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GEOTECHNICAL INVESTIGATION REPORT FOR PROPOSED CONSTRUCTION OF BUILDING

Client	**Radhakrishnan**
Project	**Commercial Space & Residential Apartmenr**
Location	**S.F.No. 604/1B2,603/4 ,Tiruvalam Road, Katpadi-632007, Vellore Dist**
SBC Value	**36.00 t/m^2 @ 3.0m Depth,**
Foundation Depth N Value	**37 @ 3.0m Depth**
Water Level	**NWT**
Borehole Final Depth	**6.30m**
Soil Investigation Date	**23.03.2022**
Report No & Date	**Ref/KPM/GKCEC/13/ST- 25.03.2022**



GKCEC

25/03/2022

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1.INTRODUCTION:

The Geotechnical Investigation Report for the Proposed Construction of Commercial Space and Residential Apartment, S.F.No. 604/1B2,603/4,Tiruvalam Road, Katpadi-632007, Vellore Dist. Tamil Nadu. In connection there with, the Soil sample was collected and Laboratory test by **GK Civil Engineering Consultancy,6/3B, Chinnakuzanthai Street, Arunachalam Nagar, Kanchipuram, Tamil Nadu**, All the laboratory and field tests were conducted as per relevant dian Standard codes.The foundations have to transfer the load to the sub - soil.The surface conditions at any given site must be adequately explored to obtain information required for the designand construction of foundations.The sub soil exploration is done for the following purpose. For Proposed construction of new structures,the purpose of subsoil exploration, 1).The selection of type and depth of foundation, 2).The determination bearing capacity of the selected foundation, 3).The prediction of settlement of the selected foundation,4).The determination of ground water level.5). The evaluation of the earth pressure against walls, basement etc.6).The suitability of soil and degree of compaction of soil.

Insite reconnaissance-Before conducting SPT test at proposed site, the inspection of site and study of topographical features is often helpful in setting useful information about the soil and ground water condition and in deciding the future programme of exploration.

The fieldwork was investigated on **23.03.2022,** This report present results of the geotechnical investigation along with foundation recommendation for proposed building.

1.2.Object of Exploration:

The object of the site exploration is to provide reliable, specific and detailed information about the soil and ground water conditions of the site which may required for a safe and economic design of foundations. For the purpose of proposed construction of building, an exploration of the site likely to be affected, the yield precise information about the following. i) The order of occurrence and extent of soil and rock strata. ii)The nature, engineering properties soil and formation iii) The location of ground water and its variation.

1.3.Scope of Investigation:

The scope of work includes the following:

1. Drilling soil investigation bore hole of 100mm diameter at a depth of 10m from Existing ground level or where the SPT value is >50 at preferably corner along diagonal line or as directed by the engineer-in-charge for proposed construction of site.

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2. Conducting Standard penetration tests (SPT) at various depths.
3. Collection of disturbed soil samples.
4. Collection of undisturbed soil samples where ever possible
5. Laboratory tests for determination Index and Engineering properties,
6. which influence the design and construction of the proposed structure.
7. Computation of safe bearing capacities and allowable bearing based on the field and Laboratory test carried out in the soil stratum encountered for design of foundations structures.
8. Observation of the water table if encountered.

1.4. Site Investigating Report:

A site investigation report is usually the culmination of the Investigation, Exploration and testing programme. The individual reports vary in form, content and presentation, a typical report will normally include the following.

1.Introduction
2. Field and Laboratory test (Methodology)
3. Sub -Surface Stratification
4. Foundation Analysis
5. Recommendations
6. Reference

Annexure

Design Computations
Laboratory Test Results
Bore Logs
Field Test Location

2.FIELD INVESTIGATION (METHODOLOGY) AND LABORATORY TEST

2.1 Field testing:

In the field,The method of Exploration should be Conducted by Standard Penetration Test (SPT), The test procedure should be performed as per IS: 2131-1981(Reaffirmed 2002).This is at the place test (In-situ test) recommended for various type soil. By used this type of test to found out Engineering properties of soil, such as density index of soil, consistency, observed N value overburden pressure, Depth of Exploration and Bearing Capacity of soil.The location of bore hole (Corners along diagonal line) is shown in layout plan. In the field work,Which type of Boring methods and equipments is explained below.

2.2 Boring Methods: The following are the various boring methods commonly used:

i) Auger boring, ii) Auger and shell boring iii) Wash boring iv) Percussion boring and v) **Rotary boring.**

In the proposed site, **PRD Rotary Dril Rig boring are used.** The depth of soil exploration consists of three stages such as boring, collecting sampling and soil testing for field as well as laboratory test. At every 1m depth, the soil samples is collected at a depth of **terminated various depth 6.33m(BH1),6.33(BH2),2.33m(BH3) and4.67m(BH4)**. The collecting samples should be carefully before testing and use the Plastic cover, mention the details of sample and avoid air releasing.The bore log particulars and location of **BH1 – BH4** bore holes are annexed with this report.

2.3 Standard Penetration Test

(At the place bearing test): As per IS: 2131-1981 (Reaffirmed 2002).

1. In This test involves the measurement of the resistance to penetration of a sampling spoon under dynamic loading
2. The resistance is empirically correlated with some of the engineering properties of soil such as density index, consistency, angle of internal friction, bearing capacity etc
3. This test is useful for general exploration of erratic soil profile for finding depth to bed rock or hard stratum and to have an approximate indication of the strength and other properties of soil, particularly the cohesion less soil, from which it is difficult to obtain undisturbed samples.
4. The importance of this test is that, even though empirical, the soil design of foundations in

gravelly sand is mostly based on the N-value. N value serves as the basic parameter for geotechnical design in gravelly sand.

5.In this test, a thick wall standard split spoon sampler, 50.8 mm outer diameter and 35 mm inner diameter, is driven into the undisturbed soil at the bottom of the auger bore hole under the blows of a 63.5 kg drive weight with 75 cm free fall. The minimum open length of the sampler should be 60 cm. the number of blows required to drive the sampler 30 cm beyond the seating drive of 15 cm, is termed as the **Penetration resistance N.**

2.4 Soil Samples and Samplers:

The soil samples can be of two types

(i) Disturbed samples ii) undisturbed samples

A **disturbed sample** is that in which the natural structure of soil gets partly or fully modified and destroyed although with suitable precautions the natural water content may be preserved. Such a soil sample should be representative of the natural soil by maintaining the original proportion of the various particles intact. In our site, the SPT sample collected were used as disturbed soil samples, in this type of sample, can easily visual and physical identification and for conducting laboratory classification tests as per IS:1498 -1970. An **Undisturbed sample** is that in which the natural structure and properties remain preserved.

2.5 Summary of Field work:

i. **BH1-BH4** bore hole at a different terminated depth. noted observed N value and >50nos

ii. Every 1m depth intervals, disturbed soil sample is collected by Standard Penetration test

iii.Each bore location, The soil profiles was shown in the tables attached.

2.6 Laboratory Testing: The operation to be performed in the laboratory depends upon the type of the nature of data required. In case of cohesion less material, like sand, The laboratory tests are usually minimum and the design parameters are worked out from field test data such as SPT-N value,

In case of cohesive soils, the programme of laboratory testing can vary from carrying out simple tests as unconfined tests to comprehensive study of behavior shear tests and consolidation tests.

Following laboratory tests are conducted

For cohesion less soil:

a) Specific gravity b) Sieve Analysis c) Direct shear test

For cohesive soil

a) Specific gravity

b) Natural Moisture Content

c) Atterberg' s Limits

d) Sieve Analysis

For Rock:

a) Core Recovery b) RQD

c) Unconfined compressive strength

2.6.1 Coarse grained samples:

On the coarse grained samples grain size distribution tests were conducted as per IS:2720 (part 4) – 1985, to know the gradation characters and to classify them these results are presented in laboratory test results.

2.6.2 Fine grained Samples:

Consistency index (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 shrinkages limits were conducted as per IS: 2720 (Part- 5) -1985, and IS: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.

3. SUB - SURFACE STRATIFICATION

3.1 Borehole (BH):

In this chapter, the details of soil layer encountered at BH1-BH4 location.The depth of exploration borehole from the ground surface at 1m intervals soil should be collected. The collecting soils are based on visual identification, laboratory testing, and other engineering characteristics derived from SPT- observed N value.Which are having correlation with strength parameters. The bore logs annotate with laboratory test results show a consistent soil profile.

The Borehole investigation indicates that the general sub soil stratum consist of following types of stratum. **Four Bore Hole (BH1-BH4)** was made at the Proposed site. At the Proposed site for Natural soil was start at a depth of 0.3m from the ground level.The Stratigraphy of the soil in BH1-BH4.

Bore Hole	Layers	Depth (m)	Type of soil
BH1	Layer -1	0.3 – 2.30	Clay With Coarse Sandy Soil
	Layer -2	2.30 -6.30m	White Gravelly Soil
	Layer -3	6.30 Below	Soft/Hard Rock
BH2	Layer -1	0.30 – 2.60	Clay With Coarse Sandy Soil
	Layer -2	2.60 – 6.30	Blackey Gravelly Soil
	Layer -3	6.30 - Below	Soft/Hard Rock
BH3	Layer -1	0.0 – 2.30	White Gravelly Soil
	Layer -2	2.30 - Below	Soft/Hard Rock
BH4	Layer -1	0.0 – 4.67	Blackey Gravelly Soil
	Layer -2	4.67 - Below	Soft/Hard Rock

3.2 Water table: Water table was NOT encountered up to depth of 6.30from the existing ground level. The Bore log details are given in the table.(Annexure)



4.FOUNDATION SYSTEM

4.1 Basic design of foundation:

When a structure such has Proposed construction of Building is constructed over the ground. Its load has to be transferred to the under ground soil in such a manner that no occurs to the structure. In fact, the two factors that need to be considered, while designing the foundation of the structures, for distributing the load safely on the soil below the structure.

The load applied to the soil should such that induced stress in the soil is lesser than its capacity, as otherwise, soil will fail by shear. The settlement in the soil should be such that it is within the tolerance limit of the super structure. In particular, differential settlement should not cause any unacceptable damages nor interfere with function of the structure. In addition, combained system of super structure and foundation, the overall stability is also governed by the super structure arrangement. Considering the above aspects foundation design,suitable type of foundation system with respect to the sub soil conditions encountered at the borehole location is presented in the subsequent sections.

4.2 Hard stratum Properties:

Investigation of sub soil in location, it can be observed that the sub- soil strata are uniformly stratified with some variation. Below the ground level near by 1m soil is having swelling characteristics at some location, The proposed construction site adopting shallow foundation proper sand cushion has to the provided to reduce the swelling effect.

4.3 Proposed to type of foundation:

An account of subsoil condition encountered at the investigation location. The foundation details finding the more economical and construction feasibility of foundation system discussed below can be adopted. In that location NOT met water from the ground level. The bearing capacity calculating as per the IS: 6403.1981. Based on the in-situ test (SPT) conducted at site as per IS: 2131 - 1981.The allowable bearing pressure is calculated as per 8009 (part -1)1976 (Reaffirmed 1998). A factor of safety of 3 has been adopted to arrive at safe bearing capacity.

The Calculated allowable bearing pressure for isolated footing, The maximum footing size 3.0**m x 3.0m** at the depth of **3.0m** from the existing ground level for **BH1-BH4**. Since the depth of stratum such as **Gravelly Soil for BH1 –BH4.** So SBC value was taken this stratum such as **3.00m** for account to Calculating the Safe Bearing Capacity of soil, used as per IS.

BH.No	Isolated Footing		Calculated Safe allowable bearing pressure - t/m^2
	Assumed size	Depth (m)	
BH1-BH4	**3.0m x 3.0m**	**3.0m**	**36.00**

Net allowable soil pressure for a permissible settlement of 40mm in (kN/m^2) = q_{nu} and calculating the safe bearing capacity as shown in table above.

The proposed construction of Building, the strength of the soil stratum is **Gravelly Soil for BH1-BH4.Verified in relation between angle of internal friction and SPT value.** So depth of the foundation mentions the above table. So designed purpose, recommended for shallow foundation should be adopted. Based on the above value, The conclusion and recommendation are mention below.

5. CONCLUSIONS & COMMENDATIONS

5.1 Types of Foundation:

i . The recommended safe bearing capacity considering shallow foundation(Isolated footing an assumed foundation size of **3.0m x 3.0m and the depth of foundation 3.0m is (BH1-BH4) is 36.00 t/m^2,** So isolated footing should be suitable for proposed construction of any other Building at site.

5.2 General Recommendations:

Based on the investigations carried out the following recommendations are made

- An isolated square footing may be laid at a minimum depth of 2.5m from the ground level.
- For back filling the foundation trench, the non- swelling soil may be used with proper layer by layer compaction.
- To reduce the swelling effect for design of foundation, mixing the sand and Lime spreading all sides.
- Drainage specialties provide to avoid water logging problem.
- The Basement area must be raised above the ground surface to avoid the rain season problem.

5.3 Limitation: The soil investigations have been carried out at locations in the client so as to represent the entire site. The recommendations provided in this report are hence valid only for these test locations. However, if there is any change in sub soil condition and properties at site between or beyond chosen test locations. Please contact us for further advice.

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6. REFERENCES

Field Investigation Code

1. IS:3043 -1966: Code practice for earthening (third reprint)
2. IS:1498 – 1970 : Classification and Identification of soil general engineering purpose
3. IS:6953 – 1973 : Determination of water levels in a bore hole
4. IS:1892 – 1979 : Code of practice for sub surface investigation for foundation
5. IS:2131 -1981 : Method of Standard Penetration Test for soils(First Revision)
6. IS:1888 - 1982 - Method of load test on soil (Second Revision)
7. IS:2132 - 1986 : Code of practice for Thin Walled Tube Sampling of Soil
8. IS:5313: Guide for Core Drilling Observations.
9. IS:6953 - 1973: Determination of water levels in a bore hole

Laboratory Tests

1.2720 – 1977 (Part40) – Method of tests for soils (Determination of free swell index of soils)
2. 2720 – 1977 (Part41) – Method of tests for soils (Determination of free swelling pressure of soil)
3. 2720 – 1980 (Part 2) – Method of tests for soils (Determination of water content)
4. 2720 – 1980 (Part 3/sec-1) – Method of tests for soils (Determination of specific gravity: Fine grained soils)
5. 2720 – 1980 (Part 3/sec-1) – Method of tests for soils (Determination of specific gravity: Fine and coarse grained soils)
6. 2720 – 1983 (Part 1) – Method of tests for soils (Preparation of dry soil samples for various test)
7. 2720 – 1985 (Part 5) – Method of tests for soils (Determination of liquid and plastic limit)

Foundation design Code

1.IS:8009 (Part -1) 1976 - Code of practice for calculation of settlements of foundation: Shallow foundation subject to symmetrical static vertical loads (Amendment 1)

2.IS:1893 -1984 :Criteria for Earthquake resistant design of structure (Fourth revision)

3.IS:2911 – Design and construction of pile foundations

4.IS:8080 – 1986 - Code of practice for Design and construction of shallow foundations on soils (Other than raft, ring and shell)

5.IS:6403 -1981 : Code of practice for determination bearing capacity of shallow foundations

6. IS:1904 -1986 : Code of practice for Design and construction of foundations in soils

Books

1. Wayne C.Teng, (1992) foundation design,13th reprint, Prentice – Hall of india PVT.Ltd

2. Bowles J.E, (1982) Foundation Analysis and design, 3rd edition, McGraw Hill International book

3.Tomlinson M.J.(1995) Foundation Design and Construction , 6TH Edition, Longman Group.

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(ANNEXTURE)

Safe Bearing Capacity Calculation

7. 0 SAFE BEARING CAPACITY OF SHALLOW FOUNDATION

Safe Bearing Capacity Calculation based on IS : 6403-1981

Design details (BH1-BH4)

Size and depth of the foundation	
Depth of foundation (D)	3.0m
Width of foundation (B)	3.0m
Length of foundation (L)	3.0m
Foundation Shape	Square
Design N Value (3.0m)	N_{obs}= 37
Shear Strength Parameter	
Cohesion (C) kN /m^2	C_u= 0
Angle of internal friction (3.0m)	Ø = 38°
Density of soil (¥) kN/m^3 (3.0m)	20.50
Depth of water table from EGL (D_W)	0
Type of Shear failure	Local

Depth of foundation – 3.00m depth

Based on IS:6403 the Net Safe Bearing Capacity is calculated as follows:

Considering C = 0 and Ø = 38^0 and ¥ =20.50 kN /m^3, Assume local shear failure

$$Ø' = \tan^{-1}(2/3x \tan 38°) = 28°$$

Bearing Capacity Factors:

N'_c and d'_c = 0 , N'_q and d'_q = 13.11, 1.05

$N'_¥$ and $d'_¥$ =11.10, 1.05. i'_q and $i'_¥$ = 1, S'_q and $S'_¥$ =1.2, 0.8

Assuming depth of foundation 3.0m depth

Net ultimate Bearing Capacity (permissible settlement of 40mm) in (kN/ m^2) = q_{nu}

$$q_{nu} = q (N_q -1) S_q d_q i_q + 0.5 B ¥ N_¥ S_¥ d_¥ i_¥ w$$

= 20.50 x 3.0 x (13.11 – 1)1.20 x 1.05 x 1+ 0.5 x 20.50 x3.0 x 11.10 x 0.8 x 1.05 x 1 x 0.5

$$= 1081.75 \text{ kN/ m}^2$$

Net safe bearing capacity q_{ns} = 1081.75/3(FS) = **360.58 kN/m^2 = 36.05t/m^2**

Result:

The Net Safe Bearing capacity value of 3.0m depth = 360.00 kN/m^2 for BH1- BH4 adopted for design of foundations.

Borelog
and
Laboratory Test Results

LAB TEST RESULTS

Soil Investigation done by: GK CIVIL ENGINEERING CONSULTANCY KANCHEEPURAM					Bore Number BH1-BH2			Location: Mention on Site: Plan			Ground Water Level: NIL			Work Commenced on		23.03.2022		
														Work Completed on		23.03.2022		
SOIL PROFILE	DEPTH OF SAMPLING (m)	IS SOIL CLASSIFICATION	NATURAL WET DENSITY (g/cc)	NATURAL MOISTURE CONTENT %	INDEX TEST			SIEVE ANALYSIS			SPECIFIC GRAVITY	SHEAR TEST		STANDARD PENETRATION TEST		ROCK PARAMETERS		
					LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX	GRAVEL	SAND	SILT + CLAY		COHESION, KN/m2	ANGLE OF INTERNAL FRICTION	DEPTH OF TESTING m	OBSERVED N VALUE	CORE RECOVERY	RQD	UCC STRENGTH Mpa
	0.3 -2.30	GW	2.05	9.65	NON-PLASTIC			65	20	15	2.67	-	35	2.00	25	-	-	-
	2.30-6.30		2.05	10.20				85	15	0	2.65	-	38	3.00	37	-	-	-
	below	S.R																

Soil Investigation done by:GKCEC Kancheepuram	PRD ROTARY (SPT) Ground Water Level - NIL								Date of Commencement	23..03.2022
									Date of Completion	23..03.2022
Borehole No:	BH 01-BH2	Thickness of Layer (m)	Type of Testing	Standard Penetration Test Data						
Location	Mention on site Plan			N -Value -Depth of Penetration						
Depth below G.L	Soil Profile / Description of Soil			1 st 15 cm	2nd 15 cm	3rd 15 cm	For Last 30cm/ Observed N' Value	Relative density/ Consistency	Graphical Representation of Penetration resistance (10 20 30 40 50)	
1.5	GRAVELLY SOIL	1	SPT	7	8	8	16	-		
3.0		1	SPT	15	17	20	37	-		
4.5		1	SPT	16	16	21	37	-		
6.0		1	SPT	17	15	22	37			
Below	SOFT ROCK		NON-PLASTIC				50>	-		



LAB TEST RESULTS

Soil Investigation done by: GK CIVIL ENGINEERING CONSULTANCY KANCHEEPURAM					Bore Number BH3-BH4			Location: Mention on Site: Plan			Ground Water Level: NIL			Work Commenced on		23.03.2022		
														Work Completed on		23.03.2022		
SOIL PROFILE	DEPTH OF SAMPLING (m)	IS SOIL CLASSIFICATION	NATURAL WET DENSITY (g/cc)	NATURAL MOISTURE CONTENT %	INDEX TEST			SIEVE ANALYSIS			SPECIFIC GRAVITY	SHEAR TEST		STANDARD PENETRATION TEST		ROCK PARAMETERS		
					LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX	GRAVEL	SAND	SILT + CLAY		COHESION, KN/m2	ANGLE OF INTERNAL FRICTION	DEPTH OF TESTING m	OBSERVED N VALUE	CORE RECOVERY	RQD	UCC STRENGTH Mpa
	0.3 -2.30	GW	2.05	12.50	NON-PLASTIC			75	15	10	2.66	-	37	2.00	38	-	-	
	below	S.R						-					-					



Soil Investigation done by:GKCEC Kancheepuram	PRD ROTARY (SPT)								Date of Commencement	23..03.2022
	Ground Water Level - NIL								Date of Completion	23..03.2022
Borehole No:	BH 03-BH4	Thickness of Layer (m)	Type of Testing	Standard Penetration Test Data						
Location	Mention on site Plan			N -Value -Depth of Penetration						
Depth below G.L	Soil Profile / Description of Soil			1 st 15 cm	2nd 15 cm	3rd 15 cm	For Last 30cm/ Observed N' Value	Relative density/ Consistency	Graphical Representation of Penetration resistance (10 / 20 / 30 / 40 / 50)	
1.5	GRAVELLY SOIL	1	SPT	12	13	13	16	-		
2.50		1	SPT	17	16	21	37	-		
Below	SOFT ROCK						50>	-		



Chemical Analysis of Water Sample

(IS:3025,P.24:R.2009)

Note: water table was not encounted in the bore hole, so water collected near by bore well)

Sl.No	Parameters	Results
1	pH value @ 25° C	7.50
2	Chlorides at Cl (mg/l)	260
3	Sulphateas SO_4 (mg/l)	133

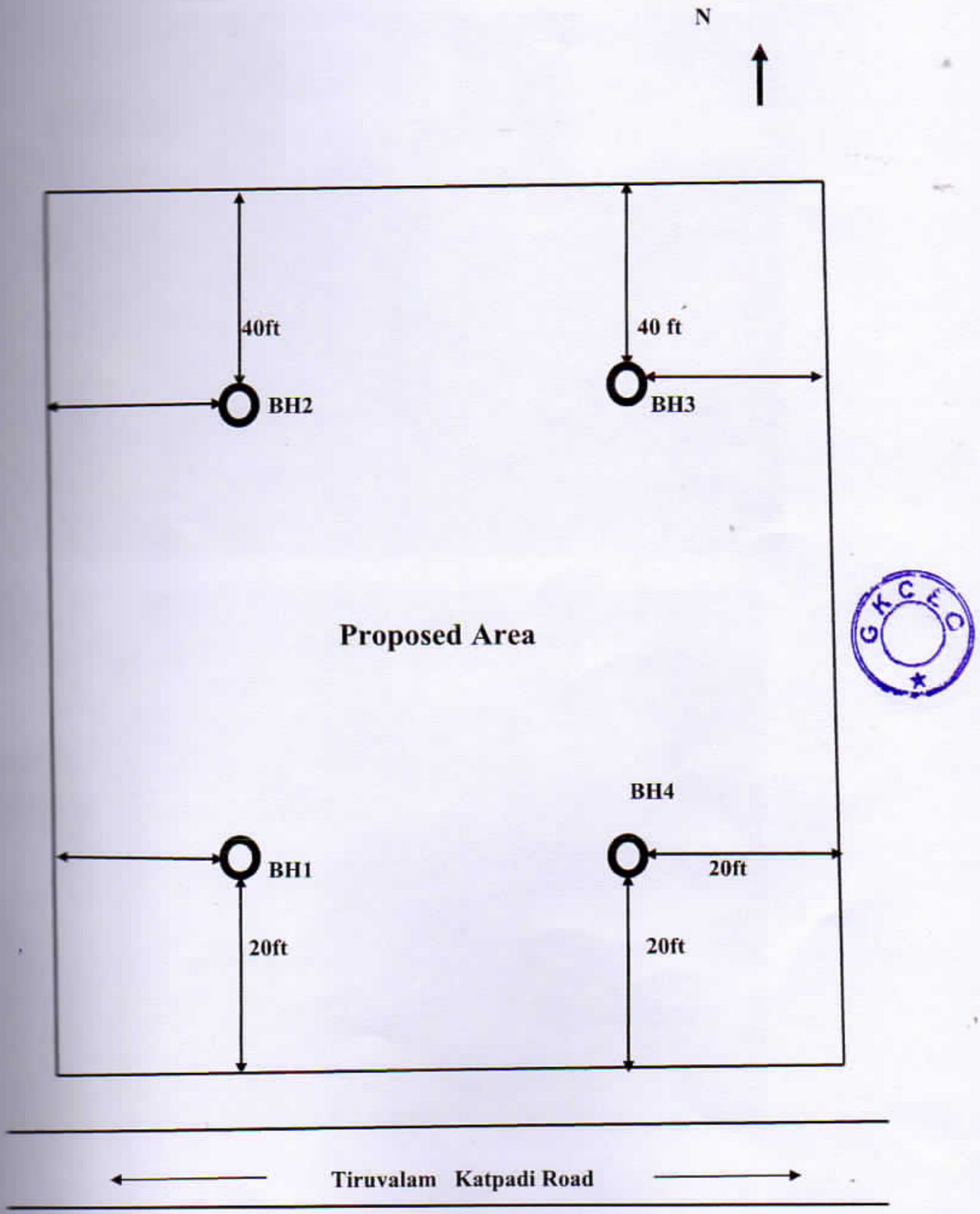
Chemical Analysis of Soil Sample

EPA Method IS 2720, P.26:R.2007)

Sl.No	Parameters	Results
1	pH value @ 25° C	7.45
2	Nitrogen (mg/kg)	112
3	Potassium (mg/kg))	350
4	Phosphorous(mg/kg)	1.75



Location/ Photography


N
40ft
40 ft
BH2
BH3
Proposed Area
BH4
BH1
20ft
20ft
20ft
Tiruvalam Katpadi Road





GKCEC





Bore Hole-BH1,BH2,BH3,BH4

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Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.



empowering your real estate decisions with smart tools

Property Valuation & Cost Estimation

Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

Ownership, Compliance & Legal Verification

Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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