 | 25 to 50 | 17.60 to 19.20 |
| 4 | 08 to 15 | Stiff | 100 to 200 | 50 to 100 | 19.20 to 20.80 |
| 5 | 15 to 30 | Very Stiff | 200 to 400 | 100 to 200 | 20.80 to 22.40 |
| 6 | > 30 | Hard | > 400 | > 200 | > 20.00 |

**Note:** These values are most appropriate values in general. However, the soil properties vary between sites to site and hence it shall be used only for guidance

**ABBREVIATION :**

| | |
|---|---|
| $W_N$ | Natural Moisture content (%) |
| $W_L$ | Liquid limit (%) |
| $W_P$ | Plasticity Limit (%) |
| $I_P$ | Plasticity Index (%) |
| F.S.I. | Free Swell Index (%) |
| IS | Indian Standard Classification |
| CL | Low Compressibility Clay of with WL < 35% |
| CI | Intermediate Compressibility Clay of with 35%<WL<50% |
| CH | High Compressibility Clay of with >50% |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

## Table of Laboratory Test Results

Client: M/s. Manghalam Properties rep. by its Sole Proprietor, Mr.T.V.Aanand

Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES

Project : Geotechnical investigation for the proposed construction of Stilt+05 Floors RCC Framed Residential Building at AD-74, Plot No.2329, AD Block, Shanthi Colony, 4th Avenue, Anna Nagar, Chennai – 600 040.

| Bore Hole No | Depth (m) | | Type of Soil | Grain Size Analaysis (Particle Retained in IS Sieve) % | | | | | Atterberg Limits | | | IS Classification | Natural Moisture Content % | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | | 4.75 mm | 2.00 mm | 0.425 mm | 0.075 mm | Fines | LL | PL | PI | | | |
| BH 1 | 0.00 | 1.10 | Filled Up / Made Up Soil | - | - | - | - | - | - | - | - | - | - | |
| | 1.10 | 6.60 | Silty Clay | 0 | 0 | 0.58 | 21.59 | 77.83 | 29.0 | 14.0 | 15.0 | CL | 5.64 | |
| | 6.60 | 13.80 | Clay | 0 | 0 | 0 | 14.32 | 85.68 | 27.0 | 13.0 | 14.0 | CL | 7.32 | |
| | 13.80 | 21.60 | Clay | 0 | 1.98 | 12.57 | 15.69 | 69.76 | 41.0 | 19.0 | 22.0 | CI | 8.14 | |
| | 21.60 | 29.10 | Silty Sandy Clay | 0.26 | 6.37 | 11.15 | 26.58 | 55.64 | 57.0 | 27.0 | 30.0 | CH | 6.79 | |
| | 29.10 | 30.00 | Slate Rock | TCR=0% | | RQD=0% | | Rock Quality = Highly Weathered / Disintegrated Rock | | | | | | |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

# DESIGN OF PILE FOUNDATION (Refer-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): | **450.0** | mm |
| Assumed R.L of E.G.L: | 0.000 | m |
| Length of pile below E.G.L.(l) : | **30.000** | m |
| R.L. of Bot. of Pile | 30.00 | m |

**1.2 Design of Pile for Vertical Compression**

**1.2.1 Computation of Skin Resistance:**

**1.2.1.1** **Layer-I**

| | | |
|---|---|---|
| Type of Strata: | Clay | |
| Average SPT of the strata,N: | 5 | |
| Bulk Density of the strata,$\gamma$: | 16 | $kN/m^3$ |
| Undrained Cohesion, Cu: | 33.3333 | kPa |
| R.L of top of Strata: | 1.10 | m |
| R.L of bottom of Strata: | 6.60 | m |
| Average Thickness of Strata,$I_c$: | 5.50 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 0.00 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 33.00 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 16.50 | $kN/m^2$ |
| Adhesion Factor, $\alpha$: | 0.70 | |
| Skin Resistance of the pile,$q_s$: | 181.43 | kN |

**1.2.1.2** **Layer-II**

| | | |
|---|---|---|
| Type of Strata: | Clay | |
| Average SPT of the strata,N: | 5 | |
| Bulk Density of the strata,$\gamma$: | 16 | $kN/m^3$ |
| Undrained Cohesion, Cu: | 33.3333 | kPa |
| R.L of top of Strata: | 6.60 | m |
| R.L of bottom of Strata: | 13.80 | m |
| Average Thickness of Strata,$I_c$: | 7.20 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 33.00 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 76.20 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 54.60 | $kN/m^2$ |
| Adhesion Factor, $\alpha$: | 0.70 | |
| Skin Resistance of the pile,$q_s$: | 237.50 | kN |

**1.2.1.3** **Layer-III**

| | | |
|---|---|---|
| Type of Strata: | Clay | |
| Average SPT of the strata,N: | 10 | |
| Bulk Density of the strata,$\gamma$: | 16 | $kN/m^3$ |
| Undrained Cohesion, Cu: | 66.6667 | kPa |
| R.L of top of Strata: | 13.80 | m |

Er.G.Manoj Kumar B.E.(Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

| | | |
|---|---|---|
| R.L of bottom of Strata: | 21.60 | m |
| Average Thickness of Strata,$I_c$: | 7.80 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 76.20 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 123.00 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 99.60 | $kN/m^2$ |
| Adhesion Factor, $\alpha$: | 0.70 | |
| Skin Resistance of the pile,$q_s$: | 514.59 | kN |

**1.2.1.4 Layer-IV**

| | | |
|---|---|---|
| Type of Strata: | Clay | |
| Average SPT of the strata,N: | 50 | |
| Bulk Density of the strata,$\gamma$: | 16 | $kN/m^3$ |
| Undrained Cohesion, Cu: | 333.333 | kPa |
| R.L of top of Strata: | 21.60 | m |
| R.L of bottom of Strata: | 29.10 | m |
| Average Thickness of Strata,$I_c$: | 7.50 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 123.00 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 168.00 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 145.50 | $kN/m^2$ |
| Adhesion Factor, $\alpha$: | 0.70 | |
| Skin Resistance of the pile,$q_s$: | 2474.00 | kN |

**1.2.1.5 Layer-V**

| | | |
|---|---|---|
| Type of Strata: | Disintegrated Particles | |
| Average SPT of the strata,N: | 50 | |
| Bulk Density of the strata,$\gamma$: | 15 | $kN/m^3$ |
| Angle of Shearing Resistance,$\phi$: | 41 | Deg. |
| R.L of top of Strata: | 29.10 | m |
| R.L of bottom of Strata: | 30.00 | m |
| Average Thickness of Strata,$I_c$: | 0.90 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 168.00 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 172.50 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 170.25 | $kN/m^2$ |
| Coeff. Of Earth Pressure, k: | 1.00 | |
| Skin Resistance of the pile,$q_s$: | 188.30 | kN |
| ($q_s$:$\sigma$*k*tan$\phi$*pi()*d*Ic) | | |

| | | |
|---|---|---|
| **Ultimate Skin Resistance,$q_s$:** | **3414.4** | **kN** |
| **Safe Allowable Pullout Capacity of Pile, Qa** | **1138.1** | **kN** |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

**1.2.2 Computation of End Bearing Resistance:**

| | | |
|---|---|---|
| Type of Bearing Strata | Disintegrated Particles | |
| Cross-Sectional Area of pile,Ap: | 0.159 | $m^2$ |
| R.L of bottom of pile: | 30.00 | |
| Minimum SPT-value of the Bearing Strata | 50 | |
| Angle of Shearing Resistance(ASR) | 41.00 | Degrees |
| Bearing Capacity Factor(Nq) | 70.00 | |
| Effecitve Over Burden Pressure at the bottom of pile (q) **(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)** | 172.50 | kPa |
| **Ultimate End Bearing Resistance (Qp)** (Qp=Ap*q*Nq) | **1920.4** | **kN** |

**1.3.0** **Ultimate Load Carrying Capacity (Qu=Qp+Qs 5334.8 kN**

**Safe Load Carrying Capacity (Qsafe =Qu/2.5) 2133.9 kN**

**However, limit $Q_{safe}$ to the structural capacity of pile: 1900.0 kN**

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

# DESIGN OF PILE FOUNDATION (Refer-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): | **500.0** | mm |
| Assumed R.L of E.G.L: | 0.000 | m |
| Length of pile below E.G.L.(l) : | **30.000** | m |
| R.L. of Bot. of Pile | 30.00 | m |

**1.2 Design of Pile for Vertical Compression**

**1.2.1 Computation of Skin Resistance:**

**1.2.1.1 Layer-I**

| | | |
|---|---|---|
| Type of Strata: | Clay | |
| Average SPT of the strata,N: | 5 | |
| Bulk Density of the strata,$\gamma$: | 16 | $kN/m^3$ |
| Undrained Cohesion, Cu: | 33.3333 | kPa |
| R.L of top of Strata: | 1.10 | m |
| R.L of bottom of Strata: | 6.60 | m |
| Average Thickness of Strata,$I_c$: | 5.50 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 0.00 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 33.00 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 16.50 | $kN/m^2$ |
| Adhesion Factor, $\alpha$: | 0.70 | |
| Skin Resistance of the pile,$q_s$: | 201.59 | kN |

**1.2.1.2 Layer-II**

| | | |
|---|---|---|
| Type of Strata: | Clay | |
| Average SPT of the strata,N: | 5 | |
| Bulk Density of the strata,$\gamma$: | 16 | $kN/m^3$ |
| Undrained Cohesion, Cu: | 33.3333 | kPa |
| R.L of top of Strata: | 6.60 | m |
| R.L of bottom of Strata: | 13.80 | m |
| Average Thickness of Strata,$I_c$: | 7.20 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 33.00 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 76.20 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 54.60 | $kN/m^2$ |
| Adhesion Factor, $\alpha$: | 0.70 | |
| Skin Resistance of the pile,$q_s$: | 263.89 | kN |

**1.2.1.3 Layer-III**

| | | |
|---|---|---|
| Type of Strata: | Clay | |
| Average SPT of the strata,N: | 10 | |
| Bulk Density of the strata,$\gamma$: | 16 | $kN/m^3$ |
| Undrained Cohesion, Cu: | 66.6667 | kPa |
| R.L of top of Strata: | 13.80 | m |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

R.L of bottom of Strata: 21.60 m
Average Thickness of Strata,$I_c$: 7.80 m
Effective overburden pressure over the top of strata,$\sigma_{top}$: 76.20 kN/m$^2$
Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: 123.00 kN/m$^2$
Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: 99.60 kN/m$^2$
Adhesion Factor, $\alpha$: 0.70
Skin Resistance of the pile,$q_s$: 571.77 kN

1.2.1.4

**Layer-IV**

Type of Strata: Clay
Average SPT of the strata,N: 50
Bulk Density of the strata,$\gamma$: 16 kN/m$^3$
Undrained Cohesion, Cu: 333.333 kPa
R.L of top of Strata: 21.60 m
R.L of bottom of Strata: 29.10 m
Average Thickness of Strata,$I_c$: 7.50 m
Effective overburden pressure over the top of strata,$\sigma_{top}$: 123.00 kN/m$^2$
Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: 168.00 kN/m$^2$
Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: 145.50 kN/m$^2$
Adhesion Factor, $\alpha$: 0.70
Skin Resistance of the pile,$q_s$: 2748.89 kN

1.2.1.5

**Layer-V**

Type of Strata: Disintegrated Particles
Average SPT of the strata,N: 50
Bulk Density of the strata,$\gamma$: 15 kN/m$^3$
Angle of Shearing Resistance,$\phi$: 41 Deg.
R.L of top of Strata: 29.10 m
R.L of bottom of Strata: 30.00 m
Average Thickness of Strata,$I_c$: 0.90 m
Effective overburden pressure over the top of strata,$\sigma_{top}$: 168.00 kN/m$^2$
Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: 172.50 kN/m$^2$
Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: 170.25 kN/m$^2$
Coeff. Of Earth Pressure, k: 1.00
Skin Resistance of the pile,$q_s$: 209.22 kN
($q_s$:$\sigma$*k*tan$\phi$*pi()*d*Ic)

**Ultimate Skin Resistance,$q_s$: 3793.8 kN**
**Safe Allowable Pullout Capacity of Pile, Qa 1264.6 kN**

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

**1.2.2 Computation of End Bearing Resistance:**

| | | |
|---|---|---|
| Type of Bearing Strata | Disintegrated Particles | |
| Cross-Sectional Area of pile,Ap: | 0.196 | $m^2$ |
| R.L of bottom of pile: | 30.00 | |
| Minimum SPT-value of the Bearing Strata | 50 | |
| Angle of Shearing Resistance(ASR) | 41.00 | Degrees |
| Bearing Capacity Factor(Nq) | 70.00 | |
| Effecitve Over Burden Pressure at the bottom of pile (q) **(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)** | 172.50 | kPa |
| **Ultimate End Bearing Resistance (Qp)** (Qp=Ap*q*Nq) | **2370.9** | **kN** |

| | | | |
|---|---|---|---|
| 1.3.0 | **Ultimate Load Carrying Capacity (Qu=Qp+Qs** | **6164.7** | **kN** |
| | **Safe Load Carrying Capacity (Qsafe =Qu/2.5)** | **2465.9** | **kN** |
| | **However, limit $Q_{safe}$ to the structural capacity of pile:** | **2200.0** | **kN** |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

| | | |
|---|---|---|
| R.L of bottom of Strata: | 21.60 | m |
| Average Thickness of Strata,$I_c$: | 7.80 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 76.20 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 123.00 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 99.60 | $kN/m^2$ |
| Adhesion Factor, $\alpha$: | 0.70 | |
| Skin Resistance of the pile,$q_s$: | 686.12 | kN |

**1.2.1.4 Layer-IV**

| | | |
|---|---|---|
| Type of Strata: | Clay | |
| Average SPT of the strata,N: | 50 | |
| Bulk Density of the strata,$\gamma$: | 16 | $kN/m^3$ |
| Undrained Cohesion, Cu: | 333.333 | kPa |
| R.L of top of Strata: | 21.60 | m |
| R.L of bottom of Strata: | 29.10 | m |
| Average Thickness of Strata,$I_c$: | 7.50 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 123.00 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 168.00 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 145.50 | $kN/m^2$ |
| Adhesion Factor, $\alpha$: | 0.70 | |
| Skin Resistance of the pile,$q_s$: | 3298.67 | kN |

**1.2.1.5 Layer-V**

| | | |
|---|---|---|
| Type of Strata: | Disintegrated Particles | |
| Average SPT of the strata,N: | 50 | |
| Bulk Density of the strata,$\gamma$: | 15 | $kN/m^3$ |
| Angle of Shearing Resistance,$\phi$: | 41 | Deg. |
| R.L of top of Strata: | 29.10 | m |
| R.L of bottom of Strata: | 30.00 | m |
| Average Thickness of Strata,$I_c$: | 0.90 | m |
| Effective overburden pressure over the top of strata,$\sigma_{top}$: | 168.00 | $kN/m^2$ |
| Effective overburden pressure over the bottom of strata,$\sigma_{bottom}$: | 172.50 | $kN/m^2$ |
| Effective overburden pressure at the middle of the strata,$\sigma_{middle}$: | 170.25 | $kN/m^2$ |
| Coeff. Of Earth Pressure, k: | 1.00 | |
| Skin Resistance of the pile,$q_s$: | 251.07 | kN |
| ($q_s$:$\sigma$*k*tan$\phi$*pi()*d*Ic) | | |

| | | |
|---|---|---|
| **Ultimate Skin Resistance,$q_s$:** | **4552.5** | **kN** |
| **Safe Allowable Pullout Capacity of Pile, Qa** | **1517.5** | **kN** |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

### 1.2.2 Computation of End Bearing Resistance:

| | | |
|---|---|---|
| Type of Bearing Strata | Disintegrated Particles | |
| Cross-Sectional Area of pile,Ap: | 0.283 | $m^2$ |
| R.L of bottom of pile: | 30.00 | |
| Minimum SPT-value of the Bearing Strata | 50 | |
| Angle of Shearing Resistance(ASR) | 41.00 | Degrees |
| Bearing Capacity Factor(Nq) | 70.00 | |
| Effecitve Over Burden Pressure at the bottom of pile (q) | 172.50 | kPa |
| **(limited to a maximum value produced by a soil layer of thickness equal to 20 times the diameter of pile from the N.G.L.)** | | |
| **Ultimate End Bearing Resistance (Qp)** | **3414.1** | **kN** |
| (Qp=Ap*q*Nq) | | |

| | | | |
|---|---|---|---|
| **1.3.0** | **Ultimate Load Carrying Capacity (Qu=Qp+Qs** | **7966.7** | **kN** |
| | **Safe Load Carrying Capacity (Qsafe =Qu/2.5)** | **3186.7** | **kN** |
| | **However, limit $Q_{safe}$ to the structural capacity of pile:** | **2800.0** | **kN** |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

Client: M/s. Manghalam Properties rep. by its Sole Proprietor, Mr.T.V.Aanand
Soil Investigation carried out and Report prepared by: GLOBE GEOTECHNIQUES
Project : Geotechnical investigation for the proposed construction of Stilt+05 Floors RCC Framed Residential Building at AD-74, Plot No.2329, AD Block, Shanthi Colony, 4th Avenue, Anna Nagar, Chennai – 600 040.
Pile Load Capacity at 30.00 m terminated Length from Ground Level

| BORED CAST IN SITU PILE - LENGTH 30.00 m | | | | | | |
|---|---|---|---|---|---|---|
| **S.NO.** | **PILE DIAMETER, mm** | **ULTIMATE LOAD CARRYING CAPACITY OF PILE (SKIN+END), kN** | **SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END), kN** | **RECOMMENDED SAFE LOAD CARRYING CAPACITY OF PILE (SKIN+END), kN** | **RECOMMENDED SAFE ALLOWABLE PULLOUT CAPACITY OF PILE, kN** | **LATERAL LOAD CARRYING CAPACITY OF PILE ,kN** |
| 1 | 450 mm dia | 5334.85 | 2133.94 | **1900.00** | **1138.13** | **171.00** |
| 2 | 500 mm dia | 6164.70 | 2465.88 | **2200.00** | **1264.59** | **198.00** |
| 3 | 600 mm dia | 7966.66 | 3186.67 | **2800.00** | **1517.51** | **252.00** |

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

# APPENDIX C

# GENERAL COMMENTS

## GENERAL INSTRUCTIONS (FOR SHALLOW FOUNDATIONS)

### STRUCTURAL FILL

It shall be made of compacted coarse gravel material and placed in layers of 50cm thickness with a minimum compaction of 95% of maximum dry density.

### FOUNDATION CONSIDERATIONS

A PCC (Plain Cement Concrete) layer of 10cm thickness is recommended below the foundations.

Any over excavation in the foundation trenches should be re-filled by plain concrete and any disturbed and loose materials found in the foundation trenches should be removed before placement of P.C.C.

### EXCAVATION

Excavation through the overburden soil can be carried out by conventional equipment such as dozers and Poclain Excavators.

### BACKFILLING AND COMPACTION

Backfilling materials shall be granular with durable particles free of deleterious matter, meeting the gradation requirement. It shall not contain stones larger than 80 mm; more than 35% fines passing # 200 sieves and is free of any deleterious foreign matter. Backfilling materials shall be placed in horizontal layers not exceeding 25 cm thickness and each layer shall be compacted to atleast 95% of the maximum dry density. If there is any over excavations in the foundation trenches, which should be refilled with either structural fill or lean concrete and all the loose and disturbed materials, should be cleared from the foundation trenches.

## GENERAL INSTRUCTIONS (FOR DEEP FOUNDATIONS)

Pile foundations shall be designed in such a way that the load from the structure can be transmitted to the sub-surface with adequate factor of safety against shear failure of sub-surface and without causing such settlement (differential or total), which may result in structural damage and/or functional

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

distress under permanent/transient loading. The pile shaft should have adequate structural capacity to withstand all loads (vertical, axial or otherwise) and moments which are to be transmitted to the subsoil and shall be designed according to IS 456.

**MATERIALS AND STRESSES**

**CEMENT:**

The cement used shall be any of the following:

a) 33 Grade ordinary Portland cement conforming to IS 269,

b) 43 Grade ordinary Portland cement conforming to IS 8112,

c) 53 Grade ordinary Portland cement conforming to IS 12269,

d) Rapid hardening Portland cement conforming to IS 8041,

e) Portland slag cement conforming to IS 455,

f) Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part 1),

g) Portland pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2),

h) Hydrophobic cement conforming to IS 8043,

i) Low beat Portland cement conforming to IS 12600,and

j) Sulphate resisting Portland cement conforming to IS 12330.

**STEEL REINFORCEMENT STEEL SHALL BE ANY OF THE FOLLOWING:**

a) Mild steel and medium tensile steel bars conforming to IS 432 (Part 1), b) High strength deformed steel bars conforming to IS 1786, and c) Structural steel conforming to IS 2062.

**CONCRETE:**

Consistency of concrete to be used for driven cast in-situ piles shall be consistent with the method of installation of piles. Concrete shall be so designed or chosen as to have a homogeneous mix having a slump/workability consistent with the method of concreting under the given conditions of pile installation.The average compressive stress under working load should not exceed 25 percent of the specified works cube strength at 28 days calculated on the total cross-sectional area of the pile. Where the casing of the pile is

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

permanent, of adequate thickness and of suitable shape, the allowable compressive stress may be increased.

For the concrete, water and aggregates specifications laid down in IS 456 shall be followed in general. The slump should be 150 to 180 mm at the time of pouring. The minimum grade of concrete to be used for piling shall be M 25. For sub aqueous concrete, the requirements specified in IS 456 shall be followed. The minimum cement content shall be 400 kg/$m^3$. However, with proper mix design and use of proper admixtures the cement content may be reduced but in no case the cement content shall be less than 350 kg/$m^3$.

Piles shall be installed as accurately as possible according to the design and drawings either vertically or to the specified batter. Greater care should be exercised in respect of installation of single piles or piles in two pile groups. As a guide, for vertical piles, an angular deviation of 1.5 percent and for raker piles, a deviation of 4 percent should not be exceeded. Piles should not deviate more than 75 mm or D/6 whichever is less (75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm) from their designed positions at the working level. In the case of single pile under a column the positional deviation should not be more than 50 mm or D/6 whichever is less (100 mm in case of piles having diameter more than 600 mm). Greater tolerance may be prescribed for piles cast over water and for raking piles. For piles to be cut-off at a substantial depth below the working level, the design shall provide for the worst combination of the above tolerances in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by redesign of the pile cap or pile ties, the piles shall be replaced or supplemented by additional piles.

**GENERAL COMMENTS**

The recommendations for foundation design and construction are based on the information obtained from borehole drilled at location. When foundation

Er.G.Manoj Kumar B.E (Civil) M.E.(Geotech)
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/03/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

construction is underway, the recommendations of this report should be checked through field inspection, to validate the information for use during the construction stage. Any variation in underground

Conditions revealed by the borehole should be brought to our attention.

**For GLOBE GEOTECHNIQUES**

**G.MANOJ KUMAR, B.E (CIVIL), M.E (GEO-TECH)**
**Mobile: 9445315710 / 9994712791.**
**E-mail: globegeotechniques@gmail.com**

GLOBE GEOTECHNIQUES

Er.G.Manoj Kumar B.E.(Civil) M.E.(Geotech.,
Registered Geotechnical Consultant
GTE/19/03/012-CMDA & GTE/TVLR/01/2019-DTCP
GLOBE GEOTECHNIQUES
Cell : 9445315710 & 6381663653
Email: globegeotechniques@gmail.com

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3/350/2 Mettukuppam,
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Chennai, India

hello@verified.realestate
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www.verified.realestate