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# SOIL EXPLORATION AND FOUNDATION REPORT

**FOR THE PROPOSED BUILDING**

**AT**

**SURVEY NO. 50 OF BLOCK NO. 72 OF**

**KODAMBAKKAM VILLAGE**

**ASHOK NAGAR IN CHENNAI CITY**

**SITUATED AT 56TH STREET**

**ASHOK NAGAR**

**CHENNAI**

**PROJECT NO. TJE/002538/2022**


T.J.ENGINEERS

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For Anirudh Foundation (P) Ltd.

Director

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## EXPLORATION REPORT

**PROJECT NO. TJE/002538/2022**

**1.INTRODUCTION:**

**M/S ANIRUDH FOUNDATION PRIVATE LIMITED** has proposed to construct a Stilt Floor + Five Floors Building at Survey No. 50 of Block No. 72 of Kodambakkam Village, Ashok Nagar in Chennai City Situated at 56th Street, Ashok Nagar, Chennai-600 083. The soil investigation work was entrusted to T.J. Engineers by the promoter. The location is shown in Fig No.1. The object of the soil exploration work done is to determine the soil properties of the proposed area and to arrive at a most suitable type of foundation system for the proposed structure.

**2.0 SCOPE OF WORK**

The Scope of Work includes the following

**Boreholes**

- Drilling of borehole at the proposed borehole locations as per the direction of the client.
- Collection of disturbed and undisturbed soil samples and carrying out the relevant laboratory test on soils.
- Conducting of standard penetration test (SPT) within the borehole at every 1.00m depth interval or as required.
- Collection of soil sample from bore hole.
- Preparation of geotechnical investigation Report.

**3.0. LOCATION & NUMBER OF BORE HOLES**

For this purpose one bore hole was bored up to maximum depth of 6.00m below existing ground level. The bore hole location is shown in Fig No.1 and bore log details are given

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in Fig No. 2. The bore hole was terminated in the Very Dense Sandy Gravel (Disintegrated Rock) layer.

## 4.0. GEOTECHNICAL INVESTIGATIONS

### 4.1. Filed Investigations of Boreholes

Rotary drilling boring technique was adopted for boring in this area. The Standard penetration tests were conducted at change of layers and at specified intervals, commencing the test at 1.00m below the existing ground level. The relative density of different soil layers obtained from the N-Values are given in the Fig No. 2. Disturbed and un disturbed samples were collected from all the layers for visual observation, classification tests and strength characteristics of the soil layers.

**Standard Penetration Test (SPT)**

Standard Penetration Tests were conducted using a split spoon sampler, as per relevant codal provision (IS: 2131 – 1981). The SPT is generally conducted in sandy and completely weathered rock strata till 45 cm penetration with number of blows recorded for every 15 cm penetration. The number of blows required for first 15 cm in neglected. The blows for last 30 cm penetration or refusal 'N' value of 100 whichever is earlier is taken as the 'N' value. In the clayey strata, when driving of sampling tube is not possible, SPT was conducted to know the consistency of the soil strata and to retrieve the disturbed soil sample. The soil samples obtained in the split spoon sampler are carefully packed in polythene bags for testing in the laboratory. The SPT values obtained at every 1.00m interval are given in the bore logs.

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### 4.2. Grain Size Analysis

Combined sieve and hydrometer analyses were conducted on the various samples collected. The results are given in Table-1. Based on the proportion of the different soil constituents, the soil is classified.

### 4.3. Laboratory Tests for Borehole samples

The following laboratory tests were conducted on collected Soil Samples.

I. Moisture Content as per IS: 2720 (Part 2)

II. Specific Gravity as per IS: 2720 (Part 2)

III. Sieve Analysis as per IS: 2720 (Part 4)

IV. Hydrometer Analysis as per IS: 2720 (Part 4)

V. Liquid Limit as per IS: 2720 (Part 5)

VI. Plastic Limit as per IS: 2720 (Part 5)

VII. Swelling Index as per IS: 2720 (Part 40)

## 5.0. BORE LOG DATA

The Summary of bore hole log data for BH-01is given in Fig-2. Bore hole location is given in Fig.1.

## 6.0. LABORATORY TEST RESULTS

The laboratory test results of boreholes samples are presented in Table-1 and Table-2.

## 7.0. GROUND WATER TABLE

The ground water table was **encountered at the depth of 1.50m** below the existing ground level at the time of soil exploration.

## 8.0. SUB SOIL PROFILE

From the visual identification from field test results, it is concluding that the sub soil is basically made-up of four distinctive layers.

i. Filled Up Soil, 0.00m to 0.50m

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ii. Medium Dense Silty Sand, 0.50m to 2.60m SPT's N= 14-18

iii. Very Dense Silty Sand, 2.60m to 4.30m SPT's N= >100

iv. Very Dense Sandy Gravel, 4.30m to 6.00m SPT's N=>100

The soil profile details are presented in the Bore logs, Presented in Fig. 2.

## 9.0. FOUNDATION ANALYSIS AND DESIGN

From the bore log data at the top from 0.00m to 0.50m Filled Up Soil layer is present. From 0.50m to 2.60m medium dense Silty Sand layer is present. From 2.60m to 4.30m very dense Silty Clayey Sand layer is present. Below 4.30m very dense Sandy Gravel-(Disintegrated Rock) layer is present, this layer is fair to rest pile foundation for heavy loaded structure.

The soil layer up to 4.30m is the critical zone for open foundation system, with in the critical zone Medium Dense to very dense Sandy layer is present. For the propose Stilt Floor + Five Floors structure open foundation of **Isolated Footing** or **Continues Strip Raft Footing or Raft Foundation** can be adopted. The open foundation can be placed at the **minimum depth of 2.00m** below the existing ground level. The open foundation should rest on the **natural undisturbed** Sandy layer.

**For heavy loaded structure**, if the Safe Bearing Capacity (SBC) is not sufficient for the expected loading intensity, it is advisable to provide **deep foundation of pile foundation.** The pile foundation can be terminated at the minimum depth of **6.00m (Including Anchorage Depth)** below the exiting ground level (Ground level at the time of soil investigation). The existing ground level was same as the road level at the time of soil investigation

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## 9.1. COMPUTATION OF THE SAFE BEARING CAPACITY AT 2.00m DEPTH

Based on the standard penetration test value the ultimate bearing capacity (qu) could be calculated from the following formula.

$qu = (\gamma' Df + (\gamma - \gamma') Dw) Nq + 0.4 \gamma' B N\gamma$

The observed N-Value is taken as 18 from Fig. 2.

The corresponding bearing capacity factors are,

$Nq = 23.89$

$N\gamma = 22.61$

Where,

$\gamma$ = Bulk density = 1.50 t/m 3

$\gamma'$ = Submerged density = 0.50 t/m 3

Df = Depth of footing = Considered minimum of 2.00 m.

Dw = Depth of water table = 1.50m

B = Breadth of the footing = Consider minimum of 1.00m.

Substitute all the above values in the formula,

$Qu = (0.50x2.00 + (1.50 - 0.50)1.50)\ 23.89 + 0.4 \times 0.50 \times 1.00 \times 22.61$

$= 59.725 + 4.52$

$= 64.245\ t/m^2$

Safe bearing capacity could be considered with a factor of safety of 2.5

Hence, safe bearing capacity $q_s = 64.245 / 2.50 = 25.698\ t/m^2$. Say $25.00\ t/m^2$.

**Therefore, Safe Bearing Capacity of the soil at the depth of 2.00m is 25.00 $t/m^2$**

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## 9.2. SETTLEMENT ANALYSIS FOR THE INTENSITY OF 25.00 t/m $^2$

### LAYER -1, SILTY SAND/SILTY CLAYEY SAND

The Settlement of the Sand layer can be calculated using the following formula.

$$S_1 = (H/C)\ Log_e\ (\sigma'_0+\Delta\sigma\ /\ \sigma'_0)$$

Where

H = The thickness of the compressible sand layer
= 2.30m

$\sigma'_0$ = The effective over burden pressure at the centre of the layer
= 3.075 t/m$^2$

$\Delta\sigma$ = The stress increases at the centre of the sand layer due to foundation loads (or) pressure
= 1.451 t/m$^2$

C = $1.5q_c / \sigma'_0$

$q_c$ = Static cone resistance
=360 t/m$^2$

C = 1.5x360/3.075
= 175.609

$S_1$ = (2.30 /175.609) x $Log_e$ (3.075 +1.451 /3.075)
= 0.0130 x 0.3859 x $10^{-3}$m
= 5.016mm

**TOTAL SETTLEMENT**

**$S_1$ = 5.016mm < 50mm**

The maximum allowable settlement as per IS: 1904-1986 for R.C.C structure with Isolated footing foundation is 50mm-75mm.**The settlement is within the permissible limit. Hence it is Safe**

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## 9.3. LOAD CARRYING CAPACITY OF THE CONVENTIONAL PILE

Based on the standard penetration test value the ultimate load carrying capacity ($q_u$) could be calculated from the following formula.

**Qu = Qb + Qs**

Qs = Ultimate unit skin friction on an individual layer

= $Ks\ \sigma'_{vo} \tan\delta\ \pi\ D\ L$

Where

Ks = Co-efficient of horizontal soil stress = 0.471

$\sigma'_{vo}$ = average effective overburden pressure = 2.75 $t/m^2$

$\delta$ = angle of wall friction = 32

D = Dia meter of pile = 0.40m

L = Length of individual layer = 1.00m

= 0.471 x 2.75 x 0.624 x 3.14 x 0.40 x 1.00

= 1.015 t

$q_b = Nq\ \sigma'_{vo}\ Ab$

where

Nq = Bearing Capacity Factor =145

$\sigma'_{vo}$ = effective overburden pressure at the toe = 3.00 $t/m^2$

Ab = Cross sectional area at the base

D = Dia of Pile = 0.40m

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$= 145 \times 3.00 \times 3.14 \times 0.40^2 / 4$

$= 54.636$ t

**Qu = Qb + Qs**

$= 54.636 + 1.015 = 55.651$ t

**Q safe** = Qu/F.S $= 55.651/2.5 = 22.260$ t say 22.00 t

The safe load carrying capacity for five different diameter of piles for the **depth of 6.00m** are worked and are given below.

| Dia of Pile | Depth of Pile | Safe Load (Tones) |
|---|---|---|
| 400mm | 6.00m | 22 |
| 450mm | 6.00m | 28 |
| 500mm | 6.00m | 35 |
| 600mm | 6.00m | 50 |
| 750mm | 6.00m | 78 |

The above safe loads are provisional and shall be confirmed by conducting pile load test as per the guide line laid down in IS: 2911 (Part: IV).

For Anirudh Foundation (P) Ltd.

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## 10.0. CONCLUSIONS

1. Soil in the shallow depth is fair to adopt open foundation system for light loaded structure.
2. For light loaded structure open foundation of **Isolated Footing** or **Continues Strip Raft Footing or Raft Foundation** can be adopted.
3. The shallow foundation can be placed at the minimum **depth of 2.00m** below the existing ground level. Existing ground level considered as the ground level at the time of soil investigation. The existing ground level was same as the road level at the time of soil investigation.
4. The **Safe Bearing Capacity** of the soil at the **depth of 2.00m is 25.00 t/m$^2$**
5. The **minimum width** of footing should be maintained as **1.00m** to avoid any punching shear failure and to achieve suggested SBC.
6. The shallow foundation should rest on natural un disturbed Sandy layer.
7. All the foundation should rest on 100 mm thick 1:4:8 concrete mat, over 100mm thick river sand or M Sand layer.
8. Since the soil strata is sandy precaution should be taken in deep excavation for underground sump, Swimming pool and septic tank etc. The soil under footing should not get disturbed, if get disturbed the foundation depth should be taken up to the deep excavation depth. The **foundation should rest on the natural undisturbed strata.**
9. **For heavy loaded structure,** the Safe Bearing Capacity (SBC) at is not sufficient for the expected loading intensity, it is advisable to provide **deep foundation of pile foundation.** The pile foundation can be Bored Cast in situ pile. The pile foundation

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can be terminated at the minimum depth of **6.00m (Including Anchorage Depth)** below existing ground level.

10. The safe load carrying capacity for five different diameter of piles for the **depth of 6.00m** are worked and are given below.

| Dia of Pile | Depth of Pile | Safe Load (Tones) |
|---|---|---|
| 400mm | 6.00m | 22 |
| 450mm | 6.00m | 28 |
| 500mm | 6.00m | 35 |
| 600mm | 6.00m | 50 |
| 750mm | 6.00m | 78 |

The above safe loads are provisional and shall be confirmed by conducting pile load test as per the guide line laid down in IS: 2911 (Part: IV)

11. The pile should be anchored in to the very dense Sandy Gravel (Disintegrated Rock) layer for minimum 1.00m depth to achieve the suggested load carrying capacity.
12. The pile boring can be done with **Percussion** drilling or **Hydraulic Rotary** Drilling with DMC method.
13. Proper precaution should be taken while boring the pile against sliding of bore hole, by maintaining the proper dense bentonite slurry or providing temporary casing or permanent casing and pile concreting should be done as soon as boring is over.
14. The bore hole should be flushed properly before laying concrete. It has to be ensured by comparing the depth of pile bore hole and Tremie Pipe. The depth of Tremie Pipe lowered can be 300mm less than borehole depth. If the gap between bore hole

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bottom and Tremie Pipe bottom is more than 300mm, there is a possibility of slush deposit in the bore hole.

15. For foundation design stress due to any eccentricity and horizontal force should be considered and stability should be checked.
16. It is advisable not to mix deep foundation and shallow foundation in same building. Combined pile and Raft can be adopted.
17. All suggested foundation recommendations and precautions should be adopted while undertaking the design aspects and construction activities.

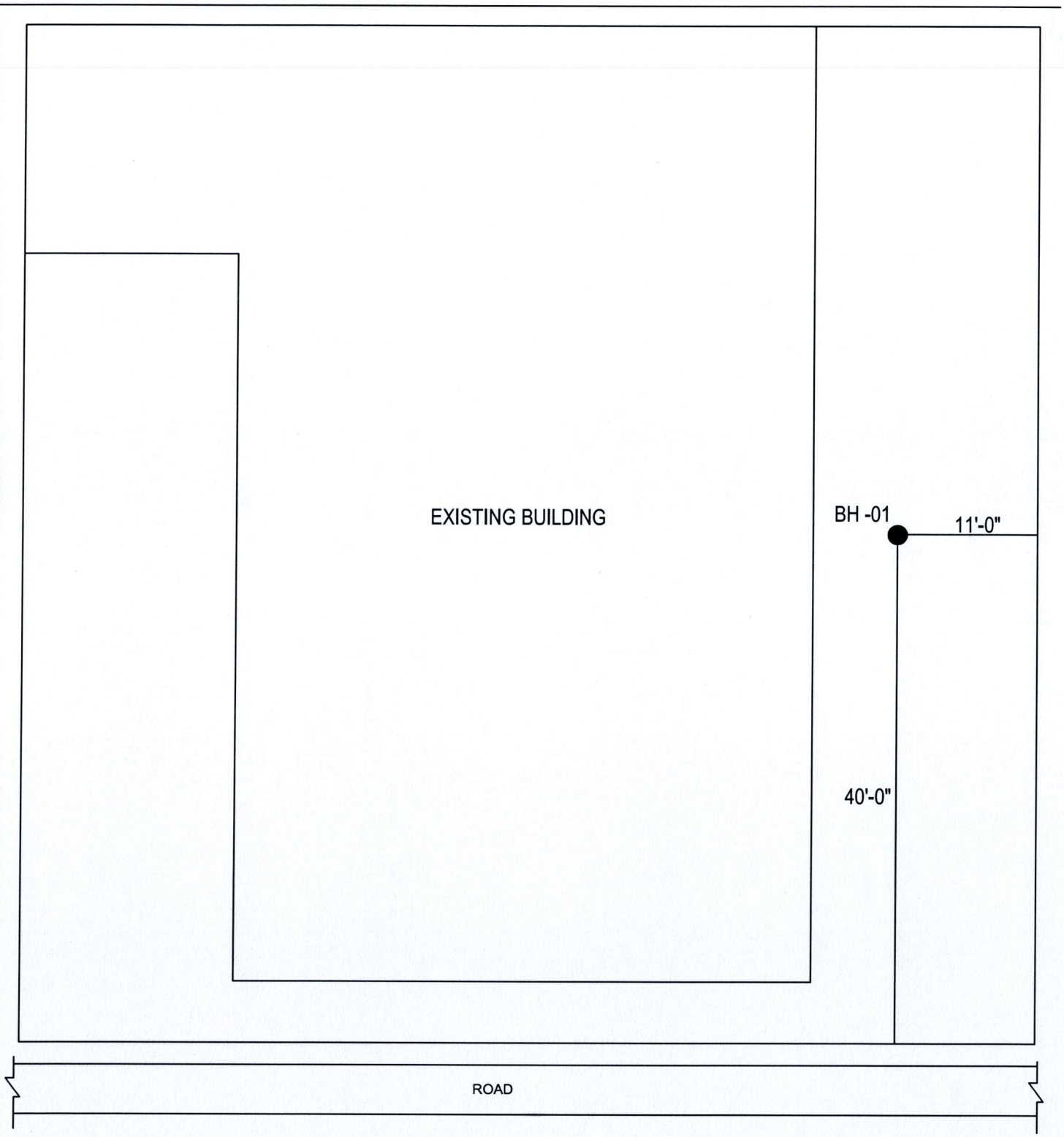
**For T.J. Engineers**

**09- 12 - 2022**

For Anirudh Foundation (P) Ltd.

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NOT TO SCALE

| CLIENT:- | PROJECT:- | | |
|---|---|---|---|
| M/S ANIRUDH FOUNDATION PRIVATE LIMITED CHENNAI. | PROPOSED BUILDING AT SURVEY NO. 50 OF BLOCK NO. 72 OF KODAMBAKKAM VILLAGE, ASHOK NAGAR IN CHENNAI CITY SITUATED AT 56TH STREET, ASHOK NAGAR, CHENNAI-600 083. | SITE PLAN FIG.1 | T.J. ENGINEERS soil investigation and foundation design division |

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# BORE LOG

PROJECT : **Proposed Building at Survey No. 50 of Block No. 72 of Kodambakkam Village, Ashok Nagar in Chennai City Situated at 56th Street, Ashok Nagar, Chennai-600 083.**

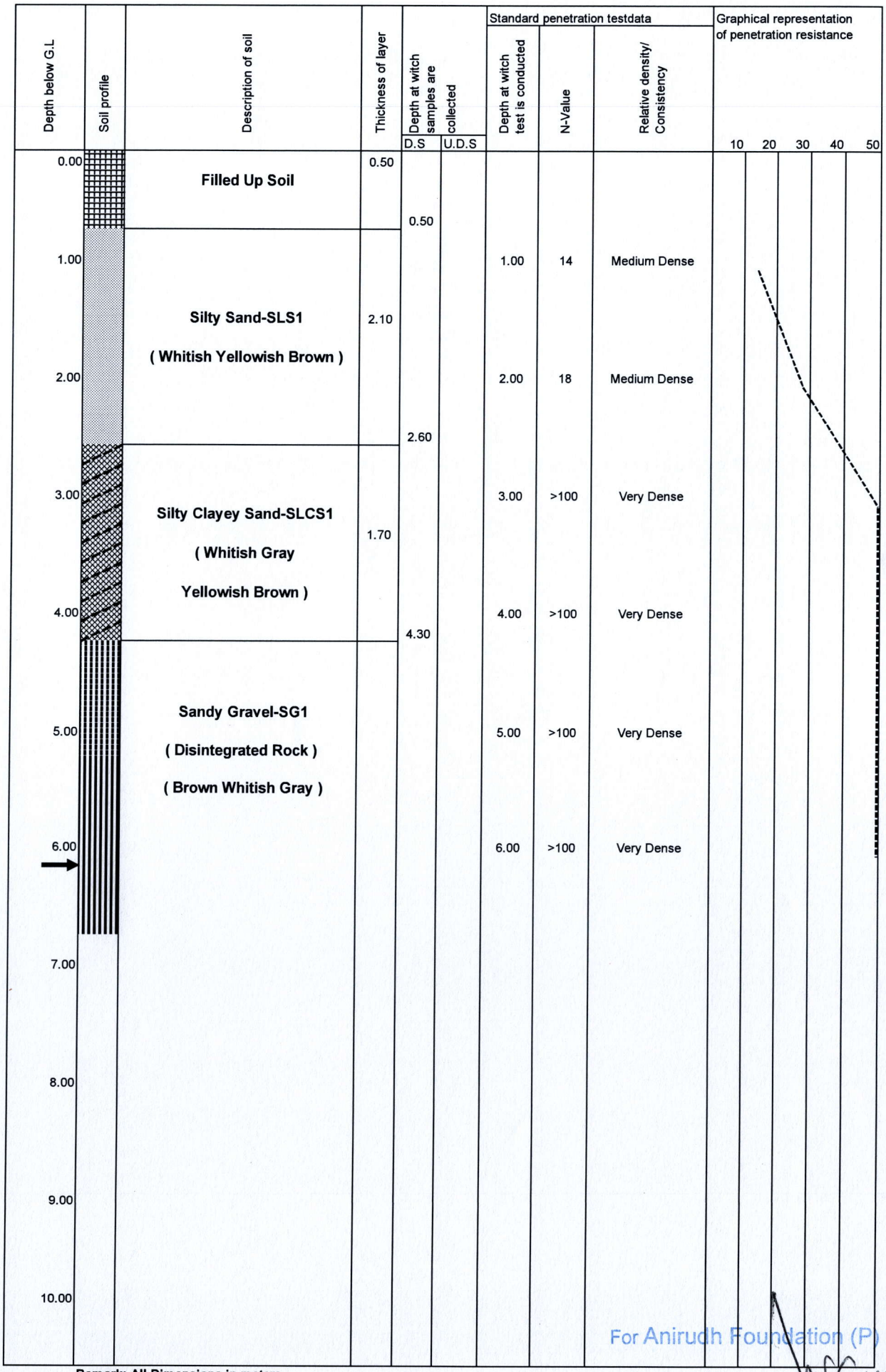
BORE HOLE NO : **B.H:01**

TYPE OF BORING : **Rotary Drilling**

DATE OF COMMENCEMENT: **03 - 12 - 2022**

DATE OF COMPLETION : **04 - 12 - 2022**

G.W.L : **1.50m**




**Remark: All Dimensions in meters**

**End of Boring**

**FIG: 2**

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soil exploration & foundation design division

Project: Proposed Building at Survey No. 50 of Block No. 72 of Kodambakkam Village, Ashok Nagar in Chennai City Situated at 56th Street, Ashok Nagar, Chennai-600 083.

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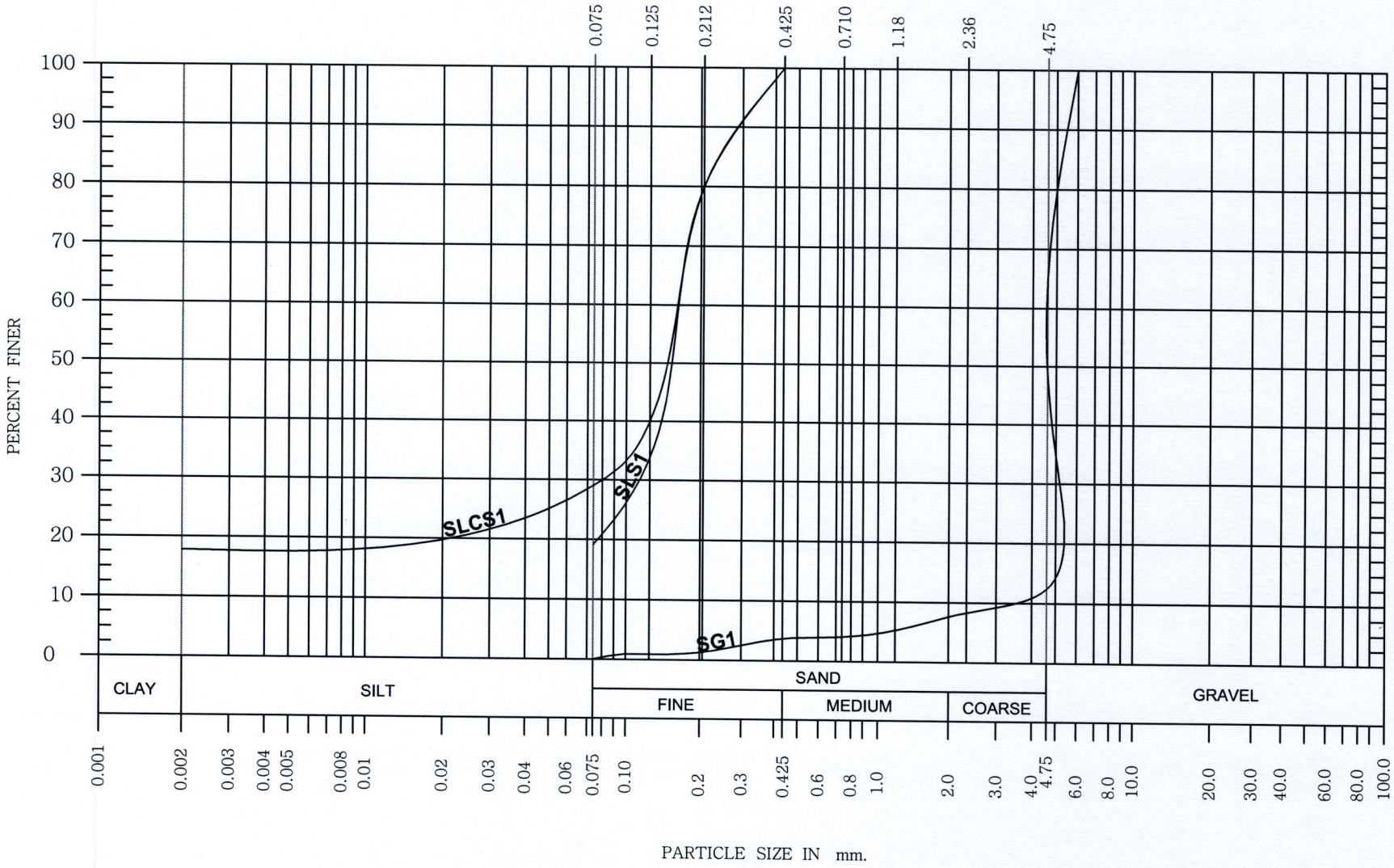



FIG. 3 GRAIN SIZE DISTRIBUTION CURVE-BH-01

# LABORATARY TEST RESULTS

## TABLE-1

| B.H No | Layer thickness | Soil classification | Depth of sample collected | | SP. gravity | %of free swell | Grain size distribution | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DS / SPT | UDS | | | Clay | Silt | Sand | Gravel | |
| | m | | m | m | | % | % | % | % | % | |
| 1 | 0.00 - 0.50 | Filled Up Soil | – | – | – | – | – | – | – | – | – |
| | 0.50 - 2.60 | Silty Sand-SLS1 | 1.00 | – | 2.63 | – | 0 | 18 | 82 | 0 | – |
| | 2.60 - 4.30 | Silty Clayey Sand-SLCS1 | 3.00 | – | 2.64 | – | 17 | 11 | 72 | 0 | – |
| | 4.30 - 6.00 | Sandy Gravel-SG1 | 6.00 | – | 2.63 | – | 0 | 0 | 13 | 87 | – |

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# LABORATARY TEST RESULTS

TABLE -2

| B.H No | Layer thickness | Soil classification | Depth of sample collected | | LL | PL | Bulk density | Consolidation Parameters | | Shear Strength Parmeters | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DS / SPT | UDS | | | | $e_o$ | Cc | Cu | ø | |
| | m | | m | m | % | % | t/m$^3$ | | | t/m$^2$ | degree | |
| 1 | 0.00 - 0.50 | Filled Up Soil | – | – | – | – | – | – | – | – | – | – |
| | 0.50 - 2.60 | Silty Sand-SLS1 | 1.00 | – | – | – | 1.52 | – | – | – | 33 | – |
| | 2.60 - 4.30 | Silty Clayey Sand-SLCS1 | 3.00 | – | – | – | 1.58 | – | – | – | 37 | – |
| | 4.30 - 6.00 | Sandy Gravel-SG1 | 6.00 | – | – | – | 1.61 | – | – | – | 40 | – |

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